2005 2nd Joint Meeting of the Nuclear Physics Divisions of the APS and The Physical Society of Japan
Maui, Hawaii
http://www.aps.org/meet/HAW05
9:00AM 1WA.00001 QCD and Hadron Physics XIANGDONG JI, —

9:30AM 1WA.00002 Strangeness Production in Electromagnetic Interactions off the Proton . DANIEL S. CARMAN, Ohio University — A program of strange particle production off the proton is currently underway with the CLAS spectrometer in Hall B at Jefferson Laboratory. Measurements have been carried out at energies up to 6 GeV with electron and real photon beams, both of which are available with high polarization. This talk will focus on a detailed overview of the results of our measurement program, which is designed to measure cross sections and polarization observables for $K^+\Lambda$ and $K^+\Sigma^0$ final states over a broad kinematic range in $Q^2$ from 0.5 to 3.5 (GeV/c)$^2$ and $W$ from threshold to 3.0 GeV, while spanning nearly the full angular range of the kaon in the center-of-mass system. The main goals of this program are to better understand the reaction mechanism of open-strangeness production, specifically with respect to the different production mechanisms for $\Lambda$ and $\Sigma$ hyperons. Additionally, these data have strong sensitivity to disentangle the different resonant and non-resonant amplitudes in the intermediate state. These studies are expected to provide insight into the nature of QCD in the confinement domain. The precision of our data has been demonstrated to be highly sensitive to different models of the production process.

10:00AM 1WA.00003 Hypernuclear spectroscopy at JLab . SATOSHI N. NAKAMURA1, Tohoku University — Lambda hypernuclei have been extensively studied by using the meson-induced reactions, such as ($\pi^+, K^+$) and ($K^-, \pi^+$) at KEK and BNL. The (e,$e'K^+$) reaction is a new method for hypernuclear spectroscopy, and it has unique advantages over those meson-induced reactions. For example, the (e,$e'K^+$) reaction excites spin-flip as well as spin-non-flip $\Lambda$ hypernuclear states and produces neutron-rich $\Lambda$ hypernuclei by converting a proton to a $\Lambda$ hyperon. From the experimental point of view, it is a great advantage that a high-quality electron beam available at JLab allows us to improve the energy resolution down to sub-MeV levels. Encouraged by the success of the first hypernuclear spectroscopy through the (e,$e'K^+$) reaction (JLab E89-009), a new improved experiment with a newly developed High resolution Kaon Spectrometer (HKS) and a new configuration of the electron spectrometer is going to start at JLab Hall C (JLab E01-011/E02-017) from June, 2005. Overview of the JLab Hall-C hypernuclear experiments and current analysis status will be presented. If time allows, an upgrade plan of the electron spectrometer will be also explained.

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11:00AM 1WA.00005 Three- and four-body structure of light hypernuclei . EMIKO HIYAMA, Nara Women’s University — Two important goals of hypernuclear physics are to investigate the hyperon-nucleon (YN) and hyperon-hyperon (YY) interactions and (2) to discover novel dynamical nuclear structure effects induced by the hyperon such as $\Lambda$, $\Sigma$, $\Xi$ and so on. At the Jefferson Laboratory and J-PARC, they are planning to produce many single hypernuclei and double $\Lambda$ hypernuclei. Here we discuss about 1) YN spin-orbit force and the structure of $^9\Lambda$Be and $^{13}\Lambda$C, 2) YN spin-spin force and the structure of $^7\Lambda$Li, 3) $\Lambda^\pi\Sigma$ coupling and the structure of $^4\Lambda$He and $^7\Lambda$He, and 4) $\Lambda$- $\Lambda$ interaction and structure of light p-shell double $\Lambda$ hypernuclei. We also emphasize what is interesting and important from the viewpoint of hypernuclear physics.

11:30AM 1WA.00006 Strangeness in Neutron Stars , FRIDOLIN WEBER, San Diego State University — Neutron stars contain cold hadronic matter gravitationally compressed to densities that may be ten to twenty times higher than the density of ordinary nuclear matter. At such extreme conditions, pressures in the cores of neutron stars might be able to break neutrons, protons, and other hadronic constituents in the centers of neutron stars into their quark constituents, creating a new state of matter known as quark matter. If quark matter exists in the cores of neutron stars, it will be a color superconductor whose complex condensation pattern changes with density inside the star. The strange quark plays a crucial role in all of this. It is also a key player for the possible existence of absolutely stable strange quark matter, a configuration of matter even more stable than nuclear matter. In the latter event, neutron stars would be largely composed of superconducting strange quark matter, possibly enclosed in a thin nuclear crust. In this talk I will review the exciting role played by the presence of strangeness in cold hadronic matter at high densities, followed by a discussion of the astrophysical implications of strangeness in neutron stars.

Sunday, September 18, 2005 9:00AM - 12:00PM — Session 1WB DNP JPS: Workshop 2A: Strongly Interacting Matter Probed at RHIC Ritz-Carlton Hotel Salon 3

9:00AM 1WB.00001 A NEARLY PERFECT INK: The strongly coupled quark-gluon plasma at RHIC , BERNDT MUELLER, Duke University — The first three years of operation of the Relativistic Heavy Ion Collider (RHIC) at Brookhaven have taught us that collisions of two gold nuclei produce rapidly equilibrating matter, which flows almost like an ideal fluid, is opaque to hard partons, and shines brightly in baryons. I will discuss the implications of these results in the context of what we know about the properties of hot, strongly interacting matter. I will also outline (some of) the problems which await a theoretical explanation.

9:30AM 1WB.00002 Hadron Spectra and Flow at Intermediate $p_T$ , PAUL SORENSEN, Lawrence Berkeley National Laboratory — Measurements of identified particles from Au+Au collisions at various center-of-mass energies are reviewed. Emphasis is placed on hadron spectra, baryon-to-meson ratios, and elliptic flow at intermediate transverse momentum ($1.5 < p_T < 5$ GeV/c). Possible connections between these measurements and the creation of a deconfined quark-gluon phase are presented.
10:00AM 1WB.00003 Recent Results on Strangeness and Exotics at RHIC, HELEN CAINES, Yale University — I will give a brief overview on strangeness production at RHIC. Yields and spectra of strange hadrons have been measured as a function of centrality in 200 GeV AuAu, dAu, and CuCu collisions as well as in pp events. Thus, system size effects on strange particle production and their kinematics, such as flow and the nuclear modification factors, R(CP), can be studied. The excitation function of these variables in AuAu collisions at 62 and 130 GeV will be discussed together with measurements from the AGS and SPS. In particular the R(CP) at lower energies can test the energy and centrality dependence of partonic energy loss and quark recombination models. Short-lived resonances which may decay and regenerate in the medium are used to examine the medium’s dynamical evolution between particle production and thermal freeze-out. Next-to-leading order (NLO) pQCD calculations show interesting deviations from the measurements of strange baryon and meson spectra in RHIC pp collisions but describe the kinematics of π rather well. By comparing the strangeness data to tuned PYTHIA and new NLO calculations, we can begin to determine the contributions from individual flavors to the fragmentation process in pp. Correlation studies with K^0_s, Λ, and Anti-Λ in pp, dAu, and AA collisions have been made to probe modifications of this fragmentation process by the medium. I also present the latest status on the search for exotica, such as strangelets and penta-quarks, at RHIC.

10:30AM 1WB.00004 Hadron Spectra at Mid and Forward Rapidities, IAN BEARDEN, Niels Bohr Institute — BRAHMS has measured transverse momentum spectra for identified charged hadron in the (pion) rapidity range 0<γ<4 for p+p, d+Au, Cu+Cu, and Au+Au collisions at 200GeV, as well as at 62.4 GeV for the two heavy symmetric systems. Such results give information on both the longitudinal and transverse momentum anisotropy in comparison with the ones observed at lower collision energies. The momentum anisotropy in noncentral collisions is characterized by measurements of double spin asymmetries in collisions of longitudinally polarized hadrons and gluons, which are absorbed by this matter and produced particles tend to move collectively in response to variations of pressure across the volume. Until recently, the rapidity dependence of many of the RHIC results has not been well explained or understood. By combining measurements of strange particle production and their kinematics, we will be able to contribute to the understanding of the spin structure of the proton.

11:00AM 1WB.00005 Probing Strongly Interacting Matter with the Measurement of Flow, HBT, and Spectra over a Wide Rapidity, RACHID NOUICER, Brookhaven National Laboratory (BNL) — Recently a general consensus has developed amongst the four experiments at RHIC and the theoretical community that mid-rapidity measurements of Au+Au central collisions at \( \sqrt{s_{NN}} = 200\text{ GeV} \) point toward the creation of strongly interacting matter with extraordinarily high energy density. Jets formed from high-energy quarks and gluons are absorbed by this matter and produced particles tend to move collectively in response to variations of pressure across the volume. Until recently, however, the rapidity dependence of many of the RHIC results has not been well explained by any models. A systematic array of charged particle, flow, HBT, and spectra results are now available over a broad range of rapidity at RHIC for a variety of collision energies from a variety of systems, including Cu+Cu, Au+Au, and d+Au. Furthermore, hydrodynamic models are becoming more sophisticated. The latest results from RHIC will be presented in this context and the theoretical implications will be explored.

11:30AM 1WB.00006 Hydrodynamic approaches to RHIC physics, TETSUFUMI HIRANO, Columbia University — One of the most intriguing findings in the experiments at Relativistic Heavy Ion Collider (RHIC) in Brookhaven National Laboratory (BNL) is a large magnitude of momentum anisotropy in comparison with the ones observed at lower collision energies. The momentum anisotropy in noncentral collisions is characterized by the second Fourier coefficient \( v_2 \) of the azimuthal distribution for observed particles. The magnitude of \( v_2 \) and its transverse momentum \( p_T \) dependence for identified hadrons are comparable with results from ideal hydrodynamic simulations around midrapidity (\( \mid y \mid < 1 \)), in low transverse momentum region (\( p_T \ll 1 \text{ GeV/c} \)), and up to semicentral collisions (\( b \ll 5 \text{ fm} \)). This is evidence for a recent announcement of the discovery of the perfect fluidity in the strongly coupled/interacting quark gluon plasma (sQGP) as distinct from the weakly coupled/interacting QGP (wQGP) which had been assumed to be created for a long time. Though the ideal hydrodynamic description at RHIC is apparently successful, in this talk I will raise a couple of questions about hydrodynamic behavior of bulk matter produced in relativistic heavy ion collisions. In this talk, I will present current understanding of matter produced at RHIC and discuss open issues in modeling dynamics of relativistic heavy ion collisions based on hydrodynamics.

Sunday, September 18, 2005 9:00AM - 12:00PM - Session 1WC DNP JPS: Workshop 3A: Spin Structure Studies at RHIC, Ritz-Carlton Hotel Salon 2

9:00AM 1WC.00001 Theoretical Overview of Longitudinal Spin Physics, FENG YUAN, RBRC, Brookhaven National Laboratory — Opening the afternoon session of mainly longitudinal spin physics results, my overview will cover the theoretical underpinnings dating from the Spin Crisis of 2000. Recent spin-related concepts, models, and expectations. The global analysis of experimental results – such as to be presented after my talk – provides a largely model-independent and coherent framework to extract the relevant theoretical information and the uncertainties thereof. I will outline the knowns and unknowns (incl. debatables) of the underlying building blocks: Perturbative expansion in terms of twist and coupling (higher orders) as well as statistical and computational tools.

9:30AM 1WC.00002 Longitudinal Spin Asymmetry Measurements at PHENIX, YUJI GOTO, IAI, Brookhaven National Laboratory — Measurements of the gluon helicity distribution (\( \Delta g \)), or the gluon spin contribution to the proton spin, is under way in the PHENIX experiment. \( \Delta g \) is obtained from the double helicity asymmetry (\( A_{LL} \)) for inclusive particle production with longitudinally polarized proton collisions at RHIC. First results for \( A_{LL} \) at PHENIX have been obtained for inclusive neutral pion production at midrapidity and \( \sqrt{s} = 200 \text{ GeV} \). The neutral pion is sensitive to the \( \Delta g \) through a mixture of gluon-quark and gluon-gluon subprocesses. The rare reaction, inclusive direct photon production, is a clean channel dominated by the gluon Compton process. By measuring \( A_{LL} \) of direct photons, \( \Delta g \) can be factored out in leading order. We have obtained the cross section of the direct photon, and will begin measurement of \( A_{LL} \) this year. It is important to also obtain the cross section for these processes, as a basis to describe the measured asymmetries using next-to-leading order perturbative-QCD (NLO pQCD) calculations. The NLO pQCD calculations have shown good agreement with the cross section measurements for both neutral pion and direct photon production. In addition, development for future measurements of heavy-flavor production and weak-boson production is in progress. Heavy-flavor production is dominated by the gluon fusion process and the asymmetry measurement probes \( \Delta g \). Parity-violating weak boson production at \( \sqrt{s} = 500 \text{ GeV} \) will be used to measure flavor-identified quark and anti-quark helicity distributions. By combining measurements of various channels at \( \sqrt{s} = 200 \text{ GeV} \) and 500 GeV with a wide \( \phi \) coverage, we will be able to contribute to the understanding of the spin structure of the proton.

10:00AM 1WC.00003 Longitudinal spin results from STAR, JOANNA KIRYLUK, MIT — One of the main goals of the spin physics program at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory is the precise determination of the spin-dependent gluon distribution function \( \Delta g \) over a wide kinematic range in the momentum fraction \( x_g \) by measurements of double spin asymmetries in collisions of longitudinally polarized protons at \( \sqrt{s} = 200 \text{ GeV} \) and \( \sqrt{s} = 500 \text{ GeV} \). We report on preliminary results for the double longitudinal spin asymmetry \( A_{LL} \), in inclusive jet production at \( \sqrt{s} = 200 \text{ GeV} \) from an integrated luminosity of about 0.5 inverse pb and beam polarizations up to 45%. The jet transverse energies are in the range of \( p_{T} < 20 \text{ GeV} \). An overview of future longitudinal STAR measurements will be presented.
10:30AM 1WC.00004 Study of longitudinal spin structure of nucleon in COMPASS1, TAKAHIRO IWATA, Yamagata University — The nucleon spin structure is studied in COMPASS at CERN by the measurement of the double spin asymmetry of the deep inelastic scattering of a polarized muon at 160 GeV off a polarized deuteron target. Thanks to the COMPASS spectrometer equipped with a RICH, semi-inclusive events are detected as well as the inclusive ones. This allows to access, in particular, the gluon polarization \( (\Delta G/G) \) and flavor decomposition of the quark helicity distributions. The gluon polarization is studied via the photon-gluon fusion process(PGF), whereby a \( q\bar{q} \) pair is produced from a gluon coupled with a virtual photon. Two different selections of the PGF are attempted: ‘open charm production’ and ‘high \( P_T \) hadron production’. In the former selection, the charmed meson decay, \( D^0 \rightarrow K^- + \pi^+ \), is selected. In the latter selection, events including two hadrons with high \( P_T \) are selected. In the both selections, hard scale is satisfied with, respectively, the charm mass and the \( P_T \) cut. Hence, one can rely on pQCD. From the double spin asymmetry of the PGF process, the gluon polarization is evaluated with a help of the polarized cross-section of the elementary process calculated by the pQCD. The ‘open charm production’ has an advantage with respect to the latter as it provides low background although it gives poor statistics. On the other hand, the ‘high \( P_T \) hadron production’ gives better statistics and larger background. The background comes from the leading process and the QCD Compton process. They are carefully evaluated with Monte Carlo simulation in order to extract the gluon polarization. The experiment has accumulated data both with a longitudinally and transversely polarized targets in its 3 years running from 2002 to 2004. The analysis of the data is in progress. The results of the analysis of the data obtained with a longitudinally polarized target are presented.

1On behalf of the COMPASS Collaboration

11:00AM 1WC.00005 Helicity Distributions of Partons in the Nucleon from HERMES Experiment, TOSHI-AKI SHIBATA, Tokyo Institute of Technology — Deep inelastic electron scattering is one of the representative methods to reveal the inner structure of the nucleon. Electron itself is a point like particle. It is therefore suited to be used for the investigation of nucleon structure. When the scattered electron is detected and momentum analysed, 4 momenta of the exchanged virtual photon are determined. From these kinematical variables, one can calculate Bjorken scaling variable \( x \) event by event. In addition to the scattered electron, produced hadrons are detected and identified. ‘Nucleon spin problem’ started by EMC in 1980’s is being studied with novel experimental technique. HERMES is a deep inelastic scattering experiment at DESY-HERA. Longitudinally polarized positron/electron beam of 27.6 GeV is available at HERA. Physics results with longitudinally polarized hydrogen and deuteron targets are presented in this talk. These targets are internal gas targets. Produced hadrons are detected and identified with Ring Imaging Cherenkov Counter (RICH). From the double spin asymmetry, the spin dependent (helicity) structure function was obtained. Quark flavor decomposition of helicity distributions was carried out making use of information on hadron identification. A positive distribution of \( u \) quark and negative distribution of \( d \) quark were extracted with a high precision. The polarizations of the sea quarks are small.

11:30AM 1WC.00006 Spin Structure of the Nucleon in the Valence Quark Region, ZEI-EDDINE MEZIANI, Temple University — With a minimal contamination from the sea quarks and gluons the valence quark region provides a clean region to study the spin structure of the nucleon. Precision deep inelastic scattering measurements of \( g_1 \) and \( g_2 \) spin-dependent structure functions and their higher moments (integrals over \( x \)) offer an opportunity for testing our grasp of this structure. The valence quark distributions offer a good testing ground for constituent quark models of the nucleon. These distributions are a crucial input for calculating cross sections for hard processes in high-energy hadron-hadron colliders such as the LHC or the Fermilab Tevatron, in searches for the Higgs boson or for physics beyond the Standard Model. Last but not least, the higher moments of the models of the nucleon. These distributions are a crucial input for calculating cross sections for hard processes in high-energy hadron-hadron colliders such as the LHC or the Fermilab Tevatron, in searches for the Higgs boson or for physics beyond the Standard Model. Last but not least, the higher moments of the

Sunday, September 18, 2005 9:00AM - 12:00PM
Session 1WD DNP JPS: Workshop 4A: Beyond qq-bar and qqq: Pentaquarks and More

9:00AM 1WD.00001 Pentaquarks: An Overview of Experimental Results, ERIK GOTTTSCHALK, Fermilab — During the past few years numerous experiments have searched for, and possibly found, evidence for pentaquarks. The experiments have covered a wide range of beam energies, different types of beam particles, and target materials. The evidence that supports the discovery of pentaquarks has been challenged by experimental data in which there is no evidence for pentaquarks. It is in this context that recent results in the search for pentaquarks will be reviewed.

9:30AM 1WD.00002 Search for pentaquark with \( \gamma, \pi^- \) and \( K^+ \) beams, KENICHI IMAI, Kyoto University — Several experiments to search for the pentaquark, \( \Theta^+ \), have been made with \( \gamma, \pi^- \) and \( K^+ \) beams at SPring8 and KEK-PS. It is important to observe the signal with both \( \gamma \) and hadron beams at low energies for the confirmation of \( \Theta^+ \). The KEK-ES22 has searched for \( \Theta^+ \) through \( \pi^- + p \rightarrow K^+ + \Theta^+ \) reaction. The KEK-ES59 searches for \( \Theta^+ \) through \( K^- + p \rightarrow \pi^- + \Theta^+ \) reaction with mass resolution of 1.3MeV(FWHM). Some results and status of these experiments are presented as well as those from SPring8.

10:00AM 1WD.00003 Search for the \( \Theta^+ \) in high statistics photoproduction experiments with CLAS, STEPHAN STEPANYAN1, Jefferson Lab — In the past two years more than 10 experiments have reported observation of a narrow exotic \( S_{11} \) baryon state in the mass range from 1.525 to 1.55 GeV/c². The minimal quark content of this state, called the \( \Theta^+ \), is \( uudd \). There have been a number of reports of non-observation of this state, mostly in high energy inclusive experiments. The main criticisms of the reported \( \Theta^+ \) signals are insufficient statistics, and variation in mass. The CLAS Collaboration at Jefferson Laboratory has published two papers on the experimental evidence for the \( \Theta^+ \), based on the analysis of previously collected CLAS photoproduction data from hydrogen and deuterium. During the past year, the CLAS Collaboration has conducted two new dedicated high-statistics experiments to search for the \( \Theta^+ \). These data now represent the world’s largest data sets for photoproduction on hydrogen and deuterium at energies up to 3.6 GeV. In this talk we present results in several reaction channels in a comprehensive search for the \( \Theta^+ \) from these experiments.

1for the CLAS Collaboration

10:30AM 1WD.00004 Nonstandard Mesons, STEPHAN OLSEN, University of Hawaii —
11:00AM 1WD.00005 Search for Exotic Baryons at HERMES\footnote{Work supported by the U.S. Department of Energy, Office of Nuclear Physics, under contract No. W-31-109-Eng-38}, H.E. JACKSON, Argonne National Laboratory — The prediction of narrow exotic baryon resonances based on the chiral soliton model has triggered an intensive search for the exotic members of an antidecuplet with spin 1/2. In this antidecuplet all three vertices are manifestly exotic. The lightest exotic member lying at its apex, named the $\Theta^-$, is predicted to have a mass near 1530 MeV and a narrow width. Its existence is currently the subject of considerable controversy. Experimental evidence for a second exotic member of the antidecuplet came from the reported observation of a $S=-2, Q=2$ baryon resonance in proton-proton collisions at $\sqrt{s}=17$ GeV. An experimental search for the $\Theta^- (1530)$ and $\Xi^- (1862)$ resonances has been performed by the HERMES collaboration using the decay modes $pK^-$ and $\Xi^- n^-$, respectively. While evidence for a peak at 1530 MeV with a statistical significance of 4$\sigma$ is observed that can be interpreted as the $pK^-$ decay of the $\Theta^-$, no evidence for the $\Xi^- (1862)$ is found. The absence of a peak in the $\Xi^- n^-$ spectrum near 1862 MeV allows only an estimate of an upper limit for quasi-real photoproduction of the $\Xi^- n^-$ (1862). Systematic studies and future plans will be discussed as well.

11:30AM 1WD.00006 Recent Results on Pentaquark Searches from STAR, HUAN ZHONG HUANG\footnote{For the STAR Collaboration}, UCLA — We have examined the $p+K^-$ and $\bar{p}+K^-$ invariant mass distribution and observe a peak structure with approximately 4-5 sigma statistical significance in $d+Au$ collisions at $\sqrt{s}_{NN}=200$ GeV and Au+Au collisions at 62.4 GeV. The apparent mass of the observed peak is at 1530 MeV/$c^2$. Its width is consistent with detector resolution. The nature of the peak is under active investigation. If confirmed as a particle, this state would be manifestly exotic with uuud-$\bar{d}$ quark structure. The observed yield is estimated to be very small. No signal above combinatoric background was observed in STAR p+p and Au+Au collisions at 200 GeV from RUN II. New analysis results from larger data samples of Run IV Au+Au 200 GeV and Run V Cu+Cu 62.4 GeV will be reported and the status of such pentaquark searches in general will be discussed.

Sunday, September 18, 2005 9:00AM - 12:30PM — Session 1WE DNP JPS: Workshop 5A: Nuclear States Under Extreme Conditions of Binding and Isospin Asymmetry Ritz-Carlton Hotel Amphitheatre

9:00AM 1WE.00001 Proton radioactivity, KRZYSZTOF RYKACZEWSKI, ORNL Physics Division, Oak Ridge — Proton radioactivity was discovered 35 years ago [1]. However, most of the data on over 40 proton-emitting states known to date were obtained recently using electromagnetic separators selecting recoiling fusion-evaporation reaction products. Observation of fine structure in proton emission [2-5] is particularly important since the deformation and structure of wave function of involved states can be determined from observed properties. Recent results obtained at Oak Ridge on rare-earth nuclei as well as the perspectives of further studies at the next generation radioactive ion beam facilities will be presented.


9:30AM 1WE.00002 Gamow Shell Model description of weakly bound and resonant nuclei, NICOLAS MICHEL, Oak Ridge National Laboratory — Recently, the shell model in the complex k-plane (the so-called Gamow Shell Model) has been formulated using a complex Berggren ensemble representing bound single-particle states, single-particle resonances, and non-resonant continuum states. The single-particle basis used is that of the Hartree-Fock potential generated self-consistently by the finite-range residual interaction. In this framework, we shall discuss binding energies and energy spectra of neutron-rich helium and lithium isotopes, as well as spectroscopic factors and spin-orbit splitting in the helium region. It is shown that correlations due to scattering components cannot be neglected. In collaboration with Wittek Nazarewicz, HRIBF Scientific Director and Marek Ploszajczak, CEA researcher.

10:00AM 1WE.00003 Correlation of halo neutrons studied via Coulomb breakup of $^{11}\text{Li}$, TAKASHI NAKAMURA, Tokyo Institute of Technology — Strong E1 excitation to the low-lying continuum is one of the manifestations of nuclear halo phenomena. This excitation, which has been observed in the Coulomb breakup, is now well understood for one-neutron halo nuclei as in the case of $^{11}\text{Be}$ [1]. On the other hand, the case of two neutron halo nucleus such as $^{11}\text{Li}$ is still in the controversial situation. For instance, there have been discrepancies among three experimental results obtained on the Coulomb breakup of $^{11}\text{Li}$ at MSU [2], RIKEN [3], and GSI [4]. The understanding of Coulomb breakup of halo nuclei is of great importance since it should have information on the three-body properties such as two-neutron correlations in the Borromean system. We have thus studied the Coulomb dissociation of $^{11}\text{Li}$ on a Pb target at 70 MeV/nucleon at the ratioactive beam facility RIPS at RIKEN, with much higher statistics and much less ambiguities caused by cross talk events in detecting two neutrons. The momentum vectors of incident $^{11}\text{Li}$ as well as outgoing $^{9}\text{Li}$ and two neutrons, and $\gamma$ rays were all measured in coincidence. Hence, we could obtain the excitation energy spectrum in combination with the angular distribution of $^{9}\text{Li}$. In addition, relative energies between two neutrons as well as those of $^{9}\text{Li}$. $^{11}\text{Li}$ were extracted. In the excitation energy spectrum of $^{11}\text{Li}$, we have observed a strong peak at the relative energy $E_{rel} \sim 0.3$ MeV. The corresponding $B(E1)$ strength has been extracted to be $1.6 \pm 0.1$ e$^2$fm$^2$ using the conventional equivalent photon method. The non-energy-weighted E1 cluster sum rule is applied to extract the neutron-neutron correlation in the ground state. Spectra of $^{9}\text{Li}$-n, and n-n relative energies are also shown to discuss the two-body correlations in $^{11}\text{Li}$.

10:30AM 1WE.00004 Spatially extended coherence induced by pairing correlation in low-frequency vibrational excitations of neutron drip line nuclei, MASAYUKI YAMAGAMI, RIKEN — Study of low-frequency vibrational excitations in neutron drip line nuclei is one of the most interesting issues in nuclear structure physics. In contrast to vibrations in stable nuclei, the contributing single-particle states are loosely-bound states, resonant and non-resonant continuum states in neutron drip line region. Therefore the two-quasiparticle states (or one-particle - one-hole states in closed shell nuclei) have rich variety of the spatial structure, and the correlations among them may bring about qualitatively new aspects of low-frequency vibrational excitations. In my talk, novel effects of pairing correlations for emergency of low-frequency vibrational excitations in neutron drip line nuclei is discussed paying special attentions to neutrons with small orbital angular momentum \( \ell \). By solving the Hartree-Fock-Bogoliubov (HFB) equation in coordinate space, we discuss the change of the spatial structure of quasiparticle wave functions induced by pairing correlations; the pairing anti-halo effect in the lower component [1] and the broadening effect in the upper component [2]. The resultant broad localization of the two-quasiparticle states of low-\( \ell \) neutrons produces the coherence in the spatially extended region, and the correlations can cause the large transition strength. By performing HFB plus quasiparticle random phase approximation calculation for the first 2\( ^+ \) states in neutron rich Ni isotopes, the unique role of pairing correlations is examined [2].


11:00AM 1WE.00005 Absolute spectroscopic factors from nucleon knockout with radioactive projectiles\(^1\), DANIEL BAZIN, National Superconducting Cyclotron Laboratory, Michigan State University — Many experiments now demonstrate that experiments with rare-isotope beams reveal effects that were not observable in the classical nuclear-physics experiments, limited as they were to experiments with stable targets. Exploration of the drip lines is therefore an essential element in reaching a full understanding of nuclear structure. This presentation will discuss the use of one- and two-nucleon knockout reactions in inverse kinematics to measure partial cross sections and to deduce spectroscopic factors for approximately 50 nuclear states. By far the most interesting result to emerge is that, owing to the firm theoretical basis and essentially parameter-free description offered by eikonal reaction theory, it is possible to obtain absolute spectroscopic factors, accurate to 5-15%, and hence to obtain information on the physical occupancy of shell model states. While knockout reactions with electrons on stable targets had suggested a constant reduction factor \( R_e \) relative to the shell model of 0.6-0.7, we find a strong dependence on isospin. Weakly-bound halo states have \( R_e \) close to unity. In contrast, some deeply-bound states near the N = Z line have \( R_e \) as low as 0.25, but in spite of this the nuclear level assignments and energies are still well described by the effective-interaction model. In other words, the quasiparticles of the model are, for these cases, only to 25% physical particles. Other recent results concern single-particle structure for neutron-rich nuclei near \( N = 20 \), where the shell gap vanishes, and near \( N = 28 \), where a new doubly magic nucleus \( ^{44}\text{Si} \) with a large shell gap above (14, 28) appears. We have demonstrated that two-proton knockout on a neutron-rich projectile proceeds as a direct reaction. In this case, the cross sections to individual final states carry detailed information about particle-particle correlations in the many-body wave function.

\(^1\)This work was supported by the National Science Foundation Grant No. PHY-01 10253

11:30AM 1WE.00006 Cluster aspect in C isotopes, YOSHIKO KANADA-EN’YO, YITP, Kyoto University — We discuss structure of ground and excited states of C isotopes, while paying attention to cluster aspect. In the neutron-rich nuclei near the drip line, there exist loosely bound three-body systems called Borromean systems. Also in stable nuclei, we can regard \( ^{12}\text{C} \) as a Borromean system when we consider the \( 3\alpha \) system, where no bound system consists of two of the three clusters. Recently, the properties of the second \( 0^+ \) state of \( ^{12}\text{C} \) has been successfully described by a gas-like \( 3\alpha \) structure. It leads us to expect that loosely bound three-body systems may appear in other \( C \) isotopes. We propose that the third \( 3/2^- \) state of \( ^{14}\text{C} \) is a candidate of such a gas-like state. It is supported by the recent observation of small Gamov-Teller transition strength, \( B(GT; ^{11}\text{B} \to ^{11}\text{C}^* \)\(^\pm \)) , measured by charge exchange reactions. We give a discussion of cluster aspect in \( ^{13}\text{C} \). In contrast to the development of three-body clustering in the highly excited states, the clusters are considered to be tightly bound in the low-lying states of \( C \) isotopes. In the neutron-rich \( C \) isotopes, it is suggested that spatial development of \( 3\alpha \) may not appear, instead, compact proton structure is favored. This feature may lead to decoupling of core and valence neutrons in neutron-rich \( C \) and has a good contrast to low-lying states of neutron-rich \( C \) which has the strong coupling nature of \( 2\alpha \) core and valence neutrons. We study structure of neutron-rich \( C \) isotopes and discuss the decoupling of proton and neutron deformations.

12:00PM 1WE.00007 Single particle gaps and the structure of neutron-rich nuclei above \( ^{44}\text{Ca} \), C.J. (KIM) LISTER, Physics Division, Argonne National Laboratory — Recent investigations have shown that single-particle level spacing and residual interactions in very neutron rich nuclei may significantly differ from those inferred from many years of studies of nuclei near the valley of stability. This presentation will focus on the region of neutron-rich nuclei above \( ^{44}\text{Ca} \) and explore issues such as the appearance of new shell gaps and the onset of deformation in the Ca-Ti-Cr region. The nuclei of interest are extremely difficult to produce and our understanding is only emerging by combining data from experiments using very different techniques ranging from beta decay of fragmentation products to gamma-ray studies following deep-inelastic reactions, and from fusion-evaporation with radioactive targets to Coulomb excitation at relativistic energies. This symbiotic relationship is a template for future exploration far from stability.

Sunday, September 18, 2005 9:00AM - 12:00PM —
Session 1WF DNP JPS: Workshop 6A: Double Beta-Decay and Neutrino Mass Ritz-Carlton Hotel Plantation 3

9:00AM 1WF.00001 Direct Determination of Neutrino Mass with KATRIN, KEITH RIELAGE, CENPA, University of Washington — The Karlsruhe Tritium Neutrino experiment (KATRIN) is a next generation tritium \( \beta \beta \) decay experiment capable of performing a high precision direct measurement of the absolute mass of the electron neutrino. The projected sensitivity of the experiment is \( m(\nu_e) < 0.2 \text{ eV} \) (90\% C.L.) improving upon previous experiments by an order of magnitude. An overview of the experiment and its current status will be presented. Some of the technical challenges being addressed by the experiment will also be discussed. KATRIN is scheduled to begin collecting data in 2009. Support for this project in the United States is provided by the DOE under contract DE-FG-97ER41020.

9:30AM 1WF.00002 Cuoricino to CUORE: Neutrinoless Double Beta Decay Measurements with TeO\(_2\) Bolometers, THOMAS D. GUTIERREZ\(^1\), Lawrence Berkeley National Laboratory — An introduction and status report are presented on the neutrinoless double beta (\( \beta\beta \)) decay search efforts at Cuoricino, a bolometric experiment located at the National Laboratory of Gran Sasso (LNGS) in Italy. Cuoricino, currently the largest operating bolometer in the world, consists of a single tower of 62 TeO\(_2\) crystals (41 kg), which serve as both the source and detector for the \( \beta\beta \) decays. The proposed CUORE (Cryogenic Underground Observatory for Rare Events) experiment will also be discussed. Similar in concept to Cuoricino, CUORE will consist of 988 TeO\(_2\) crystals in 19 Cuoricino-like towers having a total mass of 750 kg. Although having various anticipated but tractable technical challenges, CUORE will have the sensitivity to observe \( \beta\beta \) for effective masses extending into the inverse hierarchy. This work is supported in part by the US Department of Energy.

\(^1\)for the Cuoricino and CUORE Collaborations
10:00AM 1WF.00003 Neutrino mass and mixing constrained by double beta decay, HISAKAZU MINAKATA, Tokyo Metropolitan University — I will try to review the constraints imposed by neutrinoless double beta decay and direct mass measurement.

10:30AM 1WF.00004 Neutrino Properties Beyond the Standard Model, AKIF BALANTEKIN, University of Wisconsin-Madison — Recent experimental developments significantly enhanced our knowledge of neutrino mass and mixings. In this talk our current understanding of the neutrino properties beyond the Standard Model, such as neutrino magnetic moment, will be reviewed. This work was supported in part by the U.S. National Science Foundation Grant No. PHY-0244384 at the University of Wisconsin, and in part by the University of Wisconsin Research Committee with funds granted by the Wisconsin Alumni Research Foundation.

11:00AM 1WF.00005 Lepton flavor violation and neutrino mass, EIICHI TAKASUGI, Osaka University — In order to explore the neutrino mass matrix, we need to examine the Majorana nature of neutrino. The Majorana nature is explored through the lepton number violating processes such as the neutrino-less double decay, the conversion of muon to positron, muon to anti-muon, etc. In these processes, the Majorana CP phases play an important role. The neutrino mass matrix is most likely to unite through the seesaw mechanism. To explore these, we need to examine the leptogenesis and the lepton flavor violation process as well. By combining all possible experiments, the neutrino mass matrix is discussed.

11:30AM 1WF.00006 The Deep Underground Science and Engineering Laboratory (DUSEL), BERNARD SADOULET, Lawrence Berkeley National Laboratory —

Sunday, September 18, 2005 9:00AM - 12:00PM — Session 1WG DNP JPS: Workshop 7A: Neutrino Astrophysics Ritz-Carlton Hotel Plantation 2

9:00AM 1WG.00001 Nuclear structure, nuclear force and spin-isospin excitations in stellar processes, TAKAHARU OTSUKA, University of Tokyo — The spin-isospin Nucleon-Nucleon (NN) force plays crucial roles in determining shell structure of exotic nuclei. Even magic numbers can be destroyed. We will overview what changes can be expected in exotic nuclei on single-particle properties and spin-isospin excitations, including Gamov-Teller processes. The Gamov-Teller and other weak processes can be well studied by recent shell model calculations with newly determined effective NN interactions. We shall survey such new results, and look at possible implications on stellar processes. The calculations include full pf-shell calculations and pf+g1/2 calculations. We may discuss the stability of 78Ni core in exotic Ni isotopes and its implications in the r-process. Within the pf-shell, the Gamov-Teller properties will be assessed in view of their influences on stellar processes. Such studies will provide us with some information on neutrino reactions.

9:30AM 1WG.00002 Nuclear Reactions with light ion and photon beams: Contributions to Neutrino Astrophysics, MAMORU FUJIWARA, Research Center for Nuclear Physics, Osaka University — In the star burning, the reaction processes such as charge exchange, inelastic scattering and fusion take place on the basis of the star hierarchy structure with various densities and temperatures. Experimental information from the nuclear reactions has been applied to the astrophysical phenomena observed by telescopes and to understand the isotope composition of meteorites in the solar and galaxy systems. For example, charge-exchange reaction cross-sections relate closely to β-decay and electron capture processes. From the observations of isoscalar giant monopole resonances in nuclei provided via inelastic scattering, one can argue the nuclear incompressibility, which is one of the important parameters for the supernova explosions and neutron star structure. Studies of photo-nuclear reactions are deeply related to astrophysics to understand the origin of element synthesis in the galaxy since the nuclear synthesis is made in the environment with ultra high intensity photons in supernovae. In my talk, I would like to show the recent results from the 7Be+p and 7Be+ 4He fusion reactions and neutrino astrophysics experiments with light ion beams in relation to the neutrino astrophysics. I also show the future possibilities of photoreactions at new facilities in Japan.

10:00AM 1WG.00003 7Be + p and 3He + 4He fusion reactions and neutrino astrophysics, K. A. SNOVER, University of Washington — The 7Be + p and 4He + 3He fusion reactions are important steps in the solar p-p chain that lead to the production of neutrons from decay of 8B and 7Be in the Sun. Until recently the uncertainty in the 7Be + p S-factor was the largest error in the calculated solar model production rate of neutrons from 8B decay, while now it is no longer important [1,2]. The uncertainty in the 3He + 4He S-factor is now the largest nuclear uncertainty in the calculated solar model production rate of neutrons from both 8B and 7Be decay [2]. I will discuss the current status of these fusion experiments and the implications for neutrino physics including limits on sterile neutrinos.

1 Supported in part by the U.S.DOE, Grant #DE-FG02-97ER41020.

10:30AM 1WG.00004 New shell model calculations of neutrino-nucleus scattering cross sections, TOSHIKO SUZUKI, Department of Physics, College of Humanities and Sciences, Nihon University — Neutrino-nucleus reactions induced by charged and neutral currents are investigated by using new shell model Hamiltonians, where nucleon-nucleon interactions in the spin-isospin channel are improved to take into account properly the shell evolution properties. Quenching in the Gamov-Teller transition strength is somewhat weakened and agreement with experimental value is improved in several p-shell nuclei. Better agreement with observed values is systematically obtained for the magnetic moments in p-shell nuclei. Neutrino-nucleus cross sections are calculated for p-shell nuclei, for example, in 12C and 11B for supernovae and accelerator neutrinos by using the new shell model Hamiltonians. Charge of the changed and neutral current cross sections are discussed by comparing with those obtained by conventional shell model Hamiltonians. Reactions on He as well as heavy nuclei are also studied. Effects of the spreading in the width on the cross sections are shown to be important.

11:00AM 1WG.00005 A Solution to LSND’s Second Puzzle, GEOFFREY MILLS, Los Alamos — We present a calculation of the 12C(νμ,μ−)12N flux-averaged, inclusive cross section from the Liquid Scintillator Neutrino Detector. The calculation is based upon a relativistic Fermi gas model that has been corrected for long range correlation and binding energy effects. The long range correlation effects are introduced via a non-local, momentum dependent potential in the kinematics of the lepton-nucleon vertex. The potential parameters, most importantly the effective mass \( M^* \), are tuned to match electron scattering data in the appropriate energy range. The binding energy appropriate for 12C, 27 MeV, is used in stead of the traditional 25 MeV found from the electron data. The result agrees well with the LSND measurement of 10.5 × 10−4 cm2. The calculation makes up for its lack of theoretical rigor in its intuitive simplicity and reliance on well established electron scattering measurements.
11:30AM 1WG.00006 Neutrino-nucleus cross sections and their role in supernovae1, JEFF BLACKMON2. Oak Ridge National Laboratory — Interactions between neutrinos and nuclei play a crucial role in core-collapse supernovae. The intense neutrino flux carries away 99% of the total energy released in the explosion. The dynamics of core collapse and formation (and propagation) of the shock in supernova models are sensitive to the rates used for interactions of neutrinos (and electrons) with nuclei. The distribution of isotopes that are synthesized and ejected into the interstellar medium is also influenced by neutrino-nucleus interactions. Terrestrial measurements of the neutrino spectra from a nearby supernova could give valuable information, but the interpretation of such measurements can be improved by better understanding of the neutrino interactions in the detector material. Neutrino interactions at energies relevant for supernovae (tens of MeV) are quite dependent on the structure of the nucleus. Accurate cross section measurements have been made on only one nucleus, 12C. The reliability of theoretical models for cross sections is uncertain and is likely to depend upon the quality of available nuclear structure information. A collaboration, νSNS, has recently proposed to build a facility for measurements of neutrino-nucleus cross sections at the Spallation Neutron Source (SNS), currently under construction at ORNL. Detectors for νSNS have been designed to be resouled for multiple targets. The charged-current cross section for any particular target could be measured with 10% accuracy in less than one year of operation with a 20-ton instrument. The role of neutrino-nucleus interactions in supernovae and the proposed experimental program of cross section measurements at the SNS will be presented.

1 ORNL is managed by UT-Battelle, LLC for the USDOE under contract DE-AC05-00OR22725.
2For the νSNS collaboration (see http://www.phy.ornl.gov/νsns).

Sunday, September 18, 2005 9:00AM - 12:00PM
Session 1WH DNP JPS: Workshop 8A: Neutron-rich Nuclei in Nuclear Astrophysics Ritz-Carlton Hotel Plantation 1

9:00AM 1WH.00001 The Parity Radius Experiment at the Jefferson Laboratory, PAUL SOUDER, Syracuse University — The radius of the distribution of neutrons in lead can be determined by measuring the parity-violating electroweak asymmetry in the scattering of polarized electrons. This data, can, in turn, be used to obtain information about the symmetry energy of nuclear matter, with a minimum of theoretical input, and then applied to descriptions of neutron stars. However, the experiment is challenging, requiring the measurement of a tiny asymmetry to a few percent of itself. Details about the theoretical and experimental issues will be presented.

9:30AM 1WH.00002 Mean field theory for neutron rich nuclei and EOS, SATOSHI YOSHIDA, Hosei University — We have already shown that there was a clear linear correlation between the neutron skin thickness of stable nuclei, such as 208Pb, the pressure of neutron matter in the Skyrme Hartree Fock (SHF) and relativistic mean field (RMF) models. Here the pressure $P$ of neutron matter is defined by the first derivative of Hamiltonian density in the neutron matter with respect to the neutron density. There are some nuclear properties of infinite nuclear matter, such as the saturation density $\rho_0$, the saturation energy per nucleon $E_0$, the incompressibility $K$, the symmetry energy $J$, the 1st derivative of $E$ at $\rho_0$ and 2nd derivative $K_{sym}$ of $E$. The isoscalar part $h$ is characterized by $\rho_0$, $E_0$, and $K$, and the isovector part $\delta$ is characterized by $J$, $L$, and $K_{sym}$. Furthermore these isoscalar part and the isovector part of the Hamiltonian density for infinite nuclear matter play an important role to characterize the equation of state (EOS). In Skyrme Hartree Fock model (SHF) including some parameters in the Skyrme force, there are many versions of Skyrme parameter sets parameterized by the experimental results of finite nuclei such as nuclear mass, charge radii and so on. All Skyrme parameter sets which we use recently can reproduce the empirical $\rho_0$ and $E_0$, whereas the values of $K$, $J$, $L$, and $K_{sym}$ depend on the parameter sets entirely. However we found there were correlations among $K$, $J$, $L$, and $K_{sym}$ in SHF model. Furthermore if we fix the values of $\rho_0$ and $E_0$ to 0.16 fm$^{-3}$ and 16 MeV, respectively, the nuclear matter properties $J$, $L$, and $K_{sym}$ are represented as a function of the incompressibility $K$, the neutron skin thickness of 208Pb and the power of the total density in density-dependent term of Skyrme force. In addition to the content above, I will discuss the relation between the EOS of the neutron matter and the neutron skin thickness of the finite nuclei.

10:00AM 1WH.00003 Experimental studies of giant resonances and nuclear incompressibility, HARUTAKA SAKAGUCHI, Kyoto University — Isoscalar giant monopole resonances and isoscalar giant dipole resonances attract many nuclear physicists because they are related to the nuclear incompressibility and then to the equation of state(EOS) of nuclear matter, which plays an important role not only in nuclear physics but also in supernova explosion and neutron star formation. Due to the experimental difficulties to observe cleanly these giant resonances it is only recent years that we have obtained reliable data for peak positions of them and deduced a consistent value of nuclear incompressibility from them. The angular momentum transfers needed to excite them from the ordinary even-even nuclei are zero or one. Thus if we want to observe them by alpha particle scattering, we need to measure inelastic alpha particles at zero degrees and the extremely forward angles, where the angular distributions to excite them take their maximum values. In this work we report recent data on isoscalar giant monopole and dipole resonances measured at RCNP ring cyclotron, which provides us a very clean and stable beam, the positions of which were monitored continuously during our measurements. We have measured inelastic alpha scattering of 400 MeV at extremely forward angles including zero degrees with the Grand Raiden magnetic spectrometer. In order to estimate and subtract the instrumental backgrounds we have utilized the double focusing property of the spectrometer and the ray-tracing type focal plane position detector. Angular distributions of 1 MeV energy bin above the excitation energy of 10 MeV have been multipole decomposed to give the excitation strength spectra separately for each giant resonance. From our giant resonance data of 208Pb we have deduced the nuclear incompressibility of 215 MeV by comparing with nonrelativistic RPA calculations. If time allows, we would like to mention our new results on the neutron skin thicknesses in 204,206,208Pb obtained by intermediate energy proton elastic scattering at RCNP.

10:30AM 1WH.00004 Giant resonances in neutron-rich nuclei studied with TDHF simulation in the continuum, TAKASHI NAKATSUKASA, Center for Computational Sciences, University of Tsukuba — In weakly bound systems such as neutron-rich nuclei, the continuum plays an important role in the ground and excited states. Many-body correlations in low-density nuclear matter is an interesting subject in nuclear structure physics and have a significant impact on nuclear reactions as well. We study excited and resonance states in the continuum with time-dependent Hartree-Fock theory in the linear regime. In order to treat the nucleonic continuum, we adopt the absorbing boundary condition which has been shown to be useful for the description of giant resonances in stable and unstable (neutron-rich) nuclei. The isoscalar part and the isovector part of the Hamiltonian density for infinite nuclear matter play an important role to characterize the equation of state (EOS). In Skyrme Hartree Fock model (SHF) including some parameters in the Skyrme force, there are many versions of Skyrme parameter sets parameterized by the experimental results of finite nuclei such as nuclear mass, charge radii and so on. All Skyrme parameter sets which we use recently can reproduce the empirical $\rho_0$ and $E_0$, whereas the values of $K$, $J$, $L$, and $K_{sym}$ depend on the parameter sets entirely. However we found there were correlations among $K$, $J$, $L$, and $K_{sym}$ in SHF model. Furthermore if we fix the values of $\rho_0$ and $E_0$ to 0.16 fm$^{-3}$ and 16 MeV, respectively, the nuclear matter properties $J$, $L$, and $K_{sym}$ are represented as a function of the incompressibility $K$, the neutron skin thickness of 208Pb and the power of the total density in density-dependent term of Skyrme force. In addition to the content above, I will discuss the relation between the EOS of the neutron matter and the neutron skin thickness of the finite nuclei.

11:00AM 1WH.00005 Photonuclear Probe of Astrophysics, HIROAKI UTSUNOMIYA, Konan University — Real photons are a good probe of E1 and M1 γ-strength functions of nuclei. In stellar conditions, both neutron capture and photodisintegration are sensitive to the γ-strength function in the low-energy tail of the electric giant dipole resonance (GDR) that are assumed to be built on individual excited states. The γ-strength function is a key ingredient to improve the reliability of the Hauser-Feshbach model description of neutron capture and photodisintegration. Recently precision determination of photoneutron cross sections of astrophysical importance has become possible with use of quasi-monoenergetic γ beams from laser Compton backscattering at AIST. These data provide a good insight into the γ-strength function in the low-energy tail of GDR. This talk covers precision measurements of photodisintegration cross sections in the context of the p-process and s-process nucleosynthesis.
11:30AM 1WH.00006 $^4$He+$\gamma$ cross sections for astrophysical interest, TATSUSHI SHIMA, RCNP, Osaka University — Roles of the neutrino-induced nuclear reactions of $^4$He in supernova explosions and rapid process ($r$-process) of stellar nucleosynthesis are current issues in nuclear astrophysics. Recent theoretical studies of the supernova explosions suggest a critical role of the neutrino-inelastic scattering on $^4$He in energy transport by outgoing shock wave. The neutrino-inelastic scattering on $^4$He is considered to be also important for productions of $^7$Li via $r$-process in neutrino-driven wind of supernovae. To study the roles of the neutrinos in supernova explosions, one needs information about response of $^4$He nucleus to neutrino-inelastic scattering in the excitation energy range of 20–40 MeV, which corresponds to the energies of the neutrinos emitted from supernovae. Photonneutral reactions of $^4$He in the giant dipole resonance (GDR) region is a unique tool to study the nuclear response of $^4$He, since the electromagnetic transitions are direct analogs of the neutrino transitions by weak neutral current. However, there has been a large discrepancy between the existing data of the photoneutral reactions of $^4$He in the GDR region. Therefore we have performed a new measurement of the photodisintegration cross sections of $^4$He in the energy range from 21.8 to 29.8 MeV using laser-Compton backscattered photons and a time projection chamber containing $^4$He gas as an active target. The obtained cross sections increase monotonically with energy up to 29.8 MeV, contrary to a recent calculation by the Lorentz integral transform method. Most recently, a coupled-channel calculation including the tensor force has been performed, and the calculated values are in excellent agreement with the present experimental ones. In this paper the present result will be compared to recent theoretical calculations, and its astrophysical implications will be discussed.

Sunday, September 18, 2005 2:00PM - 5:00PM –
Session 2WA DNP JPS: Workshop 1B: Nuclear/Hadron Physics at the JLAB and J-PARC
Ritz-Carlton Hotel Salon 4

2:00PM 2WA.00001 Hypernuclear physics at KEK and J-PARC, TOMOFUMI NAGAIE, KEK — Recent results on hypernuclear physics obtained at the 12-GeV proton synchrotron of KEK are reviewed, and the future experimental programs at J-PARC are discussed in this talk. The first part includes the results on hypernuclear gamma-ray spectroscopy with the HyperBall detector, weak decays of light lambda hypernuclei, production of a neutron-rich lambda hypernucleus, hyperon-proton scattering, and production of a double-lambda hypernucleus. The J-PARC facility has been in construction since 2001 at Tokai, Japan. The highest intensity Kaon beams will be available at an experimental hall in the summer of 2008. Various interesting experiments are proposed so far. Two of them are considered to be the Day-1 experiments. One is the new-generation spectroscopy of hadron many-body systems with strangeness -2 and -1, and the other is a search for deeply-bound Kaonic nuclear systems. These experiments together with other interesting ideas will be discussed.

2:30PM 2WA.00002 Kaonic nuclei – dense and cold nuclear systems, YOSHINORI AKAIISHI, Niho University & RIKEN — We have predicted strongly bound kaonic states in few-body nuclei, the bindings of which are on the order of 100 MeV: the separation energies of a $K^-$ in $^4$He and $^4$He are calculated to be 108 and 86 MeV with widths of 20 and 34 MeV, respectively. Substantial contraction of the system is induced due to the strong $KN$ attraction, thus forming an unusually-dense nuclear object. Since these kaonic nuclei have large densities more than 3-times the normal density, they provide a unique playground for studying possible QCD structure in dense and cold nuclear medium. We discuss the implication of recently discovered strange tri-baryons in $^4$He(stopped-$K^-$), $pS^0(3115)$ and $^4$He(stopped-$K^-$), $nS^+ (3140)$ within the framework of deeply bound Kaonic states formed on shrunk nuclear cores. The $S^+(3140)$ corresponds to $T=0 ppmK^-$, whereas the $S^0(3115)$ to $T=1 ppmK^-$, which is an isobaric analog state of $pppK^-$. The observed binding energies can be accounted for by including the relativistic effect and by invoking a medium-enhanced $KN$ interaction by 15%. A new paradigm is discussed, which would be closely related to important issues of “chiral symmetry restoration,” “kaon condensation” and “strange matter.”

3:00PM 2WA.00003 Probing Hadron Structure with High Energy Proton Beams, RUSTY TOWELL, Abilene Christian University — The history of probing hadronic structure with proton beams is long and rich. Results from just one experiment that used an 800 GeV proton beam, FNAL E866/NuSea, have provided new insight into the composition of the nucleon sea, the partonic structure at high Bjorken-x, an upper limit on parton energy loss in cold nuclear matter, and more. Two similar experiments have been proposed at lower energies. FNAL E906 has been approved to run using the 120 GeV beam from the Fermilab Main Injector. The lower beam energy will yield more Drell-Yan events and extend the kinematical coverage to higher x values. A Letter of Intent has been submitted to J-PARC to perform the measurement using the 50 GeV proton beam. This will overlap with the E906 measurement and extend to even higher x values. The lower beam energy will also aid in the measurement of energy loss in cold nuclear matter. If a polarized proton beam were available at J-PARC in the future, then a polarized Drell-Yan measurement would be possible. I will highlight the results from FNAL E866/NuSea and discuss future plans for both E906 at FNAL and the LOI at J-PARC.

3:30PM 2WA.00004 Future Hadronic Spectroscopy at JLAB and J-PARC, MARK MANLEY, Kent State University — Hadronic spectroscopy data provide crucial information about QCD in the nonperturbative regime. One important issue concerns how many internal degrees of freedom are really needed to describe baryon resonances. Essentially all of the known baryon resonances can be described as quark-diquark states, whereas quark models predict a much richer spectrum than observed experimentally involving three dynamical quark degrees of freedom. It is important to confirm whether these “missing states” exist. A related question concerns whether there are exotics and hybrid mesons and baryons, and if so, what are their spectra. Some of these questions might be answered by future experiments at JLAB and J-PARC. My talk will focus mainly on the prospect of making dramatic improvements in our knowledge of hyperon resonances, which could be studied by production and/or formation mechanisms at these two facilities.

4:00PM 2WA.00005 $\lambda$-Nucleus Studies as J-PARC, TOMOKAZU FUKUDA, Osaka University — This abstract has not been submitted yet.

4:30PM 2WA.00006 J-PARC facility and physics opportunities, SHOJI NAGAMIYA, KEK/JAERI — J-PARC project is now in the fifth year of its construction. It will provide high-power protons at (1) 3 GeV for the usage spallation neutrons and muons and (2) 50 GeV for the usage of kaons and neutrinos. From JFY2004 the neutrino program has been officially approved for construction. The total budget is over 1,500 Oku Yen for Phase 1 project of the J-PARC. According to the present plan, the first beams will be available in 2008. In this talk, I will present a) current status of the project, b) plans for Day-1, c) plans beyond Day-1, and d) major issues that have to be solved now.

Sunday, September 18, 2005 2:00PM - 5:00PM –
Session 2WB DNP JPS: Workshop 2B: Strongly Interacting Matter Probed at RHIC
Ritz-Carlton Hotel Salon 3
Jet quenching is a unique short wavelength probe of the strongly coupled quark gluon plasma (sQGP) produced at RHIC. Recent data on the azimuthal dependence of jet quenching as a function of centrality and on heavy quark attenuation patterns at high transverse momenta have posed interesting new challenges for jet tomography theory[1]. Prediction for (Au+Au and Cu+Cu) will be confronted with the available data. Possible new physics implications of the outstanding puzzles will be discussed. [1] M. Gyulassy, I.Vitev, X. N.Wang and B.W.Zhang, Quark gluon plasma III, (Hwa, R.C. (ed.) et al.,p.123), (nucl-th/0302077)

2:00PM 2WB.00001 Jet Quenching Puzzles at RHIC. MIKLOS GYULASSY, Columbia University — Jet quenching is a unique short wavelength probe of the strongly coupled quark gluon plasma (sQGP) produced at RHIC. Recent data on the azimuthal dependence of jet quenching as a function of centrality and on heavy quark attenuation patterns at high transverse momenta have posed interesting new challenges for jet tomography theory[1]. Prediction for (Au+Au and Cu+Cu) will be confronted with the available data. Possible new physics implications of the outstanding puzzles will be discussed. [1] M. Gyulassy, I.Vitev, X. N.Wang and B.W.Zhang, Quark gluon plasma III, (Hwa, R.C. (ed.) et al.,p.123), (nucl-th/0302077)

2:30PM 2WB.00002 High-pt particle production and its modifications in nucleus-nucleus collisions at RHIC. MARCO VAN LEEUWEN, LBNL — One of the most striking results from RHIC is the strong suppression of high-pt particle production observed in nucleus-nucleus collisions. Di-hadron correlations of high-pt particles clearly demonstrate that these particles originate from fragmentation of high-pt partons and that these particles are strongly absorbed by the hot and dense medium in central Au+Au collisions. I will review the relevant results on particle spectra, nuclear modification factor, elliptic flow and di-hadron correlations at high-pt with focus on the new results from the high-statistics RHIC run 4 which have significantly reduced statistical uncertainties and cover a larger range in pt than the existing results. RHIC has also recorded Cu+Cu collisions at 200 GeV this year, to systematically explore the path-length and system size dependence of the observed suppression. If available, first results from this run will also be discussed.

3:00PM 2WB.00003 Jets and Single Charm Production at RHIC. EDWARD O’BRIEN, Brookhaven National Lab — Heavy quarks are powerful probes that are being used to characterize the state of matter created in heavy ion collisions at RHIC. The behavior of the charm and beauty quarks in HI collisions has been predicted to be quite different than that of the light quarks. The charm quark energy loss was expected to be smaller than that for light quarks, due to its heavy mass. Azimuthal anisotropy of the charmed hadrons was also expected to be less than that for the hadrons made of light quarks due to the limited thermalization of heavy quarks. Experiments at RHIC are conducting systematic studies of transverse momentum spectra of open charm, azimuthal anisotropy of heavy flavor hadrons and correlations between single leptons and jets from charm in A+A collisions. In addition measurements of heavy quark production in p+p and d+Au collisions have been carried out at RHIC to address the separation of physics associated with the hot, dense medium created in RHIC A+A collisions from non-pQCD processes such as cold nuclear effects. We present results from heavy quark studies covering particle production, transverse momentum distributions vs centrality, azimuthal anisotropy and jet correlations in p+p, d+Au and Au+Au collisions at RHIC.

3:30PM 2WB.00004 Measurements of J/Ψ and photons at RHIC. KYOICHIRO OZAWA, CNS, Univ. of Tokyo — Recent results on measurements of J/Ψ and photons are reported. In spite of fruitful results in the first four years of RHIC operation, there are still remaining questions to be answered to further characterize the state of matter formed at RHIC. In particular, direct information of deconfinement of quarks and gluons and of the dense matter produced has not been obtained, and should be provided. From this point of view, electro-magnetic probes are important. They created in the medium, and emerge from the matter without strong final state interaction. Thus, they carry direct information about conditions and properties of the medium. Especially, direct photons and lepton decays of J/Ψ are unique observables. They allow direct access to the initial state of the collision and information of deconfinement. The J/Ψ yield is considered to be one of the most promising probes of deconfined matter, since theoretical models predict that the J/Ψ yield could be suppressed due to the color Debye screening effect in QGP. On the other hand, recent theoretical efforts shows the possibility of the J/Ψ yield increasing due to the coalescence of uncorrelated e+ and e− quarks. Also, a cold nuclear effects, such as nuclear absorption, may affect the final J/Ψ yield. Thus, the detailed study of J/Ψ yield in several kinds of collisions is important. We present the latest results of J/Ψ invariant yield and J/Ψ pT distribution obtained by using its lepton decay mode p+p, d+Au, and Au+Au collisions at RHIC. In addition to information from J/Ψ measurements, information from photon measurements is obtained at RHIC. the PHENIX discovery of a large photon excess over the meson-decay background in central Au+Au collisions at high pT confirms the final-state nature of the high-pT hadron suppression previously observed. We present a systematic study of direct photon production in p+p, d+Au, and Au+Au collisions.

4:00PM 2WB.00005 Color Glass Condensate and its implication. KAZUNORI ITAKURA, Institute of Particle and Nuclear Studies, KEK — I will briefly explain the basic concepts behind the physics of Color Glass Condensate (CGC), which appears as the universal state of hadrons and nuclei in very high-energy scatterings. The CGC is made of high density gluons which have only a small fraction of the total momentum, and is characterized by coherent strong gauge fields. Its density is saturated (typically of the order of 1/αs), which is induced by recombination process of two gluons into one (that is relevant when the gluon density is high). Theoretically, the CGC can be described by the weak-coupling technique since the typical transverse momentum of gluons, “saturation momentum,” Qs, becomes large enough at high energies. I will also discuss some phenomenological implications of the CGC picture to the RHIC experiments.

4:30PM 2WB.00006 The Future of High Energy Density Nuclear Physics at RHIC. SAMUEL ARONSON, Brookhaven National Laboratory — Brookhaven’s Relativistic Heavy Ion Collider (RHIC) is the world’s premier machine for the study of nuclear matter at extremely high energy density. RHIC has been in operation for five years and its experimental program has made discoveries that transform our understanding of strongly interacting matter at high energy density. From this new understanding compelling questions can be asked about the nature of QCD (e.g., confinement, chiral symmetry breaking, hadronization, etc.). I will discuss the plans to address these questions in the context of the future development of RHIC.

Sunday, September 18, 2005 2:00PM - 5:00PM – Session 2WC DNP JPS: Workshop 3B: Spin Structure Studies at RHIC Ritz-Carlton Hotel Salon 2

2:00PM 2WC.00001 Physics of Transverse Spin. YUJI KOIKE, Niigata University — In this talk, I present a theoretical overview on the novel features of the transverse spin phenomena in hard scatterings, in particular, single spin asymmetries (SSA). The large SSAs observed in pp collisions and semi-inclusive DIS reflects the chiral-symmetry breaking in QCD, and its understanding requires extension of the framework for hard processes: It requires formulating new concepts, such as intrinsic transverse momentum of quarks (“T-odd” distribution and fragmentation functions), quark-gluon correlation in a hadron (twist-3 effects) and the transverse extension of hadrons (impact-parameter dependent parton distribution) etc. I discuss recent developments in our understanding on SSA in terms of these novel effects.
study the fall-apart decay of beyond a nucleon-kaon scattering state. The challenges in the identification of resonances and scattering states in lattice QCD will be discussed. I will identify studies will be reviewed. Claims in the literature are varied, with some calculations reporting evidence of a pentaquark state and others indicating nothing have predicted pentaquark baryons, but the predicted masses are generally much higher than the observed one. I will discuss possible solutions between the features which are not necessarily expected from naive constituent quark model pictures. On the other hand, quark models with various interaction models energies.

The resulting cross section is only a few nb, which does not contradict the new CLAS result. large asymmetry between the production rates of the two targets; production from the proton is very much suppressed as compared with that from the neutron.

On behalf of the Belle Collaboration

3:00PM 2WC.00005 Measurement of Spin Dependent Fragmentation Functions in e+e- Annihilation at Belle1, RALF SEIDL, UIUC — The so-called Collins fragmentation function connects the transverse quark spin with a measurable azimuthal dependence of the produced hadrons around the quark’s momentum axis. Therefore, it can be used as a transverse spin analyzer in semi-inclusive DIS and proton-proton collisions. While in those measurements the Collins function appears convoluted with the so far unknown quark transversity distribution, it is directly accessible in e+e- collisions, where one measures a combination of a quark and an antiquark fragmentation function. We present measurements of azimuthal asymmetries for certain charge combinations of hadrons in which it is possible to minimize other systematic effects that could obscure the effect of spin-dependent fragmentation.

1On behalf of the Belle Collaboration

3:30PM 2WC.00006 Lattice QCD and Spin Physics , SHOICHI SASAKI, RIKEN BNL Research Center — The computation of nucleon properties in lattice QCD is now progressing with steadily increasing accuracy. I review the current status of recent and ongoing lattice calculations relevant for spin physics. This talk also includes a brief introduction of lattice techniques intended for the non-expert.

Sunday, September 18, 2005 2:00PM - 5:00PM –
Session 2WD DNP JPS: Workshop 4B: Beyond qq-bar and qqq: Pentaquarks and More Ritz Carlton Hotel Salon 1

2:00PM 2WD.00001 Theory overview , CARL CARLSON, College of William and Mary — This talk will attempt an overview of the theory relevant to pentaquarks, with some emphasis on anticipated widths for the different parities, and on production rates for different circumstances and energies.

2:30PM 2WD.00002 Spectroscopy of Pentaquark Baryons , MAKOTO OKA, Tokyo Institute of Technology — I summarize analyses of QCD-based approaches and constituent quark models of pentaquark baryon spectroscopy. QCD sum rules as well as lattice QCD simulations have been applied to the S = +1 pentaquark (Σ₅⁺) and its siblings. Their results do not completely agree with each other, but show interesting features which are not necessarily expected from naive constituent quark model pictures. On the other hand, quark models with various interaction models have predicted pentaquark baryons, but the predicted masses are generally much higher than the observed one. I will discuss possible solutions between the discrepancy between QCD and quark models, and most importantly with experiment.

3:00PM 2WD.00003 Summary of Lattice Pentaquarks , ROSS YOUNG, Jefferson Lab — The status of lattice pentaquark studies will be reviewed. Claims in the literature are varied, with some calculations reporting evidence of a pentaquark state and others indicating nothing beyond a nucleon-kaon scattering state. The challenges in the identification of resonances and scattering states in lattice QCD will be discussed. I will identify the differences between various lattice pentaquark simulations and aim to provide a physical description of the results.

3:30PM 2WD.00004 Production and decay of Θ⁺ , ATSUSHI HOSAKA, RCNP, Osaka University — In the first part we study the fall-apart decay of Θ⁺ within a non-relativistic quark model. Assuming J² of Θ⁺ are 1/2², matrix elements and decay rates are computed in such way that the role of the overlap functions (ΚΝ|Θ⁺) for spin, flavor, color and orbital wave functions can be studied. We find that for 1/2⁻ of (0s)², the width is too large to be identified with a narrow resonance, while it is about a several tens MeV for 1/2⁻. By assuming strong diquark correlations, the width is reduced to be of order 10 MeV. It is then pointed out that within a quark model, strong suppression can occur if J² = 3/2⁻. Based on these observations, we study more on the possibility J² = 3/2⁻. We take a brief look at an analysis based on flavor SU(3), where we see that the present data seems to favor the 3/2⁻ quantum numbers. Then we reconsider photo-productions of Θ⁺ from the proton and neutron again but this time for J = 3/2⁻. It is found that there is a large asymmetry between the production rates of the two targets; production from the proton is very much suppressed as compared with that from the neutron. The resulting cross section is only a few nb, which does not contradict the new CLAS result.
4:00PM 2WD.00005 Chiral Structure of D Mesons in the Vector Manifestation. MASAYSU HARADA, Nagoya University — Recently, BaBar, CLEO and Belle discovered the excited D mesons with J^P = 0^+ and 1^+. There are several proposal of their constituents for explaining the mass splitting between the D(0^+,1^+) mesons and the well-known D(0^−,1^−) mesons which is much smaller than the one calculated in the constituent quark model: The 4-quark picture, the D-K molecule picture, and so on. In this talk, I will introduce our work in which we consider the D(0^+,1^+) mesons as the chiral partner to the D(0^−,1^−) in the 2-quark picture. I will first introduce how to include the D(0^+,1^+) mesons and the D(0^−,1^−) mesons together with the pseudoscalar and vector mesons made from a light quark and a light anti-quark incorporating the heavy quark symmetry and the chiral symmetry. Then, starting with a hidden local symmetry Lagrangian at the vector manifestation fixed point and matching the bare theory to QCD, I will show that the mass splitting is well reproduced. I will also present our predictions on the hadronic decay processes of the excited D(0^+,1^+) mesons.

4:30PM 2WD.00006 Summary of Workshop. GERALD MILLER, University of Washington — I plan to discuss the experimental and theoretical talks and related publications that will be presented during the workshop.

Sunday, September 18, 2005 2:00PM - 5:00PM — Session 2WE DNP JPS: Workshop 5B: Nuclear States Under Extreme Conditions of Binding and Isospin Asymmetry Ritz-Carlton Hotel Amphitheatre

2:00PM 2WE.00001 Newly synthesized an isotope of the 113th element. KOJUKE MORITA, RIKEN (The Institute of Physical and Chemical Research) — The convincing candidate event of the isotope of the 113th element, were observed, for the first time, in the ^209Bi + ^70Zn reaction at a beam energy of 349.0 MeV with a total dose of 1.7 × 10^{19}. Alpha decay energies and decay times of the candidates, ^{278}_{113}, ^{274}_{111}, and ^{272}M_{t}, were (11.68 ± 0.04 MeV, 0.344 ms), (11.15 ± 0.07 MeV, 9.26 ms), and (10.03 ± 0.07 MeV, 7.16 ms), respectively. The production cross section of the isotope was deduced to be 55^{+10}^{-45} fb (10^{-39} cm^{-2}) [1]. The experiment was performed at RIKEN (The Institute of Physical and Chemical Research) Linear Accelerator (RILAC) Facility. The evaporated residues produced by the fusion reaction with a ^70Zn beam provided by the RILAC and the bismuth targets, were separated by a gas-as gas recoil separator (GARIS) from the beam particles and the target recoils, and were collected at the focus of GARIS. We observed an event of implantation of an evaporated residue in the position-sensitive semiconductor detector followed by four consecutive alpha decays terminated by a spontaneous fission decay. Assignment of the event was based on genetic correlation of sequential alpha decays to the already known nuclides ^{266}Db and ^{268}Db. The fourth alpha decay and the following spontaneous fission decay were assigned to be the decays of ^{266}Db and ^{268}Db, respectively because of agreements of decay energies and decay times with the reported values [2]. As a consequence, the preceding three alpha decays were assigned to be ones of ^{278}_{113}, ^{274}_{111}, and ^{272}M_{t}.


2:30PM 2WE.00002 Fusion mechanism of weakly-bound nuclei. KAZUHIRO YABANA, Institute of Physics, Univ. Tsukuba — Fusion mechanism of nuclei with halo structure is investigated theoretically. We describe the reaction as a three-body problem consisting of a halo nucleon and a core nucleus, which constitute the projectile, and a target nucleus. The three-body dynamics is solved by using the time-dependent wave-packet method. There are several advantages to employ the time-dependent method for the static problem: The method is useful to solve the three-body Schrödinger equation accurately. No explicit boundary condition is necessary to calculate the fusion probabilities from a wave-packet solution. A single wave-packet calculation provides reaction information for a certain incident energy range. The animation of the wave-packet dynamics provides us with intuitive pictures about the reaction dynamics. We find that the fusion probability of neutron halo nuclei is slightly hindered by the presence of the halo neutron, in opposite to a naive expectation that the weakly-bound neutron may enhance the fusion. In contrast, the fusion probability of proton halo nuclei is found to be much enhanced. The fusion cross sections are calculated for ^{6}He - ^{230}U and ^{11}Be - ^{208}Bi reactions, and are compared with recent measurements.

3:00PM 2WE.00003 Innovations and Opportunities for laser spectroscopy of exotic nuclei in Europe. JONATHAN BILLOWES, The University of Manchester — High resolution laser spectroscopy is a well-established method for measuring nuclear moments and charge radii of radioactive nuclei. Recent breakthroughs in ion beam bunching with RFQ devices and the in-source application of resonance ionization spectroscopy (RIS) open up the prospect of measuring exotic nuclei. The first ion beam cooler-buncher to be used in this way was installed at the IGISOL facility in the Accelerator Laboratory, Jyväskyla (JYFL). The Birmingham-Manchester-JYFL collaboration has used the improved sensitivity to make measurements of the neutron-rich fission fragments in the zirconium and yttrium isotope chains. The fast release times of the IGISOL ion source has also allowed a number of isomers to be measured both in the yttrium chain and also amongst the recently-measured scandium isotopes. The beam time-structure has allowed the collaboration to demonstrate a collinear-beams resonance ionization spectroscopy technique (CRIS) which has no duty-cycle losses associated with low repetition rate lasers and has the potential of an order of magnitude increase in sensitivity. It has the additional advantage over in-source RIS measurements pursued by the RILIS and FURIOUS groups of having much reduced Doppler broadening. A similar cooler-buncher is being built at Europe’s premier on-line isotope separator facility, ISOLDE, at CERN. The first on-line experiments are planned for 2006. The benefit this will bring to the laser techniques, coupled with the higher production rates of the volatile exotic nuclei will allow measurements in hitherto unexplored regions of the nuclear landscape. In the longer term, plans are well developed for laser spectroscopy experiments at the future GSI-FAIR facility. The LaSpec collaboration involves more than ten groups from Europe and America who will apply a range of techniques at the facility’s low energy beamline.

3:30PM 2WE.00004 Recent experiments of interaction and reaction cross sections and the related results. AKIRA OZAWA, University of Tsukuba — Recent experiments of interaction (σ_I) and reaction (σ_R) cross sections will be reviewed. Measurements of σ_I and σ_R have been proved to be effective tools to reveal the halo or skin structure in proton-rich and neutron-rich nuclei [1]. Very recently, σ_I for ^{72-80}Kr on carbon targets have been measured at FRS in GSI with relativistic energies (~1.4 GeV). Since the charge radii for the nuclei are known by optical isotope-shift measurements, by our σ_I measurements the proton skin thickness of the nuclei can be investigated. Some tentative results of the measurements will be presented. σ_R at intermediate energies are quite indispensable to deduce the effective matter density distributions by their energy dependence. Recently, σ_R have been extensively measured at RIPS in RIKEN by a new setup [2]. As a byproduct, longitudinal momentum distributions of fragments from a projectile can be measured at the same time [3]. In special, one and two nucleon(s) removal channels can be observed at the same time. Recently, by the setup, we performed experiments for ^{14-19}C and some proton rich nuclei including ^{20}Al, that is a potential proton halo candidate due to its small proton separation energy. Some results of the experiments will also be introduced.

4:00PM 2WE.00005 Pinpointing Structure of Exotic Nuclei Using Simple Signatures, E.A. MCCUTCHEON, Yale University — The advent of radioactive nuclear beams opens up entirely new regions of exotic nuclei for study. However, the experimental data on these nuclei will be sparse and different methods for elucidating structure from a few simple observables are necessary. An approach using the interacting boson approximation (IBA) model to interpret the low energy spectra of collective even-even nuclei will be presented. By investigating the intersection of constant contours of simple observables within the IBA symmetry triangle, the structure of a particular nucleus can be determined relative to the three dynamical symmetries of the IBA and to the phase structure in the triangle. This approach can be tested on isotopic chains near stability, then applied to exotic regions of nuclei.

1This work was supported by the U.S. DOE Grant No. DE-FG02-91-ER-40099.

4:30PM 2WE.00006 Shell model applications to new regions of nuclei, B. ALEX BROWN — I will outline the progress that is being made on applying the techniques of large-basis configuration mixing to new regions of nuclei, in particular the regions where radioactive beam facilities can explore now and over the next five years. The regions include those around the nuclei $^{24}$O, $^{42}$Si, $^{54}$Ca, $^{78}$Ni and $^{132}$Sn. The problems for determining the single-particle energies and the effective interactions starting from the NN interaction will be discussed.

3:30PM 2WF.00002 Recent results from NEMO 3 experiment, HIJENAKI OHSUMI, Saga University — The main goal of the NEMO3 experiment is to study neutrinoless double beta decay of different isotopes ($^{100}$Mo, $^{128}$Se etc.) with a sensitivity of up to $O(10^{25}$ y), which corresponds to a sensitivity for the effective Majorana neutrino mass at the level of $\sim (0.1 - 0.3)$ eV. The experiment is now going on in the Frejus underground laboratory (Laboratoire de souterrain de Modane, LSM). The recent results of this experiment are reported here.

3:00PM 2WF.00003 MOON (Mo Observatory Of Neutrinos) for double beta decay, MASAHARU NOMACHI, Osaka University — MOON (Mo Observatory Of Neutrinos) is aiming to observe neutrino-less double beta decay for studying neutrino mass of 50 meV region, which is important to be explored according to recent neutrino oscillation measurements. MOON is layers of plastic scintillator which are interleaved with thin $^{100}$Mo foils. Energies of two beta-rays are measured with the plastic scintillator. A few tons of $^{100}$Mo sources are necessary to collect enough number of events. Area of the foil will be several thousands square meters. In order to put many layers of Mo foils, compact and simple structure is applied to MOON detector. Because of high Q-value of $^{100}$Mo double beta decay, energies of most background events are far below the Q-value. Therefore, major source of background will be coincidence of two background events. To reject such events, time resolution and position resolution will be powerful tools. Two-neutrino double beta decay is also a background event to neutrino-less double beta decay, which is related to neutrino mass. Difference of energy spectrum is only way to separate them. Therefore, good energy resolution is also required. We have developed a proto-type detector, which is named MOON-1, to investigate performances of MOON detector. MOON-1 has 5 layers of plastic scintillator plate, which size is 53 cm x 53 cm and 1 cm thick. In order to obtain good energy resolution and position sensitivity, the plates are surrounded with 32 square PMTs, which size is 6cm x 6cm, Test measurements shows that position resolution is better than 4 cm (r.m.s.). Because of good coverage of PMTs, 12% (FWHM) energy resolution for 1 MeV electrons is achieved. Details of the measurements and background rejection capability are reported.

3:30PM 2WF.00004 The EXO-200 detector, ANDREA ROCAR, Stanford University — EXO-200 is a prototype detector for the Enriched Xenon Observatory (EXO) searching for double beta decay ($\beta\beta$) of xenon 136. It employs 200 kg of enriched liquid xenon (enriched to 80% in the isotope Xe-136, already in hand for the project). The xenon, in liquid phase (LXe) is also used as active medium contained in an all-Teflon, cylindrical, time projection chamber (TPC). Currently under construction at Stanford, its functionality will be tested prior to being housed underground at WIPP, New Mexico. EXO-200 will serve as a prototype for the 1-10 ton scale EXO experiment. It will allow researching low radioactivity building materials, optimizing the performance and operation of a large-scale xenon detector, and studying some of its crucial parameters, such as energy resolution. On the other hand, once completed, it will also be the largest running double-beta decay experiment. It will not employ the Ba-136 ion tagging technique being developed for EXO. EXO-200 is designed to have very competitive sensitivity for the effective Majorana neutrino mass at the level of $10^{-3}$ eV. It also aims at measuring the lifetime of the standard, although not yet observed, $\beta\beta$ decay of Xe-136 accompanied by neutrinos ($2\nu\beta\beta$). Both the ionization signal and the scintillation light produced by ionizing events in the xenon will be recorded. Such complementary information is proven to significantly improve the energy resolution of xenon detectors, a crucial requirement in order to separate the $2\nu\beta\beta$ and $0\nu\beta\beta$ processes. The TPC displays an electric field parallel to the cylinder axis with a central cathode and two sets of orthogonal wires at each end for 3D position reconstruction of the events. 700 large area avalanche photodiodes collect the scintillation light. A double-walled, vacuum-insulated copper cryostat filled with fluorocarbon fluid surrounds the xenon, providing a significant buffer for external gamma radiation as well as the necessary cryogenics.

4:00PM 2WF.00005 XMAS experiment and its double beta decay option, SHIGETAKA MORIYAMA, ICRR, University of Tokyo — XMAS is an underground experiment aimed at rare event search by using ultrapure liquid xenon in the Kamioka mine, Japan. The main physics targets of XMAS are cold dark matter, neutrinoless double beta decay, and low-energy solar neutrinos. We have done several test data taking during 2003 and 2004. We succeeded to reduce and measure Kr radioactivity in xenon. U and Th chain radioactivities were measured by Bi-Po method and found to be very low level. Although we are mainly developing dark matter detector, we have an option for double beta decay experiment with xenon. Unfortunately, due to high radioactivity of our PMTs, it is hard to utilize the dark matter detector for double beta decay search. We will report some activities for developing a detector for double beta decay experiment.

4:30PM 2WF.00006 Double Beta Decay Options in SNO, AKSEL HALLIN, Queen’s University — The heavy water experiment in SNO will complete data taking at the end of 2006. We are preparing a proposal for an experiment in which we will replace the heavy water with liquid scintillator, to measure low energy solar neutrinos, geo-neutrinos, reactor oscillations and double beta decay. We plan to measure double beta decay by dispersing isotopes into the scintillator volume. Large masses are possible, which allow us to set effective mass limits at a sensitivity $<100$ meV. I will report on the various techniques and isotopes that we are considering.
Hotel Plantation 1

2:00PM 2WG.00001 Neutrino processes in the Big-Bang and Supernovae, TOSHIKAZU KAJINO, National Astronomical Observatory, and University of Tokyo — Recent data of CMB anisotropies have suggested cosmological parameters which may manifest accelerating universal expansion. However, inferred baryonic density does not agree at 1σ C.L. with that determined from the Big-Bang nucleosynthesis (BBN) which satisfies all light element (D, 3,4He, and 7Li) abundance constraints. BBN is a unique cosmological process to test not only the cosmological theory but also the fundamental theory of particles and nuclei. We firstly discuss recent progress in particle and nuclear physics which may resolve partly the cosmological discrepancy of Ω b. We emphasize an important consequence of newly measured weak coupling constant in terms of neutrino life. Secondly, we discuss astrophysical aspect of the supernova (SN) neutrino-processes which contribute to the production of 7Li and 11B Li. SN neutrino thus plays an essential role in constraining chemical evolution of the light elements. We discuss that the neutrino-processes help understand the origin of the Spite-plateau of 7Li observed in metal-deficient halo stars, which makes the biggest uncertainties in the determination of Ω b from the BBN. Thirdly, we propose a theoretical model of disappearing cold dark matter model of SUSY particles in brane world cosmology, and discuss how the BBN constraints allow this model, satisfying many other observational constraints from CMB anisotropies, Type Ia supernova magnitude-redshift relation, galaxy M/L ratios, and galaxy gas-fractions. We finally discuss other possible improvements in nuclear reaction rates which have common significance both in BBN and SN r-process where the neutrino processes again play the important role.

2:30PM 2WG.00002 Supernova Neutrinos and Nucleosynthesis of Light Elements, TAKASHI YOSHIDA, Tohoku University — During supernova explosions, a huge amount of neutrinos are emitted from the proto-neutron star. The neutrinos interact with nuclei in the supernova ejecta and change the compositions. This is called the neutrino-process. The neutrino-process plays an important role for 11B and 7Li production in supernovae and the amounts of 11B and 7Li strongly depend on the characteristics of supernova neutrinos, such as the total neutrino energy and the neutrino spectra. The continuous 11B and 7Li production in supernovae contributes to Galactic chemical evolution of the light elements. In this workshop, we show the dependence of the yields of 11B and 7Li in supernovae on the characteristics of supernova neutrinos such as the total neutrino energy and the neutrino energy spectra. Then, we constrain the supernova neutrino spectra from recent Galactic chemical evolution models of light elements. It is known that neutrino oscillations change the energy spectra of supernova neutrinos during the neutrino propagation in the supernova ejecta. This change would also affect the yields of 11B and 7Li in supernovae. We also discuss the effect of the neutrino oscillation on the light element synthesis in supernova explosions.

3:00PM 2WG.00003 Nucleosynthesis of rare heavy elements in supernova explosions, TAKEHITO HAYAKAWA, Japan Atomic Energy Research Institute — The origin of the p-nuclei among heavy elements has been discussed for long years. Analyzing the solar system abundances, we have found the empirical scaling laws concerning the p- and s-nuclei with the same atomic number. The abundance ratio of s- and p-nuclei is almost constant with a wide range of the atomic number. In addition, the ratio of two p-nuclei with the same atomic number is also constant. They are an evidence that twenty-seven p-nuclei are dominantly synthesized by the p-process in SNe. We have calculated the ratios by a Type II SN model and the results have reproduced these scalings. The other eight p-nuclei may be synthesized by different processes such as the r-process. We have proposed two novel concepts of universality of the p-process and a new nuclear cosmochronometer of the p-process, which are based on the scalings. We also report the experimental study using thermal neutrons provided by nuclear reactors for the 187Re,187Os cosmochronometer of the r-process. Co-authors: Toshiyuki Shizuma, Nobuyuki Iwamoto, Satoshi Chiba, Tuneo Nakagawa, Nobuo Shinhara, Toshitaka Kajino, National Astronomical Observatory, Hideyuki Umeda, Ken’ichi Nomoto, University of Tokyo.

3:30PM 2WG.00004 Simultaneous Matter-Enhanced Transformation of Neutrinos and Anti-neutrinos in Astrophysical Environments, GEORGE FULLER, University of California, San Diego — The neutrino flavor evolution problem in supernovae is notoriously difficult. We point out a simple neutrino energy-independent solution in a specific limiting case that corresponds closely to some of the “synchronization” solutions seen numerically. Neutrino-neutrino forward scattering produces both flavor diagonal and off-diagonal potentials for neutrinos propagating coherently above the proto-neutron star in supernovae and in the early universe. We show that both the active neutrinos (ν e,ν μ,ν τ) and the corresponding antineutrinos can be maximally mixed in medium over broad ranges of neutrino energy when the flavor off-diagonal potential is large compared to the neutrino-matter potential. With this simple criterion we can identify epochs in the evolution of the supernova environment where large neutrino and antineutrino mixing can occur. We discuss the effects of this on shock re-heating and r-process nucleosynthesis models and on the expected neutrino signal.

4:00PM 2WG.00005 Neutrinos At The Heart Of Gamma Ray Bursts, JAMES KELLER, University of Minnesota — The identification of redshifts in the optical afterglows of long-duration gamma-ray bursts (GRB) has settled the dispute of their location in favor of an origin at cosmological distances. Other observational evidence points towards their association with the death throws of massive stars. This has led many to posit that the most plausible model for the GRB central engine is the formation of a stellar mass black hole and an accretion disk at the center of a collapsing massive star. The accretion disk cools by neutrino emission and successful explosions may, in part, rely upon the ability to extract momentum and energy from the large neutrino luminosity. I present calculations for the energy/momentum transfer and discuss their implications for these GRB models.

Sunday, September 18, 2005 2:00PM - 5:00PM –
Session 2WH DNP JPS: Workshop 8B: Neutron-Rich Nuclei in Nuclear Astrophysics Ritz-Carlton Hotel Plantation 1
2:00PM 2WH.00001 Nuclear equation of state from neutron star structure and cooling, JAMES LATTIMER, Stony Brook University — Neutron stars represent the ultimate laboratory for the study of dense matter, especially neutron-rich dense matter. Such matter may exhibit phenomena and conditions not observed anywhere else in the universe, such as hyperon-dominated matter, deconfined strange quark matter, superfluidity and superconductivity, opacity to neutrinos, and extreme magnetic fields. To date, the two most important properties of neutron stars, their typical radii and their maximum mass, remain elusive. The determination of each would yield important information about two different aspects of dense matter, the radius being primarily a function of the isospin dependence of the nucleon-nucleon force near the nuclear saturation density, and the maximum mass depending upon the composition and stiffness of supranuclear matter. This talk will focus on how the structure of neutron stars (i.e., the maximum mass, radii, moments of inertia, crustal thicknesses, and central densities) depends upon the equation of state and the composition of dense matter. In addition, it will summarize how recent observations are constraining these structural properties. These observations include radio and X-ray studies of binary pulsars, radio studies of pulsar glitches, X-ray and optical studies of the thermal emission from isolated neutron stars and pulsars, and observations of burst sources believed to be associated with the neutron star surface. Radio binary pulsars already yield several accurate mass measurements, and several more estimated masses, some of which challenge conventional wisdom concerning the maximum neutron star mass. In addition, the potential exists to measure the moment of inertia of at least one neutron star (PSR J0737-3039) in a radio binary which could provide a radius determination of unprecedented accuracy. Glitches from pulsars can help determine the thickness of neutron star crusts, which depends upon the stellar mass and radius, as well as the unknown pressure at the core-crust interface at approximately one half of the nuclear saturation density. Thermally emitting sources yield valuable data about the redshifted area, redshifted temperatures, and ages of the emitting sources, which in turn proffer information about the cooling histories of neutron stars. Neutron star cooling indirectly informs us about the internal composition and the superfluid properties of dense matter. Burst sources, including quasi-periodic oscillators, may convey surface redshift data, which together with radiation radius information, will yield neutron star masses and radii. Parallel constraints from laboratory data, such as nuclear binding energies, dipole resonance energies, and neutron skin thickness determinations are also discussed for comparison.

2:30PM 2WH.00002 Pycnonuclear burning on accreting neutron stars and constraints on the nuclear equation of state, EDWARD BROWN, Michigan State University — Many neutron stars accrete H- and He-rich matter from a stellar companion. Over the lifetime of the binary, enough matter can be transferred to replace the crust of neutron star. As the material is compressed, the rising electron Fermi energy induces electron captures. When the ionic charge becomes sufficiently small, the zero-point motion of the ions induces the pycnonuclear fusion of nuclei. These reactions release approximately 1 MeV per accreted nucleon deep in the crust, where the thermal diffusion time is years to decades. The temperature in the crust is set by balancing this heating with thermal radiation from the surface and neutrino emission from the crust and core. Many neutron stars accrete intermittently; when the accretion halts, the surface is detectable with X-ray telescopes such as Chandra and XMM. Observations of transiently accreting neutron stars thus provide a means to infer the neutrino emissivity of the core, complimentary to observations of isolated neutron stars. In this talk, I compare theory and observations of transiently accreting neutron stars. Observations can detect the thermal relaxation of the neutron star crust following the end of rapid accretion, and appear consistent with an enhanced neutrino emissivity, such as direct Urca, from the core. The temperature of the crust also sets, in part, the depth at which carbon unstably ignites. Unlike the transients, the recurrence time and energetics of unstable carbon burning are more consistent with a hotter neutron star crust, as if the neutrino emissivity were suppressed. I discuss ongoing work to improve the nuclear physics input for models of the neutron star crust.

3:00PM 2WH.00003 Measuring Neutron Star Radii and the Dense Matter Equation of State, ROBERT RUTLEDGE, McGill University — Normal stars – like our sun, which is \( \approx 10^6 \) km in radius – have their size governed by the gas equation of state, which is well understood. White dwarfs – \( \approx 5000 \) km – have their size governed by electron degeneracy pressure, also well understood. Neutron stars – \( \approx 10 \) km – have their size governed by the dense matter equation of state (dEOS), which is not well understood. Measuring neutron star radii can place important constraints on the dEOS. Precise measurements of neutron star radii have only recently been made possible, using X-ray spectroscopy from modern observatories: NASA’s Chandra X-ray Observatory, and ESA’s XMM-Newton Observatory. I will review the theoretical background which makes these measurements possible, the observational results to date, the resulting constraints on the dEOS, and future prospects for improved constraints.

3:30PM 2WH.00004 Phases of Dense Quark Matter and Neutron Star Structure, ANDREW STEINER, Los Alamos National Laboratory — We review recent work on the phase structure of dense quark matter. At densities of relevance to compact objects the strange quark mass is negligible compared to quark chemical potentials. We discuss the role of the strange quark mass in determining the phase structure. The color-flavor-locked (CFL) phase, the 2SC (two-color superconducting) phase, gapless phases, and the LOFF phase as well as Bose condensates may all play a role. We discuss how these quark matter phases may affect observable aspects of neutron star evolution and the neutrino signal in core-collapse supernovae. We highlight a recent calculation which includes the six-fermion interactions in the quark-quark channel for the first time.

4:00PM 2WH.00005 Origin of r-process elements, KAORI OTSUJI, University of Chicago — Astrophysical sites for the r-process are still unknown. Recent observations indicate that there is a scatter of the r-process elements to iron ratios in metal-poor stars. In addition, there is a scatter of light r-process elements (Sr, Y, Zr) to heavy r-process elements (heavier than Ba) ratios. Those results imply that there are at least two different r-processes, main r-process and weak r-process. As the candidates of main r-process site, Type II supernovae and neutron star mergers have been discussed by several authors. I will show new nucleosynthesis calculations in high entropy environments (Type II SNe) and low entropy environments (neutron star merger). Our results suggest that it is difficult to reproduce observed abundance distribution with r-process in low entropy environments. On the other hand, the mass range of progenitor of r-process supernovae is also a point of issue. Two different authors support main r-process in light mass progenitor supernovae based on their Galactic chemical evolution models. However, there are uncertainties related to models. I will discuss the possibilities of main r-process in massive Type II supernovae.

4:30PM 2WH.00006 The future of neutron rich matter in heaven and earth, CHARLES HOROWITZ, Indiana University — Neutron stars and other compact astrophysical objects are made of neutron rich matter. We describe a variety of laboratory experiments that indirectly probe neutron rich matter using beams of electrons, heavy ions, and radioisotopes. The Parity Radius Experiment (PREX) aims to measure the neutron radius of \( ^{208}\text{Pb} \) using parity violating electron scattering. Precisely measuring the neutron rich skin of a heavy nucleus determines the density dependence of the structure, or how the energy rises for systems with excess neutrons. This has many implications for the crust, composition, radius, and cooling rate of neutron stars. PREX is a precision experiment on a stable nucleus and yields complimentary information to experiments with neutron rich radioactive beams. Next, we present semiclassical molecular dynamics simulations of the nonuniform neutron rich matter in the inner crust of a neutron star. This complex material is called nuclear pasta and results from competition between nuclear attraction and coulomb repulsion. Pasta phases are closely related to the multiple large fragments formed in some heavy ion collisions. The properties of pasta may be important for the electromagnetic, neutrino, and gravitational radiations of neutron stars. Finally, we present the model independent equation of state of low density nuclear matter based on the virial expansion using nn, n-alpha, and alpha-alpha elastic scattering phase shifts.

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Session 3S JPS: Nishina Commemorative
Ritz-Carlton Hotel Ritz-Carlton Ballroom

Sunday, September 18, 2005 6:30PM - 7:00PM
resonances. The third topic is “gas-like” states in light nuclei.

Deformations of neutron and proton distributions in unstable nuclei. The second is the superdeformation in sd shell nuclei and its relation to nuclear molecular

Department of Physics, Kyoto University — Three recent topics of theoretical studies of exotic nuclear structure are discussed. The first topic is different

Spiral2, we hope that a new ans comprehensive picture for the nuclear system is established and the mechanism of creating chemical elements in the universe

compared with the present facility. In-flight fission of a 350 MeV/nucleon primary beam of uranium will be used as well as projectile fragmentation of ions, such

now under construction and will be commissioned during the year 2006. The RIBF is designed to provide much wider range of RI beams with higher intensities

researches, a new project called RI Beam Factory (RIBF) has been planned at RIKEN. Its basic part (accelerators and an RI beam separator called BigRIPS) is

many light unstable nuclei. Through investigations with such exotic beams provided by RIKEN facility together with similar ones in the world, NSCL, GANIL,

GSI, and Lanzhou, for example, many new nuclear properties have been found, such as particle-stability in the vicinity of the neutron drip-line, properties of

But, the result is clarified.

them “radioactive isotope (RI) beams”, which have been provided since 1990. The separator RIPS can produces a beam with the world’s highest intensity for

Many graduate students, including myself, as well as other young astrophysicists were inspired by the discussions with Bethe. I was fortunate to have had an opportunity to collaborate with Bethe on the subject of “nuclei in neutron star matter.” In this talk, I shall speak about my memories of Bethe during this period. Although it was for but a short time, the research which was initiated in the collaboration with Hans Bethe developed into a full program involving neutron stars, supernovae, and neutrino astrophysics.

Monday, September 19, 2005 1:45PM - 5:30PM —

Session AP DNP JPS: Plenary Session: Future Directions in Nuclear Physics Ritz-Carlton Hotel

Ritz-Carlton Ballroom

1:45PM AP.00001 Welcome , VIRGINIA R. BROWN, Massachusetts Institute of Technology and University of Maryland —

2:00PM AP.00002 The Great Science Questions Driving Nuclear Science Today , MICHAEL S. TURNER, National Science Foundation — In today’s highly competitive world of funding for discovery science, each field must clearly articulate its science goals and priorities, before it talks about how much money it needs and what it wants to build (Science First!). Also important is identifying the synergies and overlaps with other disciplines, coordination between agencies and plans for international cooperation/coordination. I believe that Nuclear Science has a rich agenda for discovery, and in this talk I will engage the community in a discussion of what the big questions are, in preparation for the NRC Decadal Survey in Nuclear Science.

2:45PM AP.00003 Perspective of nuclear physics and nuclear astrophysics studies , TOHRU MOTOBAYASHI, RIKEN — In recent decades, studies with beams of unstable nuclei have greatly developed in the fields of nuclear structure physics and nuclear astrophysics. At RIKEN, beams of unstable nuclei with a few tens MeV/nucleon energies have been produced by the projectile-fragmentation scheme. We call them “radioactive isotope (RI) beams”, which have been provided since 1990. The separator RIPS can produces a beam with the world’s highest intensity for many light unstable nuclei. Through investigations with such exotic beams provided by RIKEN facility together with similar ones in the world, NSCL, GANIL, GSI, and Lanzhou, for example, many new nuclear properties have been found, such as particle-stability in the vicinity of the neutron drip-line, properties of neutron halo and skin, appearance and disappearance of magic numbers, and decoupling of neutron and proton motion. Nuclear astrophysics studies have also been made with direct and indirect methods for nuclear burning processes involving unstable nuclei. Encouraged by the achievements of these RI-beam based researches, a new project called RI Beam Factory (RIBF) has been planned at RIKEN. Its basic part (accelerators and an RI beam separator called BigRIPS) is now under construction and will be commissioned during the year 2006. The RIBF is designed to provide much wider range of RI beams with higher intensities compared with the present facility. In-flight fission of a 350 MeV/nucleon primary beam of uranium will be used as well as projectile fragmentation of ions, such as those of Xe, Kr and Ca. We aimed at greatly extending the region of nuclei to be studied. Toghther with other new generation facilities like RIA, FAIR and Spiral2, we hope that a new ans comprehensive picture for the nuclear system is established and the mechanism of creating chemical elements in the universe is clarified.

3:30PM AP.00004 Coffee Break —

4:00PM AP.00005 Some topics of theoretical studies of exotic nuclear structure , HISASHI HORIUCHI, Department of Physics, Kyoto University — Three recent topics of theoretical studies of exotic nuclear structure are discussed. The first topic is different deformations of neutron and proton distributions in unstable nuclei. The second is the superdeformation in sd shell nuclei and its relation to nuclear molecular resonances. The third topic is “gas-like” states in light nuclei.
Monday, September 19, 2005 7:00PM - 10:00PM — Session BA DNP JPS: Recent Progress in Nuclear Astrophysics Ritz-Carlton Hotel Salon 4

7:00PM BA.00001 Damped Lyman Alpha Systems: Neutral gas Reservoirs for Star Formation and Element Production at High Redshifts, ARTHUR WOLFE, UCSD — Damped Lya systems (DLAs) are a population of quasar absorption systems that dominate the neutral-gas content of the Universe in the redshift interval \( z = 0.5 \). I discuss evidence that the DLAs serve as important neutral-gas reservoirs for star formation at high redshifts, and as a result, appear to be the progenitors of modern galaxies. Specifically, accurate measurements of the neutral-gas mass per unit comoving volume, \( \Omega_{\text{gas}} \), reveals evidence for a statistically significant decrease in \( \Omega_{\text{gas}} \) with time, which is suggestive of gas consumption by star formation. Further indirect evidence for star formation stems from the observed increase in metal abundance with time, which indicates element enrichment by star formation: measurements of abundance ratios such as (Si/Fe) and of the “odd-even” effect further indicate metal enrichment primarily by type II supernovae. Finally, I discuss a technique for measuring the heating rate of the gas. The most plausible heat source is shown to be UV radiation emitted by massive stars residing in DLAs. The implied UV luminosity per unit comoving volume implies that a subset of DLAs is heated by compact regions of intense star formation that are identified as the Lyman break galaxies.

7:45PM BA.00002 Experimental studies of high-temperature hydrogen burning using low-energy radioactive beams, TAKASHI TERANISHI, Kyushu University — Nuclear reactions of unstable nuclei play a key role in explosive burning in the universe. We have been conducting experiments with low-energy radioactive beams to learn the critical nuclear reactions under explosive condition, especially the early stage of the rp-process. We will report recent results using the CRIB separator at CNS, University of Tokyo. Low-energy radioactive beams at about 5 MeV/nucleon or below are produced by the low-energy in-flight method from high-intensity heavy-ion primary beams. The CRIB line, consisting of a magnetic separator and a Wien filter, can effectively purify the secondary beams. A series of experiments was performed to study proton elastic resonance scattering \(( A + p \) with unstable nucleus \( A \). The information of the \( A + p \) resonances \(( E_e, J^\pi \) and \( I^\pi \) in nucleus \( B \) may help understand resonance contributions to hydrogen-burning \(( p + \gamma)B \) reactions under high temperature conditions. We will show the resonance data of \( ^{11}C + p / ^{22}N + p \) (relevant to the hot pp-chain), \(^{14}N + p \) (hot CNO), \(^{21}Mg + p \) (break out from the NeNa cycle), and some others. Other experimental projects for measurements of stellar reactions are in progress. For example, the direct measurement of \( ^{14}O(p, x) \) at the first stage of the high-temperature rp-process was performed for the first time using a high-intensity \(^{14}O \) beam and a thick cold He target. The current status of the projects and future outlook will be discussed.

8:30PM BA.00003 Neutrinos and the r-process, GAIL MCLAUGHLIN, North Carolina State University — While the mechanism for producing the heaviest elements has been understood for half a century, the astrophysical site remains a mystery. We will consider and compare two possible sites: the neutron-driven wind of the type II supernovae and the outflow from accretion disks surrounding black holes. These disks are likely to form from either neutron star mergers or from the collapse of rapidly rotating massive stars. In either case there is a significant flux of neutrinos which will impact the neutron-to-proton ratio and thus the nucleosynthesis. We will discuss the role of the neutrinos and the prospects for obtaining an r-process in each environment.

9:15PM BA.00004 Core-collapse supernovae, r-process nucleosynthesis, and the physics of unstable nuclei, KOHSUKE SUMIYOSHI, Numazu College of Technology and National Astronomical Observatory of Japan — Recent findings of r-process elements in extremely metal-poor stars are considered to be clear evidence that these heavy elements are created in explosive astrophysical phenomena such as core-collapse supernovae. Accumulated observational data suggest further that there might be more than one episode responsible for the r-process nucleosynthesis. These observed facts are the important clues to identify the astrophysical origin of r-process elements, and furthermore strengthen the motivation to clarify the explosion mechanism of core-collapse supernovae. I discuss two aspects of supernova physics in this invited talk:

First, I discuss that the r-process depends on the outcome of supernova explosions from various progenitor masses through hydrodynamical mass ejection mechanism, thermodynamic conditions of the neutrino-driven winds, and others. We demonstrate that the nuclear reactions of neutron-rich nuclei in the light mass region play the crucial roles in the r-process.

Secondly, I discuss recent progress and continuing efforts in understanding explosion mechanism of core-collapse supernovae, in the light of nuclear physics of unstable nuclei. The data table of relativistic equation of state (EOS), which we have constructed by adopting the data of unstable nuclei such as neutron-skin thickness, enables us to study the influence of EOS in modern supernova simulations. I report on how the supernova dynamics is different each other with the new EOS table and the conventional set of EOS. I also reveal the thermal evolution of central core at late stage and the resulting signals of supernova neutrinos. I stress that the different compositions including neutron-rich nuclei would appear in supernova cores, so that they might change the electron-capture and neutrino-reaction rates to help successful explosions. I discuss current needs and possible extensions of nuclear physics in supernova simulations.
7:30PM BB.00002 Updates on $\beta$-$\nu$ correlation measurement of optically trapped $^{21}$Na atoms, REINA MARUYAMA, JAMIL ABO-SHEAER, PAUL VETTER, STUART FREEMAN, UCBerkeley/LBNL — Using magneto-optically trapped sodium-$21$ neutral atoms produced at the Berkeley 88-inch cyclotron, we are measuring the beta-neutrino correlation coefficient. Optical traps offer a suitable environment for precision measurements, and offer us isotopically pure sodium atoms that are localized, nearly at rest, and relatively free from external perturbations. We can reconstruct the decay kinematics from the time-of-flight of the daughter nuclei from the trap to our detector. Our last measurement yielded a beta-neutrino correlation coefficient, $a_{\nu}$, that disagrees by 3.6$\sigma$ from the Standard Model prediction. I will discuss the status of the experiment, our studies of systematic effects, and possible explanations for this discrepancy.

7:45PM BB.00003 Beta-neutrino correlations from the beta decay of optically trapped $^{38m}$K atoms, A. GORELOV, D. MELCONIAN, M. TRINCZEK, Simon Fraser U., W.P. ALFORD, U. Western Ontario, J.A. BEHR, P.G. BRICAULT, M. DOMBSKY, K.P. JACKSON, TRIUMF, D. ASHERY, Tel Aviv U., F. GLUCK, U. Mainz — The $\beta$-$\nu$ correlation parameter, $a$, has been measured in the $0^- \rightarrow 0^+$ beta decay of trapped $^{38m}$K (lifetime 0.924s) atoms to place limits on the possible contribution of a scalar interaction to nuclear beta decay [A. Gorelov et al., PRL, 94, 142501(2005)]. A magneto-optical trap provides an isomERICly selected and backing-free source of atoms, localized in a volume less than 1mm in diameter, so the low-energy recoiling nuclei can freely escape and be detected in coincidence with betas in back-to-back geometry. The $\beta$-$\nu$ correlation is measured by observing the positron in a $\Delta E$-$E$ telescope and the time of flight of the recoiling Ar nucleus in a micro-channel plate (MCP). The application of a uniform electric field along the detection axis toward the MCP allows separation in time of the $\alpha^+$, $\alpha^-$ and higher charge states of Ar ions as well as increasing both their collection and detection efficiencies. Analysis of about 160,000 events with the positron energy above 2.5 MeV ($1/2$ the $Q$-value) resulted in the $\beta$-$\nu$ correlation parameter $a = 0.9981 \pm 0.0030$, consistent with the Standard Model prediction $a = 1$. Future modifications of the experimental apparatus and data analysis may give us a possibility to reduce systematic errors and extend the search to lower beta energies.

8:00PM BB.00004 Search for right-handed currents in the $\beta^+$ decay of laser-cooled, polarized $^{37}$K, D. MELCONIAN, A. GORELOV, Simon Fraser University, J.A. BEHR, K.P. JACKSON, TRIUMF, D. ASHERY, O. AVIV, Tel Aviv University, S. GU, M.R. PEARSON, University of British Columbia, W.P. ALFORD, University of Western Ontario, S. FOSTNER, University of Guelph — We have finished analyzing a measurement of the neutrino asymmetry parameter of the decay of polarized $^{37}$K, which is sensitive to physics outside of the Standard Model. The atom cloud, initially cooled and confined by a magneto-optic trap, was optically pumped to achieve (96.5 $\pm$ 0.7)% nuclear polarization. We non-destructively monitored this polarization and the cloud characteristics using a novel photoionization technique. The observed recoil asymmetry, directly related to the neutrino asymmetry, yielded $B_{\nu^{-}} = -0.771 \pm 0.020$ (stat) $\pm 0.011$ (syst). This initial measurement — the first in a system other than the neutron — is in agreement with the Standard Model prediction of $-0.7692(13)$. In the manifest left-right symmetric model, this limits the mass of a possible right-handed boson to be $\gtrsim 180$ GeV/c$^2$ (90% CL). Though this is not yet competitive with limits from other nuclear, neutron and $\mu$ decay experiments, systematics of this first measurement have been identified and can be reduced. Modest improvements of this method will reach an accuracy of $< 0.5\%$, at which point it becomes complementary to other experiments. Supported by NSERC, NRC through TRIUMF, and CIPi.

8:15PM BB.00005 UCNA: A Measurement of the beta-asymmetry using Ultracold Neutrons (UCN), HENNING O. BACK, A.T. HOLLEY, R.W. PATTIE, A.R. YOUNG, NCSU, B. FILIPPONE, B. PLASTER, J. YUAN, Caltech, P. GELTENBORT, University of California, Berkeley — Using ultracold neutrons (UCN), one can extract the $V_{ud}$ element of the CKM matrix, a critical element in CKM unitarity tests. By using a new SD$_3$ super thermal source at LANSE, large fluxes of UCN are expected for the UCNA project. These UCN will be 100% polarized using a 7T field, and directed into the beta spectrometer. This approach, together with an expected large reduction in backgrounds, will result in an order of magnitude reduction in the critical systematic corrections associated with current neutron beta-asymmetry measurements.

8:30PM BB.00006 Measuring the lifetime of the muon to 1 ppm with MuLan at PSI, DAVID HERTZOG, University of Illinois at Urbana-Champaign, MULAN COLLABORATION — The MuLan collaboration$^1$ will measure the positive muon lifetime to 1 ppm. This precision will determine the Fermi coupling constant $G_F$, which sets the strength of the weak interaction, to 0.5 ppm. In addition to its fundamental connection to the structure of the standard model, the $\mu^+$ lifetime is needed as a normalization for muon capture experiments. A $\sim 12.5$ kV electric kicker is used to impose a pulse structured on the continuous muon beam at the Paul Scherrer Institute, with a bunch of $\sim 50$ muons arriving within a 5 $\mu$s beam-on time followed by a 22 $\mu$s beam-off measuring period. Muons are stopped in a depolarizing target, either amorphous sulfur or Arnokron-3, to reduce the effects of spin rotation; an external magnetic field is applied to dephase the muons over the accumulation time. A scintillator hodoscope with 170 tile pairs arranged in a truncated icosahedral ("soccer ball") geometry provides a high level of segmentation to minimize pulse pileup. Similarly, new waveform digitizers will resolve pulses at separations of 4 ns. A dataset is in hand that should provide an initial result with 7 to 10 ppm precision, a factor of 2 better than the current world average, and major production running is scheduled in 2005 and 2006. MuLan is supported by the National Science Foundation and the Department of Energy$^1$ U.C. Berkeley - Boston U. - U. Illinois - Istanbul Tech. U. - James Madison U. - U. Kentucky - KVI - PSI

8:45PM BB.00007 Precise Measurement of Muon Capture on the Proton, FREDERICK GRAY, University of California, Berkeley, MUCAP COLLABORATION — The $\mu$Cap experiment is measuring the rate of muon capture on the proton in hydrogen. Muons are stopped in a time projection chamber (TPC) filled with isotopically pure protium gas that contains of order $10^{-6}$ deuterium and $10^{-6}$ higher-$Z$ impurity contamination. The active target allows the muon to be tracked to its stopping point so that only those stopping within the chamber, well away from the walls, are included in the data set. The effective lifetime of the negative muon is measured in this environment from the time spectrum of decay electrons. It is compared with the positive muon lifetime to determine the capture rate, which in turn gives $g_\nu$, the induced weak pseudoscalar form factor of the proton. Precise theoretical predictions of $g_\nu$ have been made using heavy baryon chiral perturbation theory, with uncertainties at the level of 3%. The current experimental situation is controversial and inconsistent, with significant ambiguity introduced by the formation of $pp\mu$ molecular states in the liquid hydrogen targets that were used in these experiments, a difficulty that is avoided with the present gas target of 100 times lower density. A precise measurement to compare with theory will provide a sensitive test of the chiral symmetry of QCD. A "blind" analysis of the data collected in fall 2004 (a $\sim 15\%$ measurement of $g_\nu$) is in progress. Data collection will continue in 2005 and 2006, with an eventual precision goal of 1% in the capture rate corresponding to $7\%$ in $g_\nu$. The support of DOE and NSF is gratefully acknowledged.

9:00PM BB.00008 Towards Higher Precision Measurements of the Muon Decay Parameters by TWIST, RICHARD MISCHKE, TRIUMF, TWIST COLLABORATION — The TWIST experiment has just published its first results for the Muon Decay Parameters $\rho = 0.795800 \pm 0.000023$ (stat) $\pm 0.000079$ (syst) $\pm 0.000243$ (pdf) and $\delta = 0.74964 \pm 0.00060$ (stat) $\pm 0.00112$ (syst). These results limit any possible deviations from the Standard Model predictions for these parameters by a precision of 2 to 3 times better than the previous results. This talk will discuss the next phase of the experiment, which will include higher statistical precision and reduced systematic uncertainties.
9:15PM BB.00009 First Direct Measurement of \(P_{\mu, \xi}\) by TWIST  . MICHAEL HASINOFF, University of British Columbia, TWIST COLLABORATION — The TWIST experiment is completing its first direct measurement of the Muon Decay Parameter \(P_{\mu, \xi}\). Together with the other Michel parameters describing normal muon decay, \(\xi\) provides sensitive tests of the Standard Model of electroweak interactions. This talk will discuss the measurement and the assessment of systematic uncertainties, which dominate the precision of the result. The physics implications will be presented.

9:30PM BB.00010 New results from the PIBETA experiment\(^1\). DINKO POCANIC, University of Virginia, PIBETA COLLABORATION — The PIBETA project has undertaken a to make precise measurements of the branching ratios of the rare pion decays: \(\pi^+ \rightarrow e^+\nu\nu\) (beta), and \(\pi^+ \rightarrow e^+\gamma\gamma\) (radiative), as well as the muon radiative decay \(\mu^+ \rightarrow e^+\nu\nu\gamma\). We report updated results for the integral and differential branching ratio for these processes, as well as derived physical quantities: \(V_{ud}\), the Cabibbo-Kobayashi-Maskawa quark mixing matrix element, \(F_A\) and \(F_V\), the pion axial and vector form factors, respectively, a new limit on \(F_V\), the pion tensor form factor, as well as a new value of the muon decay parameter \(\eta\). The project will next turn its attention to a new measurement of the \(\pi^+ \rightarrow e^+\nu\nu\) decay rate.

\(^1\)Supported by US NSF, US DOE, PSI, JINR Dubna and RFBR

9:45PM BB.00011 aCORN: A Precision Measurement of the Neutron Decay \(a\)-coefficient . F.E. WIETFELDT, R. BADICI, B.M. FISHER, C. TRULL, Tulane University, M. LEUSCHNER, IUCF, B. COLLETT, G.L. JONES, Hamilton College, A. KOMIVES, DePauw University, R. WILSON, B. C. YEROZOLIMSKY, Harvard University, M.S. DEWEY, J.S. NICO, NIST, YU. MOSTOVOY, Kurchatov Institute, J. BYRNE, University of Sussex — The \(a\)CORN experiment will make a precision (< 1\%) measurement of the electron-antineutrino angular correlation (\(a\)-coefficient) in neutron beta decay. It uses a novel collimation geometry in which the \(a\)-coefficient is proportional to an asymmetry in beta-proton coincidence count rates, so that precision spectroscopy of the particles is not necessary. The apparatus is now being constructed; it will be integrated and tested at the new LENS facility at Indiana University in 2007 and then moved to the NIST Center for Neutron Research for a precision physics measurement in 2008. The current status of design and construction will be presented. Work supported by NSF grants PHY-0420851, PHY-0420361, PHY-0420716, PHY-0420563, and NIST (U.S. Dept. of Commerce).

10:00PM BB.00012 Measuring the Proton’s Weak Charge . DAVID MACK, T.JNAF, JEFFERSON LAB QWEAK COLLABORATION — Precision measurements of Standard Model-suppressed, weak-scale observables provide a window on potential new physics at the TeV scale. The proton neutral weak charge, \(Q_{W, p}\), is just such a suppressed quantity being proportional to \(1 - 4 \sin^2 \theta_W \approx 0.05\). In particular, \(Q_{W, p}\) can be shifted from its Standard Model value by any new physics which modifies electron-quark interactions such as leptoquarks, substructure, or R-parity violating SUSY. Our experiment, currently under construction, will measure the proton’s neutral weak charge with a projected total error of 4\%. The interference between the \(\gamma\) and \(e + p\) elastic scattering produces a parity-violating asymmetry which at low momentum transfers is dominated by \(Q_{W, p}\). The measurement is highly interpretable and complements other measurements of the weak charge of the electron and atomic nuclei. Achieving the necessary sensitivity is just such a parity-violating asymmetry which at low momentum transfers is dominated by \(Q_{W, p}\). The measurement is highly interpretable and complements other measurements of the weak charge of the electron and atomic nuclei. Achieving the necessary sensitivity is expected to require high-intensity and high polarization electron beam as well as the world’s highest power liquid Hydrogen target (2.5 KWatts). Elastically scattered electrons will be focused by a resistive, toroidal spectrometer onto one of eight 2 meter long bars of radiation-hard fused silica. Cerenkov light will be converted to current by PMTs and digitized by 18-bit, fast sampling ADC’s. The beam polarization will be reversed at nearly 300 Hz. After overviewing the physics and the experiment, the status of the construction effort will be summarized.

10:15PM BB.00013 PRISM and Search for Charged Lepton Mixing . YOSHITAKA KUNO, Osaka University — Search for charged lepton mixing has much interest after neutrino mixing has been discovered. The search is known to be sensitive to new physics beyond the Standard Model (SM) and beyond neutrino oscillation phenomena. One of various extension to the SM is supersymmetric grand unification theories - Search for charged lepton mixing attracts much interest after neutrino mixing has been discovered. The search is known to be sensitive to new physics beyond the Standard Model (SM) and beyond neutrino oscillation phenomena. One of various extension to the SM is supersymmetric grand unification theories. The predictions of these models are just a few orders magnitudes lower than the present experimental limits, indicating large discovery potentials. One of the best system to search for charged lepton mixing is the muon. In Japan, we are developing a new muon source with high intensity, high purity and high luminosity. It is based on solenoid pion capture, phase rotation by FFAG (fixed field alternating gradient accelerator). The purpose is to carry out an experiment to search for the muon-to-electron conversion processes at a sensitivity of \(10^{-18}\). At Osaka university, the FFAG ring accelerator is being constructed. The status and future plan of the PRISM project will be presented.

Monday, September 19, 2005 7:00PM - 10:15PM —
Session BC DNP JPS: Mini-symposium on Hypernuclei Ritz-Carlton Hotel Plantation 2

7:00PM BC.00001 Spectroscopy of \(\Lambda\) Hypernuclei: Recent Progress and Future Prospects . TOSHIO MOTOBA, Osaka Electro-Commun. University — Recently, great progress has been made in spectroscopic studies of \(\Lambda\) hypernuclei. In this talk, the present status and future plans of \(\Lambda\) hypernucleus spectroscopy are presented, particularly on precision \(\gamma\)-ray spectroscopy. We have been investigating detailed structure of \(\Lambda\) hypernuclei by means of the precision \(\gamma\)-ray spectroscopy technique with a large germanium detector array, Hyperball. We have studied \(\gamma\) transitions in various p-shell \(\Lambda\) hypernuclei, \(^7\)Li, \(^9\)Be, \(^{10}\)B, \(^{11}\)B, \(^{15}\)N, and \(^{16}\)O via the \((\pi^+ + K^+)\) reaction at KEK and the \((K^- + \pi^-)\) reaction at BNL. The precise level structure data of these hypernuclei allowed us to determine all the spin-dependent (spin-spin, spin-orbit, and tensor) \(\Lambda N\) interaction strengths, which give stringent constraints to baryon-baryon interaction models. The upgraded apparatus (Hyperball2) is now ready for further studies, where one of the most important subjects is the study of magnetic moment of \(\Lambda\) in a nucleus through measurement of \(B(M1)\) values for \(\Lambda\)-spin-flip M1 transitions in hypernuclei. In near future, hypernuclear \(\gamma\) spectroscopy will be greatly developed by using strong beams from the 50 GeV proton synchrotron at J-PARC. In addition, recent progress and future plans are summarized for high-resolution \(\Lambda\) hypernuclear spectroscopy via the \((e, e'K^+)\) reaction at Jlab and spectroscopy of neutron-rich \(\Lambda\) hypernuclei via the \((\pi^+, K^+)\) reaction at KEK.

7:30PM BC.00002 Spectroscopy of \(^{11}_\Lambda\)B\(^1\). JOHN MILLENER, Brookhaven National Laboratory — Hypernuclear \(\gamma\)-ray transitions in \(^7\)Li, \(^9\)Be, \(^{10}\)B, \(^{11}\)B, \(^{15}\)N, and \(^{16}\)O have been studied with the Hyperball Ge array in a series of experiments at KEK and BNL. Comparison of the observed transition energies with shell-model calculations using a basis of \(\Lambda\) and \(\Sigma\) states with the hyperon in the lowest s orbit have led to a determination of the strengths of the spin-spin, spin-orbit, antisymmetric spin-orbit, and tensor components of the \(\Lambda N\) effective interaction from the data on \(^7\)Li, \(^9\)Be, and \(^{16}\)O. Here, the strength of the \(\Lambda\)-\(\Sigma\) coupling (essentially an effective central \(\Lambda N\)-\(\Sigma N\) interaction) has been fixed by theory and other data but it could be varied. The observed transitions in other hypernuclei then serve as consistency checks on the parametrization of the YN interaction. Specifically, six transitions in \(^{11}_\Lambda\)B have been observed and their interpretation will be discussed.

\(^1\)Work supported by the US DOE under Contract No. DE-AC02-CH10886
7:45PM BC.00003 γ-ray spectroscopy of $^{12}$C and $^{11}$B via the Hyperball2 array, SARI KINOSHITA, Dept.of Phys.Tohoku Univ., E566 COLLABORATION — Based on the success of a series of Hyperball experiments, an upgrading of Hyperball has been undertaken. The new array, Hyperball2, houses six Clover-type detectors, which are segmented into four Ge crystals, plus 14 single-crystal Ge detectors. Each detector is surrounded by BGO scintillator counters for a reduction of backgrounds in γ-ray spectrum by vetoing contaminated events. The photo-peak detection efficiency of Hyperball2 is nearly doubled from that of the previous array. We examined the performance at Tohoku Univ. CYRIC. The first experiment of Hypernuclei with this array, in conjunction with Superconducting Kaon Spectrometer (SKS), is scheduled at the KEK beam facility to perform γ-ray spectroscopy of $^{12}$C and $^{11}$B using the ($^p$, $^+$) reaction on $^{12}$C target. In this experiment, one of the main goals is to measure a lifetime of $^7\Lambda$ state in $^{12}$B, which is selectively produced via one proton emission decay of $^{12}$C($^p$, $^+$). The measured lifetime, by means of Doppler shift attenuation method, determines the reduced transition probability of the $^{11}\Lambda$(7/2$^+$→5/2$^+$$^+$) transition. Properties of a $\Lambda$ particle in free space may change in nuclear matter and the magnetic moment is one of them. The measurement of the B($^1\Lambda$(7/2$^+$→5/2$^+$$^+$)) value will provide a quantitative account for the change of the magnetic moment of a $\Lambda$ if at all. Equally as important, strengths of the $\Lambda N$ interaction can be inferred from excited energy levels of $^{12}$C.

8:00PM BC.00004 A new prediction for the binding energy of $^7\Lambda$He hypernucleus, VLADIMIR SUSLOV, IGOR FILIKHIN, BRANISLAV VLAHOVIC, North Carolina Central University — P-shell A=7 hypernuclei are considered in the cluster$^7\Lambda$He+N+N model. The folding procedure using the OBE simulating (NSC97f) model for $\Lambda N$ potential and various $\alpha\Lambda$ potentials are applied to construct the $^7\Lambda$He-N interaction. Configuration space Faddeev calculations are performed for hyperon binding energy of the $^7\Lambda$He($^\nu$) and $^6\Lambda$Li($^\nu$) and $^5\Lambda$Li($^\nu$) hypernuclei. A new predicted value for $B_\text{N}(^7\Lambda\text{He})$ is 5.35 MeV. This value was obtained for the $^6\Lambda$He($^\nu$) excitation energy equal to 0.26 MeV. Since the $^6\Lambda$He($^\nu$) has not yet been observed, the $^6\Lambda$He($^\nu$) excitation energy was chosen to reproduce the experimental value of the $^5\Lambda$Li($^\nu$) excitation energy by the adjustment of the $^6\Lambda$He-N effective potential. Our results are compared with those from [1]. 1. E. Hiyama et al. Phys. Rev. C53, 2075 (1996), Phys. Rev. C59, 2351 (1999).

8:15PM BC.00005 Spin-orbit splittings deduced from DWIA analysis of the $^{89}\Lambda Y$($^π^−$, $^k^+$)$^{89}\Lambda Y$ reaction, TOSHIKO MOTOBA, Osaka Electro-Commun. University, JOHN MILLENER, Brookhaven National Lab, DMITRY LANSKOY, Moscow State University, YASUO YAMAMOTO, Tsuru University — High resolution measurements of hypernuclear γ rays from the $^8\Lambda$(Be($^π$), $^k^+$)$^8\Lambda$Be and $^{11}\Lambda$(K$^-$, $^π^−$)$^{11}\Lambda$C reactions have shown clearly that the $\Lambda N$ spin-orbit force is very small. In heavier cases such as $^{89}\Lambda Y$, however, the ($^π^−$, $^k^+$) experiments show a series of strong peaks having doublet-like substructure which apparently suggests sizable $\Lambda N$ spin-orbit splittings. In order to resolve this discrepancy, detailed structure calculations of $^{89}\Lambda Y$ have been performed by taking nuclear core excitation into account. The obtained wave functions have been used to estimate the ($^π^−$, $^k^+$) reaction cross sections within DWIA. Based on a careful analysis of the peak structure, a theoretical explanation is given for the first time how to understand the doublet substructure in a series of observed major peaks in $^{89}\Lambda Y$. In the discussion we conclude small $\Lambda$ spin-orbit force which is consistent with the two light hypernuclear cases.

8:30PM BC.00006 Hypernuclear Spectroscopy in JLab’s Hall A: experimental aspects, FRANCO GARIBALDI, INFN/Roma’, FOR THE JLAB HALL A COLLABORATION, AND THE KAON COLLABORATION — With the addition of two superconducting septum magnets and a Ring Imaging Cerenkov detector (RICH), the high resolution spectrometer pair in Hall A at Jefferson Lab have become a powerful tool for high resolution Hypernuclear spectroscopy. With both spectrometers set at 6°, the very good momentum resolution capability, the state of the art particle identification, and the very high quality CEBAF beam enable us to observe bound states in Lambda-hypernuclei with sub-MeV FWHM resolutions. The use of the proximity focusing RICH detector for kaon identification in the 2 GeV/c region of momenta reduced the large pion and proton backgrounds in the hypernuclear spectra to a negligible level. The basic parameters, the data analysis procedure, and the resulting performance of the RICH detector obtained during the hypernuclear spectroscopy experiment will be presented and compared with Monte Carlo simulations. Technical and optical features of the two septum magnets will also be discussed.

8:45PM BC.00007 High Resolution 1p Shell Hypernuclear Spectroscopy at JLAB, MAURO IODICE, INFN/Roma’, FOR THE JLAB HALL A COLLABORATION, AND THE KAON COLLABORATION — Hypernuclear physics is a unique tool for providing information on the nature of the potential between nucleons and strange baryons. Information on the nature of the force between nucleons and strange baryons, i.e. the Lambda-N interaction, can be accessed by studying the spectroscopy of nuclei in which a nucleon has been replaced by a Lambda particle to form a bound state. The experiment E94107 at Jefferson Lab, Hall A, using a pair of high resolution spectrometers coupled to a pair of septum magnets, together with a RICH detector for particle identification, completed its first measurements of hypernuclear electroproduction on carbon and beryllium targets in June 2004. Data on oxygen using a windowless waterfall target were recently taken during June 2005. Results on Carbon and Beryllium and preliminary data on oxygen will be presented and compared with theoretical models.

9:00PM BC.00008 Spectroscopic study of hypernuclei via (e,e$'K^+$) reaction, YUICHI OKAYASU, Dept. of Phys., Tohoku Univ., JLAB E01-011 COLLABORATION — A new hypernuclear spectroscopy experiment by the (e,e$'K^+$) reaction will be carried out in June 2005 at Hall C, Jefferson Lab (E01-011). In order to improve the successful pioneering Jlab E89-009 experiment, we introduce a newly designed high resolution and large solid angle spectrometer (HKS) for the kaon arm, and employ "Tilt method" for the electron arm. In the "tilt method," the electron spectrometer is vertically tilted by −8° with respect to the horizontal plane to reduce drastically the background electrons originating from beamstrahlung and Møller process. By adopting the new setup, we expected to: 1) increase hypernuclear yield by 50 times with higher beam current (~30 µA) and thicker target(~100 mg/cm²), 2) improve to hypernuclear mass resolution twice better(~400 keV[FWHM]). Under such condition, we plan to measure hypernuclear spectra for higher Z targets i.e. 28Si, 51V and 89Y. We investigate $\Lambda$ single particle behavior both inside the nucleus and try to understand the nature of $\Lambda N$ interaction comparing with ordinary nuclei. In this report, the analysis procedure for kaon identification will be described with preliminary hypernuclear mass spectrum.

9:15PM BC.00009 Direct Measurement of Lifetime of Heavy Hypernucleus by JLab E02-017, LULIN YUAN, Hampton University, JLAB E02-017 COLLABORATION — JLab E02-017 aims to measure hypernuclei $^{89}$Pb lifetime with less than 5% precision, much better than previous measurements in this mass range. The experiment will be carried out in August, 2005. The hypernucleus is produced by (e,e$'K^+$) reaction. The experiment utilizes the fine time structure of CEBAF electron beam. Hypernuclear delayed fission products are detected by a LPMWPC in coincidence with scattered $K^+$ to positively identify hypernuclear production and its weak decay. These techniques result in much improved time resolution and reduced background. The experimental setup will be described and the preliminary fission time spectrum will be presented.
9:30PM BC.00010 Strength of the $\Sigma$ mean field deduced from SCDW model analyses of $(\pi^-, K^+)$ inclusive spectra on $^{12}$C, $^{28}$Si, $^{58}$Ni and $^{209}$Bi, M. KOHNO, Kyushu Dental College, Y. FUJWARA, Kyushu Univ., Y. WATANABE, K. OGATA, M. KAWAI, Kyushu Univ — The semiclassical distorted wave model is developed to analyze $(\pi^-, K^+)$ $\Sigma$ formation inclusive spectra on various nuclear targets. We do not introduce a factorization approximation in terms of Fermi averaging of the elementary cross sections in nuclear medium. Confirming first that the model works well for the $(\pi^-, K^+)$ $\Lambda$ formation inclusive spectra, we apply it to the $\Sigma$ case. The shape and magnitude of the experimental spectra for various target nuclei taken at KEK [P.K. Saha et al., Phys. Rev. C70, 044613 (2004)] are satisfactorily reproduced using a repulsive $\Sigma$-nucleus single-particle potential whose strength is of the order of 30–50 MeV. The isovector part of the $\Sigma$ single-particle potential is also determined from the data of heavier nuclei.

1Supported by Grant-in-Aid for Scientific Research (C) from the Japan Society for the Promotion of Science, No. 15540284.

9:45PM BC.00011 Roles of $A_1$ meson exchange interaction in the hypernuclear nonmesonic weak decay observables, KAZUNORI ITONAGA, Lab. of Physics, Faculty of Medicine, University of Miyazaki, Japan, TOSHIO MOTOBA, Lab. of Physics, Faculty of Engineering, Osaka Electro-com. University, Japan, TAMOTSU UEDA, Chiyoda-cho, Hiroshima, Japan, TH. A. RIJKEN, Inst. for Theoretical Physics, University of Nijmegen, The Netherlands — The most puzzling and challenging problem in the nonmesonic weak decay at present is to resolve the large discrepancy between the theory and the data of asymmetry parameters of the proton emitted in the decay of $\frac{3}{2}$He and $\frac{3}{2}$C. In our previous meson exchange model, the $1\pi, 2\pi/\sigma, 2\pi/\rho, 1\omega$ and $1K$ exchange mesons are employed. The $\pi$ and $\sigma$ mesons are chiral partners and play role to bring the right magnitude of the decay rates. In the present study we introduce the $a_1$ meson exchange in the decay interactions, where the $a_1$ meson is $1^+$ and is a chiral partner of the $p$ meson. In our model, we consider the $\omega \rightarrow \pi\pi$ decay process in the intermediate meson exchange and the $\pi$ is connected to the weak $\Lambda N\pi$ vertex by choosing the appropriate coupling constants, we construct the $\rho\pi/a_1$ exchange potential $V_{\rho\pi/a_1}$. We will discuss on the roles of $\rho\pi/a_1$ exchange potential on the asymmetry parameter and other weak decay observables.

10:00PM BC.00012 Double Strangeness Weak Interaction, KAZUMA KAKAZAWA, Phys. Dept., Gifu Univ., E373 (KEK-PS) COLLABORATION — In the E373 (KEK-PS) experiment, several hundred events caused by $\Xi^-$ hyperon capture at rest in nuclei were located in nuclear emulsion to study $S = -2$ systems. Among those events, we detected seven candidate events with topologies shown by the production and decay of double-$\Lambda$ hypernucleus, and also found an event showing that a $\Sigma^-$ hyperon was probably emitted from $\Xi^-$ hyperon capture point, very recently. This kind of phenomenon, $\Sigma N \rightarrow \Sigma' N'$ or $\Lambda\Lambda \rightarrow \Sigma N$, shall be quite useful to know the weak interaction involving double strangeness. The result of the analysis will be reported not only for the event, but also about the probability for such kind of the reaction caused by at rest capture of $\Xi^-$ hyperon in nucleus. E373 (KEK-PS) Collaboration: Gifu, Kyoto, Kobe, Toho, Wonkwang, Korea, New-Mexico, U.C. London, KEK, Nagoya, Chonnam, Gyeongsang, Konkuk, Carnegie-Mellon, BNL, Tohoku, Kyoto-Sangyo, Aichi, Tokyo, NIRS, Osaka City U., Osaka Pref. Edu.

Monday, September 19, 2005 7:00PM - 10:15PM — Session BD DNP JPS: Mini-symposium on Compton Scattering from Nucleons and Nuclei Ritz-Carlton Hotel Salon 1

7:00PM BD.00001 Compton Scattering from Nucleons and Nuclei, ALAN NATHAN, University of Illinois — This talk will introduce the minisymposium by presenting an overview of the physics issues that are addressed by Compton scattering from nucleons/nuclei. At low energies, the scattering determines the generalized polarizabilities, which characterize the response of the system to slowly-varying external electric and magnetic fields. These quantities provide stringent tests of models of nucleon or nuclear structure, such as chiral perturbation theory, lattice QCD, and the effective nucleon-nucleon interaction. The simplest of these are the dipole electric and magnetic polarizabilities, which are well measured for the proton and less well measured for the neutron. With polarized beams and targets, one can measure the spin polarizabilities. With incident virtual photons, one can probe the spatial distribution of charges and currents contributing to the polarizabilities, allowing a separation of short-range (e.g., quark core) from long-range (e.g., pion cloud) contributions. For high energies and momentum transfers, the scattering is sensitive to the spatial distribution of the scattering centers. For nuclei, the photon scatters from quarks, giving rise to new form factors that are derived from the same generalized parton distributions as the electron scattering form factors. The present status of these issues will be discussed in light of recent and planned experiments.

7:30PM BD.00002 Compton scattering on the proton and deuteron in chiral effective field theory, D. PHILLIPS, Ohio University — In this talk I will discuss recent efforts I have been involved in to describe Compton scattering in one- and two-nucleon systems using chiral perturbation theory (\chiPT). I will begin by summarizing the status of \chiPT scattering. For this reaction we fit the two undetermined parameters in the O(Q^4) $\gamma\rho$ amplitude of McGovern [1] to experimental data in the region $\sqrt{t} \leq 180$ MeV, obtaining a $\chi^2$/d.o.f. of 133/113 [2]. This yields a model-independent extraction of proton polarizabilities based solely on low-energy data: $\alpha_p = (12.1 \pm 1.1 \text{(stat.)})_{-0.5}^{+0.5} \text{(theory)}$, both in units of 10$^{-4}$ fm$^2$. I will then discuss how the \chiPT formalism can be extended to treat deuteron Compton scattering. In particular, \chiPT provides a systematic treatment of the large isoscalar exchange currents that occur in this process, and so it facilitates extractions of nucleon polarizabilities from $\gamma d$ data which have a well-motivated theoretical error bar [2].

References

1Work supported by the US Department of Energy
Jefferson Lab 12 GeV upgrade results from Deeply Virtual Compton Scattering (DVCS) from the experimental program at 6 GeV. I will also outline the future experimental program at the CLAS. I will present first allow, for the first time, to construct "tomographic" images of the nucleon's charge and quark helicity distributions in transverse impact parameter space. I will study the transverse spatial dependence and the longitudinal momentum dependence. At the twist-2 level, for each quark species there are two spin-dependent GPDs, \(H\) and two spin-independent GPDs, \(E\), and two spin-independent GPDs, \(E\) and \(H\). The first moments of GPDs in \(x\) link them to the proton's form factors, while the second moments of the short-distance propagator \(x\) link them to the proton's form factors, while the second moments of the short-distance propagator.

1 There is sensitivity to \(\Delta\) and \(\nu\); \(\nu\) is insensitive to neutron electromagnetic polarizations. However, one of the double polarization asymmetries, \(\Sigma\), is sensitive to \(\gamma_{1n}\). [1] In the first part of the talk I will present these results. Thereafter, I will discuss the formalism for similar calculations for He-3 and report some preliminary results.

1 http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=PRVCAN000007100004044002000001&idtype=cvips&gifs=Yes

8:00PM BD.00004 Of Neutron polarizabilities and polarization observables in Compton scattering on deuteron and He-3, DEEPSHIKA CHOUDHURY, DANIEL PHILLIPS, Ohio University — The HICS upgrade program has motivated us to investigate how sensitive observables involving polarized beam and/or polarized target are to neutron polarizabilities. Thus, we calculate several polarization observables for Compton scattering on deuteron and He-3 using chiral perturbation theory (\(Q^{2}\)) at energies of the order of the pion mass. For deuteron we have found that the photon polarization asymmetry, \(\Sigma\), is insensitive to neutron electromagnetic polarizations. However, one of the double polarization asymmetries, \(\Sigma_{2}\), is sensitive to \(\gamma_{1n}\). [1] In the first part of the talk I will present these results. Thereafter, I will discuss the formalism for similar calculations for He-3 and report some preliminary results.

8:15PM BD.00005 Polarizabilities of light nuclei, GIUSEPPINA ORLANDINI, Department of Physics University of Trento — An overview of the present knowledge of the polarizabilities of light nuclei will be presented. It will be explained why this knowledge is at present rather limited, describing the difficulties in the theoretical calculations and how they may be overcome using integral transform approaches. Results obtained for systems up to \(A=7\) will be presented and their sensitivity to the potential model will be discussed. The need of an experimental determination of these observables in light target systems will be emphasized.

8:30PM BD.00006 Compton scattering from nuclear targets at Hi\(^{7}\)S\(^{1}\), B.A. PERDUE, M.A. AHMED, M.A. BLACKSTON, Y. PARPOPAS, A.P. TONCHEV, H.R. WELLER, Duke U./TUNL, V.N. LITVINENKO, I.V. PINAYEV, Y. WU, Duke U./DCELL, R.M. PRIOR, M.C. SPRAGER, NGCSU/TUNL, G. FELDMAN, GWU, B.D. SAWATZKY, B. NORUM, UVA, J.R. CALARCO, UNH — A Compton scattering program is presently being developed at Hi\(^{7}\)S utilizing the nearly-monoenergetic beams of 100% polarized \(\gamma\)-rays produced by intra-cavity Compton backscattering of FEL photons. Polarization asymmetries of Compton scattering on \(^{16}\)O have been measured between 25-40 MeV to search for a narrow iso-vector giant quadrupole resonance (IVGQR). A beam with \(\Delta E/E<10%\) was incident on a \(^{12}\)C target. The scattered \(\gamma\)-rays were detected by four \(10\times10\) NaI detectors located between \(\theta=90-150\) and \(\phi=0, 90, 180, \) and \(270\). The data indicate that significant, narrow concentrations of E2 strength are not present below 40 MeV. Another measurement of the Compton scattering cross section of \(^{3}\)He between \(E_{\gamma}=3-11\) MeV is proposed to extract the electric polarizability, \(\alpha_{E}\). The \(^{4}\)He nucleus. A preliminary run has been performed to study the backgrounds, and a high pressure gas target system has been tested.

8:45PM BD.00007 Double Distributions, Wide-Angle Compton Scattering, and \(\gamma\gamma \rightarrow \pi\pi\), ANATOLY RADYUSHKIN, ALES PSAKER, Old Dominion University and Jefferson Lab — Double Distributions (DD) are the basis of a novel approach to hadronic structure. They represent a form of Generalized Parton Distributions, which attracted recently a considerable attention both from theoretical and experimental side. We develop a DD-based approach to wide-angle Compton scattering and annihilation processes like \(\gamma\gamma \rightarrow \pi^{+}\pi^{-}\) in kinematics when all Mandelstam variables \(s, t, u\) are large. We take into account both twist-2 and twist-3 effects, and also show that \(t\)-dependence of the short-distance propagator can be treated as a generalized target mass correction, in a treatment analogous to that developed by Nachtmann and Georgi and Politzer for deep inelastic scattering. We study the dependence of the amplitude on polarization of participating photons and give estimates for cross sections. To this end we propose models for double distributions in spacelike and timelike regions.

9:00PM BD.00008 Wide-angle Compton scattering, BOGDAN WOJTSEKHOWSKI, TJNAF — Real photon Compton scattering from nucleon in hard scattering regime is a powerful tool for study of partonic structure. We review RCS experimental results and a program of future experiments at Jefferson laboratory. Deep inelastic Compton scattering could be investigated by using a beam charge difference and a beam helicity effect.

9:15PM BD.00009 Virtual Compton Scattering at \(Q^{2}=0.05\) (GeV\(^{2}\)), YOSHIYUKI SATO, Tohoku University, PAUL BOURGOEIS, University of Massachusetts, OOPS COLLABORATION — The generalized polarizabilities of the proton describe the response of the proton to a quasistatic electric or magnetic field, and provide a test of our understanding of low-energy QCD. We have measured the virtual Compton scattering (VCS) cross section at \(Q^{2}=0.05\) (GeV\(^{2}\)) at MIT-Bates. Out-going protons were detected using the multiple out-of-plane spectrometer system (OOPS), which allows to suppress the normally dominant Behter-Heitler radiation. In this talk, the experiment is described in more detail. The cross section and the polarizabilities are presented and discussed.

9:30PM BD.00010 Study of Generalized Parton Distributions via Deeply Virtual Compton Scattering with the CLAS detector at Jefferson Lab, LATIFA ELOUADRHIRI, Jefferson Lab — The Generalized Parton Distributions (GPDs) carry new information about the dynamical degrees of freedom of quarks inside the nucleon. The GPDs have been introduced in the recently developed formalism for description of the deeply exclusive leptoproduction reactions. The GPDs are two-parton correlation functions that encode both the transverse spatial dependence and the longitudinal momentum dependence. At the twist-2 level, for each quark species there are two spin-dependent GPDs, \(E(x, \xi, t)\), \(H(x, \xi, t)\), and two spin-independent GPDs, \(E(x, \xi, t)\), and \(H(x, \xi, t)\). The first moments of GPDs in \(x\) link them to the proton’s form factors, while at \(t=0\), the GPDs \(H\) and \(R\) reduce to the quark longitudinal momentum \(q(x)\) and the helicity distributions \(\Delta q(x)\), respectively. Mapping out the GPDs will allow, for the first time, to construct “tomographic” images of the nucleon’s charge and quark helicity distributions in transverse impact parameter space. I will discuss the experimental program to study the GPDs in the deeply exclusive processes with CEBAF Large Acceptance Spectrometer (CLAS). I will present first results from Deeply Virtual Compton Scattering (DVCS) from the experimental program at 6 GeV. I will also outline the future experimental program at the Jefferson Lab 12 GeV upgrade.
9:45PM BE.00011 Compton Scattering from a High Pressure Polarized \(^3\)He Target at HI\(_7\)S and the neutron spin polarizabilities

Compton scattering from a polarized \(^3\)He target. We discuss a future measurement of the spin-dependent asymmetries from Compton scattering of circularly polarized photons from a high-pressure polarized \(^3\)He gas target at both the quasielastic and elastic kinematics. The Compton scattered photons and the recoil neutron will be detected in coincidence for the quasielastic process, and only the scattered photons will be detected for the elastic scattering process. This experiment will be carried out at a photon energy between 100 - 140 MeV. In combination with the forward and backward polarizabilities extracted from existing experiments, the new experiment will allow for the first time the extraction of all four neutron spin polarizabilities, and provide crucial tests of predictions based on effective field theories, and dispersion theories. This work is supported by the U.S. Department of Energy (DE-FG02-03ER41231) and by the Duke University.

10:00PM BD.00012 Generalized Power Counting Rule

FENG YUAN, Brookhaven National Laboratory — In this talk, I will present a generalized power counting rule for the hard exclusive processes involving parton orbital angular momentum and hadron helicity flip. We introduce a systematic way to write down the Fock components of a hadronic light-cone wave function with n partons and orbital angular momentum projection \(I_\ell\), from which we derive the generalized counting rule. As an example, I will show the power counting result for the nuleon’s Pauli form factor \(F_2(Q^2)\) in perturbative QCD.

Monday, September 19, 2005 7:00PM - 9:30PM — Session BE DNP JPS: Mini-symposium on Nuclear Moments I

Ritz-Carlton Hotel Amphitheatre

7:00PM BE.00001 Exotic structure of unstable nuclei from the nuclear moment study

YUTAKA UTSUNO, Japan Atomic Energy Research Institute — The structure of unstable nuclei is often rather different from that of stable ones, including the disappearance of the magic structure, halo structure, new types of cluster structure, etc. For even-even nuclei, the in-beam spectroscopy is very useful to such exotic structures, while the nuclear moment is one of the most powerful probes to directly investigate the ground-state structure of odd-\(A\) and odd-odd nuclei. For instance, the systematic study in Na isotopes has played a crucial role in determining where the \(N = 20\) magic structure disappears. Namely, this disappearance was considered to be restricted to some \(N \geq 20\) isotopes from a naive comparison of experiment with the sd-shell calculation about the ground-state spin and the separation energy. On the other hand, it has been recently clarified that the disappearance completely occurs at \(N = 19\) from a comparison of the magnetic dipole and electric quadrupole moments between a recent experiment and the Monte Carlo shell model calculation. Along this line, several experimental data for other nuclei are being accumulated now. As for the moment of the excited state, it is pointed out, in fact, that the \(g\) factor and the quadrupole moment of the \(2^+_1\) state carry much information on the collectivity: the former tells us the proton- and neutron-contribution to the rotation, and the latter is related to the intrinsic shape. Around \(^{132}\)Sn, a recent shell-model calculation has succeeded in reproducing both the \(E2\) transitions and the \(g\) factors in this region, showing a certain deviation from simple collective models. In this talk, I would like to give an overview about how the nuclear moment clarifies exotic structure of unstable nuclei as exemplified above.

\(^1\)Supported in part by Grants-in-Aid (13002001), (14740176) and (17740165) from the MEXT of Japan.

7:30PM BE.00002 Electric quadrupole moment of \(^{25}\)Na

KENSAKI MATSUTA, TAKASHI NAGATOMO, HIRONOKI FUJISAWA, SHINICHI KUMASHIRO, RYOHEI MATSUMIYA, MASAKO OGURA, MOTOTSUGU MIHARA, MITSU average 2 over 11

YUICHI NOJIRI, Kochi Univ. of Tech., TAKASHI OHTSUBO, MASASHIRO OHTA, Niigata Univ., ATSUHI KITAGAWA, MITSUKATA KANAZAWA, MASAMI TAKAGIO, SHINJI SATO, NIRS, TADANORI MINAMISAKI, Fukui Univ. of Tech., KEI MINAMISAKI, MSU, T.J.M. SYMONS, G.F. KREBS, J.R. ALONSO, LBL — Among the many Na isotopes, whose electric quadrupole moments \(Q\) are known, the precision of the \(Q\) moment of \(^{25}\)Na \((I = 5/2^+, T_{1/2} = 59.1s)\) has been extremely poor, which prevents us from the quantitative discussion of nuclear structure of the Na isotopes. In the present experiment, the \(Q\) moment of \(^{25}\)Na has been determined precisely by means of \(\beta\)-NMR technique. Polarized \(^{25}\)Na nuclei were produced through the projectile fragmentation process in the \(^{25}\)Mg on Be collisions at 100.4 MeV. The NMR/NQR were observed on the \(^{25}\)Na nuclei implanted in NaCl and/or TiO\(_2\) single crystals, by means of the asymmetric emission of \(\beta\) rays. As a result, the absolute values of the magnetic and the \(Q\) moments were precisely determined to be \(6.385(3)\ \mu_N\) and \(1.0(4)\ \mu_N\) mb, respectively. The obtained \(Q\) moment is much precise than the old value \(-64(44)\) mb. The present \(Q\) moment is reproduced well by the shell model value \(-2.7\) mb.

7:45PM BE.00003 Magnetic moments of neutron-rich nuclei \(^{30}\)Al and \(^{32}\)Al

DAISUKE KAMEDA, HIDEKI UENO, KOICHIRO ASASHI, AKIHIRO YOSHIMI, TOMOHITO HASEYAMA, HIROSHI WATANABE, YOSHIKO KOBAYASHI, GO KIJIMA, HISANORI MIYOSHI, KENZI SHIMADA, GO KATO, DAISUKE NAGAE, SHOKEN EMORI, MASASHI TSUKUI, RIKEN COLLABORATION, TOKYO INSTITUTE OF TECHNOLOGY COLLABORATION — The magnetic moments of the ground-state \(^{30}\)Al and \(^{32}\)Al have been measured by means of the \(\beta\) ray-detected nuclear magnetic resonance (\(\beta\)-NMR) technique with spin polarized radioactive nuclear beams produced from projectile fragmentation reactions. The fragmentation processes that involved large numbers of removed nucleons, 10 and 8, from the 95 MeV/u \(^{40}\)Ar projectile were successfully utilized to produce the polarized \(^{30}\)Al and \(^{32}\)Al fragments. A single-crystal corundum sample was employed as a stopper of the projectile fragments. The stopper temperature was maintained below 100 K to preserve the spin polarizations during the \(\beta\) decays. The quadrupolar splitting in the crystal was avoided by employing the “magic angle” technique.

The magnetic moments have been successfully obtained, as \(|\mu^{(30)\text{Al}}| = (3.010 \pm 0.007)\ \mu_N\) and \(|\mu^{(32)\text{Al}}| = (1.959 \pm 0.009)\ \mu_N|\). Shell model calculations within the sd valence orbits using the USD interaction reproduced the both magnetic moments within 6 %. The border of the “island of inversion” will be discussed in comparison with the magnetic moments of \(N = 19\) isotones.

8:00PM BE.00004 Ground-state nuclear moments of neutron-rich \(p\) and \(sd\)-shell nuclei

DAISUKE KAMEDA, HIDEKI UENO, RIKEN, AKIHIRO YOSHIMI, TOMOHITO HASEYAMA, HIROSHI WATANABE, DAISUKE KAMEDA, Tokyo Institute of Technology, GO KIJIMA, KOICHIRO ASASHI, HISANORI MIYOSHI, KENZI SHIMADA, GO KATO, DAISUKE NAGAE, SHOKEN EMORI, MASASHI TSUKUI — We have been conducting a series of experiments at RIKEN for the measurement the nuclear moments in the light unstable nuclei based on the \(\beta\)-NMR method with the spin-polarized radioactive-isotope beams. So far the measurements have been carried out in the region of neutron-rich \(p\)-shell nuclei. The obtained experimental nuclear moments have been shown quite effective in discussing the effect of neutron excess on their nuclear structure, where we discussed the deviation of magnetic moments from the Schmidt value and the isospin dependence of the effective charges. To extend the observation into the neutron-rich \(sd\)-shell region, the ground-state magnetic moments of \(^{30}\)Al and \(^{32}\)Al were measured. Important issue in this region is to understand what causes the manifestation of the “island of inversion”. Microscopic studies of such nuclei close to the “island of inversion”, as well as those inside it, would offer a clue to this question. The obtained \(\mu\) moments, \(|\mu^{(30)\text{Al}}| = 3.010(7)\ \mu_N\) and \(|\mu^{(32)\text{Al}}| = 1.959(9)\ \mu_N|\), are in agreement with shell model calculations within the sd valence space, although a reduction in the energy-gap between the \(sd\) and \(pf\) states is predicted for \(^{32}\)Al in recent theoretical studies. Recent progress in this region will be presented.

\(^2\)Supported in part by Grants-in-Aid (13002001), (14740176) and (17740165) from the MEXT of Japan.
8:15PM BE.00005 Ground-state magnetic moment of $^{35}$K, P.F. MANTICA, T.J. MERTZIMEKIS, A.D. DAVIES, D.E. GROH, S.N. LIDICK, B.E. TOMLIN, NSCL. Michigan State University — Spin-polarized $^{35}$K fragments were produced at the NSCL using a single-proton pickup, two-neutron removal reaction from an $^{40}$Ar primary beam at an energy of 150 MeV/A incident on a $^9$Be target. The polarized $^{35}$K nuclei were implanted into a KBr crystal placed at the center of a beta-NMR magnet for magnetic moment analysis. The new value of the $^{35}$K magnetic moment improves on the precision of the previously measured value by an order of magnitude. The isospinocal magnetic moment of the T = 3/2 mirror pair $^{35}$K-$^{35}$S was found to compare well with the systematic variation of isoscalar moments extracted for heavy, T = 1/2 mirror pairs. Work supported in part by the NSF Grant Nos. PHY-01-10253 and PHY-99-83810.

8:30PM BE.00006 Magnetic Moment of the extremely proton rich nucleus $^{23}$Al, TAKASHI NAGATOMO, KENSAKI MATSUTA, YOSHIKI NAKASHIMA, MOTOTSUGU MIHARA, RYOHEI MATSUMIYA, MITSUNORI FUKUDA, Osaka Univ., AKIRA OZAWA, TAKUMA YASUNO, Univ. of Tsukuba, KAZUNARI YAMADA, Rikkyo Univ., TAKASHI OHTSUBO, TAKUJI IZUMIKAWA, DAISUKE SHINOJIMA, HIDEKI TANAKA, Niigata Univ., TAKAYUKI YAMAGUCHI, SHIN-PEI NAKAJIMA, HISASHI MAEURA, TAKESHI SUZUKI, Saitama Univ., TOSHIIUKI SUMIKAMA, KANENOBU TANAKA, KOICHI YOSHIUDA, Riken, SADAO MOMOTA, YOICHI NOJIRI, Kochi Univ. of Tech., TADANORI MINAMISONO, Fukui Univ. of Tech., ISAO TANIHATA, ANL — We have studied the spin purity of $^{23}$Al through the measurement of the magnetic moment by the $\beta$-NMR method. The experiment was performed at RIKEN/ RIPS. The polarized $^{23}$Al nuclei were produced through the 135-AMeV $^{20}$Si and Be collisions, and were separated by the RIPS separator and RF deflector. The NMR was observed by the $\beta$-ray asymmetry change. From the resonance frequency, we determined the g-factor of $^{23}$Al as $g(\mu(23\text{Al})) = 1.56(9)$. From the comparison between the present result and the shell model calculation, it was found that $^{23}$Al had the normal spin purity of 5/2. The magnetic moment was determined as $\mu(^{23}\text{Al}) = 3.89(22) \mu_N$. The level inversion between $d_{5/2}$ and $t_{1/2}$ states was not seen in the structure of $^{23}$Al.

8:45PM BE.00007 Magnetic moment of $^{23}$Ne, M. MIHARA, K. MATSUTA, R. MATSUMIYA, T. NAGATOMO, M. FUKUDA, Osaka University, T. MINAMISONO, Fukui University of Technology, S. MOMOTA, Y. NOJIRI, Kochi University of Technology, T. OHTSUBO, T. IZUMIKAWA, Niigata University, A. KITAGAWA, M. TORKIYOSHI, M. KANAZAWA, S. SATO, National Institute of Radiological Sciences, J.R. ALONSO, G.F. KREBS, T.J.M. SYMONS, Lawrence Berkeley Laboratory — The magnetic moment of the $\beta$-emitting nucleus $^{23}$Ne ($I^+ = 5/2^+$, $T_{1/2} = 37.2$ s) has been remeasured by means of the $\beta$-NMR method. The $^{23}$Ne nuclei were produced in the single neutron pickup and the projectile fragmentation processes using 100-AMeV $^{22}$Ne and $^{26}$Mg beams, respectively, impinged on a Be target at NIRS-HIMAC, and were separated by the fragment separator. After selection of the reaction angle and the momentum to obtain polarization, the $^{23}$Ne nuclei were implanted into a NaF single crystal at 15 K. The magnitude of polarization of ~3% for $^{23}$Ne in NaF obtained in the pickup process was much larger than that in the fragmentation process. From the NMR spectra, we obtained the magnetic moment $\mu(23\text{Ne})_{uncorrected} = (1.081 \pm 0.001) \mu_N$ as the preliminary result.

9:00PM BE.00008 Nuclear polarization of the ground state of $^{57}$Cu produced through a nucleon pick up reaction at the primary beam energy 140 MeV/nucleon, KEI MINAMISONO, PAUL MANTICA, THEODORE MERTZIMEKIS, ANDREW DAVIES, JORGE PEREIRA, JOSH STORKER, BRYAN TOMLIN, R. RANJITH WEERASIRI, NSCL, Michigan State University, MICHAEL HASS, Weizmann Institute, WARREN ROGERS, Westmont College — In order to measure the magnetic moment of the ground state of $^{57}$Cu ($I^+ = 3/2^-$, $T_{1/2} = 199$ ms), which is one proton outside doubly-magic $^{56}$Ni, a polarized $^{57}$Cu beam has been developed at NSCL/MSU. $^{57}$Cu ions were produced through a (p, 2n) reaction process of a 140 MeV/nucleon $^{56}$Ni primary beam on Be target and separated from other products in the A1900 fragment separator. To produce polarization, $^{57}$Cu ions ejected at an angle of 2 degree relative to the normal beam axis were selected. Polarized $^{57}$Cu ions were implanted into a single-crystal NaCl under an external magnetic field $H_0 > 0.1$ T. The degree of the polarization was measured by an $H_0$ on and off technique with normalization runs without polarization. The degree of the polarization as a function of the momentum of $^{57}$Cu and $H_0$ will be discussed.

9:15PM BE.00009 Bohr-Weisskopf effect measurements using NMR-ON, TAKASHI OHTSUBO, SUSUMU OHYA, Dept. of Phys., Niigata Univ., JAPAN, KATSUHIKO NISHIMURA, Faculty of Engineering, Toyama Univ., JAPAN, TAKUJI IZUMIKAWA, JUN GOTO, RI center, Niigata University, JAPAN, MINORU TANIGAKI, AKIHIRO TANIGUCHI, YOSHITAKA OKUBO, YOICHI KAWASE, KUR, Kyoto Univ., JAPAN, SUGURU MUTO, Neutron Science Laboratory, KEK, JAPAN — The difference between the point nuclear magnetic structure and the finite magnetic structure is referred as Bohr-Weisskopf (BW) effect (hyperfine anomaly), which depends on the nuclear structure. If the spin and orbital contributions to the magnetic moment have opposite sign, the large BW effect is expected. Recently, we have measured BW effects using NMR-ON and Brute force (12T) NMR-ON method. For Sc isotopes ($A = 44, 46, 48, 50$) we determined the BW effects comparing the magnetic resonance frequencies in Fe and the magnetic moments from atomic beam method. We also deduced the large BW effect of ~4.2% between $^{51}$V and $^{51}$V$_{yn}$ in Fe from the precise measurement of the field shift of resonant frequency. Furthermore, we determined the BW effects between $^{95}$Tc and $^{96}$Tc, and $^{106}$Ag and $^{110}$Ag comparing resonance frequencies of Brute force NMR-ON and those of the known NMR-On results in Fe. These results will be discussed in terms of the shell model including core polarization and exchange current effects.

Monday, September 19, 2005 7:00PM - 9:45PM — Session BF DNP JPS: RHIC: p-p, d-Au, and Cu-Cu Ritz-Carlton Hotel Plantation 3

7:00PM BE.00001 The excess of positive charged particles measured at forward rapidities in d+Au collisions and baryon transport, RAMIRO DEBBE, Brookhaven National Laboratory, BRAHMS COLLABORATION — The difference between positive and negative hadronic yields, measured by BRAHMS in d+Au at $\eta = 3.2$ (1), has been identified as a challenge to partonic descriptions based on pQCD (2). Within such descriptions, the hadronic yields are dominated by pion production, and isospin conservation fixes the abundance of positive and negative pions to be roughly equal. The measured difference was found to be due to a high number of protons up to the highest pt measured (3). To shed additional light on this subject, we studied baryon transport in d+Au by extracting net-proton distributions in eta. A net-proton excess at $\eta = 3.2$ identifies the higher yield of positive particles as “beam fragments.” Comparisons to theory are done to elucidate the mechanism that gave these baryons such high pt.

7:15PM BF.00002 Measurement of low mass vector mesons by $e^+e^-$ pairs in $\sqrt{s_{NN}} = 200$GeV d+Au collisions at PHENIX. YUJI TSUCHIMOTO, Hiroshima University, PHENIX COLLABORATION — In-medium modification of low mass vector mesons is predicted if chiral symmetry restoration occurred in the hot/dense matter created by heavy ion collisions at RHIC. The measurement of vector mesons in cold nuclear matter is important not only for a baseline measurement for our understanding of the in-medium effect in Au+Au collisions, but also for improving our understanding of in-medium modification of the meson properties inside the cold matter. The PHENIX detector can measure electrons and hadrons within the same acceptance at mid rapidity. $\omega$ and $\phi$ mesons have both hadronic and leptonic decay modes. Because the electron has a much larger mean free path, it suffers little from the final state effect, therefore he comparison of the effect; therefore the measurement in these two channels will provide us a powerful tool to study the possible in-medium effect due to the chiral symmetry restoration. PHENIX has substantial data sets for $p+p$, $d+Au$, $Au+Au$ and $Cu+Cu$ collisions to make a complete study of these effects. The current status of the $\omega$ and $\phi$ analysis will be shown for the $d+Au$ analysis.

7:30PM BF.00003 Systematic Investigations of Femtoscopic Radii in Heavy Ion Collisions. RON SOLTZ, Lawrence Livermore National Laboratory, PHENIX COLLABORATION — The technique of femtoscopy has been used for many years to extract radii from multi-particle correlations to characterize the spatio-temporal extent of the emission region in heavy ion collisions. We will present a systematic study of these radii as a function of colliding species, centrality, energy, and orientation for a variety of identified particle correlations over a range transverse and longitudinal momenta. We will highlight a number of simple and elegant trends that reveal much about the nature of particle production in heavy ion collisions. Comparisons to models will be discussed in the context of constraining the equation of state for the state made in these collisions. Future lines of inquiry will be considered.

7:45PM BF.00004 $R_{dd}$ measurement with muons from light and heavy flavor decay in $\sqrt{s_{NN}} = 200$GeV/c$^2$ p-p and d-Au collisions in PHENIX experiment at RHIC. XIAORONG WANG, New Mexico State University, PHENIX COLLABORATION — The particle production in d-Au collisions at RHIC in the forward and backward directions is sensitive to various nuclear effects. A study of light meson and heavy flavor production in d-Au collisions in various kinematics regions presents an opportunity to probe cold nuclear medium effects - from parton shadowing, Color Glass Condensate to initial state energy loss. The PHENIX muon arms cover both forward and backward directions in the rapidity range of 1.2 < |y| < 2.4, and are in a good position to make such measurements. We investigate nuclear medium effects on light meson and heavy flavor hadron via decay muons in the p-p and d-Au collisions. The current status of this analysis will be presented.

8:00PM BF.00005 Measurements of the total Cu-Cu Cross Section at RHIC. ANGELIKA DREES, Brookhaven National Laboratory, COLLIDER-ACCELERATOR DEPARTMENT TEAM — Using the Vernier Scan or Van der Meer Scan technique, where one beam is swept stepwise across the other while measuring the collision rate as a function of beam displacement, the transverse beam profiles, the instantaneous luminosity and the cross section can be measured. The cross section is an important ingredient when the total delivered luminosity is determined and when the instantaneous luminosity is monitored. The experimental detectors need the cross section to normalize their measurements. Though it can be calculated to some level of accuracy it has never been measured so far. This report presents the measurements and the results from the FY2005 Cu-Cu run.

8:15PM BF.00006 Measurement of single muons in Cu-Cu collisions with the PHENIX experiment at RHIC. DONJOJO KIM, MINKYUNG LEE, Yonsei University, PHENIX COLLABORATION — The measurement of open charm production in various collision species at different energies is important to study the properties of matter formed in the early stage of relativistic heavy ion collisions, especially to understand charm energy loss and recombination systematically. The RHIC facility provided Cu-Cu collisions at both high and low energy in 2005. This lighter colliding system compared with Au-Au can give much better precision on the centrality measurement in the lower $N_{part}$ region, and the comparison between two different colliding energies may give us a better systematic understanding of charm production. PHENIX detectors measure muons in the rapidity range 1.2 < |y| < 2.4, thus enabling us to study open charm as well as light meson production at forward rapidity. The status of single muon measurements of the centrality, transverse momentum and rapidity dependence of semi-leptonic open charm decays and light meson production, in Cu+Cu collisions at $\sqrt{s_{NN}}$=200 GeV and 62.4GeV will be presented.

8:30PM BF.00007 Measurement of vector mesons via di-electrons in Cu+Cu collisions at $\sqrt{s_{NN}} = 200$ GeV at RHIC-PHENIX. SUSUMU ODA, CNS, University of Tokyo, THE PHENIX COLLABORATION — Measurement of vector mesons via di-leptons is considered to be one of the most promising probes for the early hot dense stages of relativistic heavy ion collisions. The yields of heavy quarkonia are predicted to be suppressed in a deconfined quark gluon plasma due to the color Debye screening. However, the yields will be modified by other competing processes such as recombination, shadowing and heavy quark energy loss. Therefore systematic study of $J/\psi$ production for several system sizes and energy densities is necessary to understand the production and suppression mechanism. The light vector mesons ($\omega$, $\phi$ and $\eta$) are expected to be sensitive to possible in-medium modifications by chiral symmetry restoration. In the RHIC Run-5 starting in January 2005, the PHENIX experiment measured Cu+Cu collisions at $\sqrt{s_{NN}} = 200$ GeV. The current status of $J/\psi$, $\phi$ and $\omega \rightarrow e^+e^-$ analysis in Cu+Cu collision will be presented.

8:45PM BF.00008 System-size and energy dependence of elliptical flow. RICHARD BINDEL, University of Maryland, PHOBOS COLLABORATION — Azimuthal correlations are proving to be an extraordinarily powerful tool in elucidating the initial conditions and dynamical evolution of matter created in relativistic heavy ion collisions. As our theoretical vision of heavy ion collisions evolves, differential flow measurements are providing both guidance and strong constraints. This work examines the elliptic flow as a function of pseudorapidity, centrality, transverse momentum, energy, and species. The data presented were taken with the PHOBOS experiment at RHIC during Au-Au and Cu-Cu collisions ranging over an order of magnitude in energy. The implications of these data on the source initial conditions and dynamics will be discussed.

9:00PM BF.00009 $J/\psi \rightarrow \mu^+\mu^-$ Production in Cu+Cu collisions from the PHENIX Experiment. ABIGAIL BICKLEY, University of Colorado at Boulder, PHENIX COLLABORATION — Heavy quarkonia provide a sensitive probe of the modification of the QCD confining potential that is expected to occur at high temperatures. As these quark-antiquark states hadronize, they interact with the strongly coupled deconfined medium and provide a useful diagnostic for probing the state of matter present in heavy ion collisions. It is predicted that one of the signatures of a deconfined medium is the suppression of heavy quarkonia production due to color screening. However, other competing effects such as shadowing, heavy quark energy loss, and charm recombination influence the charmonium yield as well. In the PHENIX experiment the charmonium yield can be studied through the dimuon channel using the forward muon spectrometers. The $J/\psi$ yields obtained from Cu+Cu collisions will be presented as a function of centrality, transverse momentum, collision energy, and species.
9:15PM BF.00010 Charged Hadron Transverse Momentum Spectra in Cu+Cu Collisions from PHENIX, CARLA VALE, Iowa State University, PHENIX COLLABORATION — The observed suppression of high-\(p_T\) hadrons at mid-rapidity in central Au+Au collisions at RHIC has generated a high level of interest, since it may be a consequence of the energy loss of hard partons traveling through the hot and dense medium created in these collisions. The understanding of these results can significantly benefit from additional studies of how the high-\(p_T\) suppression depends on collision energies and system sizes. During the latest RHIC run, PHENIX collected data on Cu+Cu collisions at \(\sqrt{s_{NN}} = 200\) GeV and \(\sqrt{s_{NN}} = 62\) GeV, allowing for comparison with both the larger system size collisions in Au+Au and the baseline measurements performed in d+Au and p+p collisions. We present results from PHENIX on the charged hadron transverse momentum spectra in Cu+Cu collisions and its centrality dependence, as well as comparisons with other colliding systems and energies.

9:30PM BF.00101 Identified charged hadron spectra in Au+Au and Cu+Cu collisions in PHENIX\(^1\), MASAYA OKA, University of Tsukuba, PHENIX COLLABORATION — One of the most significant observations at the RHIC is that unlike mesons, baryons are not suppressed at intermediate \(p_T\) (2 - 5 GeV/c) region. This has prompted the development of a new theoretical framework, quark recombination, however, the agreement between recombination models and data is still qualitative. The systematic measurement of identified hadron spectra up to large \(p_T\) region is crucial for the further understanding of hadron production at RHIC energies. The PHENIX experiment has measured the \(\pi^\pm, K^\pm, p,\) and \(\bar{p}\) production in Au+Au collisions at \(\sqrt{s_{NN}} = 62.4\) and 200 GeV and in Cu+Cu collisions at \(\sqrt{s_{NN}} = 22.5, 62.4\) and 200 GeV. These data will be used to study the system size and collision energy dependence of hadron production. In this session, we will present new results on identified charged hadron spectra at large \(p_T\) region in \(\sqrt{s_{NN}} = 62.4\) and 200 GeV Au+Au, measured by the Time-of-Flight detector and Aerogel Cherenkov Counter in PHENIX. The latest studies on Cu+Cu collisions in different energies will also be presented.

\(^1\)Masaya Oka, for the PHENIX Collaboration

Monday, September 19, 2005 7:00PM - 10:00PM —
Session BG DNP JPS: Sub-nucleonic Degrees of Freedom Ritz-Carlton Hotel Plantation 2

7:00PM BG.00001 Effect of bound nucleon internal structure change on nuclear structure functions , KAZUO TSUSHIMA\(^1\), Physics Division, NCTS, Taipei, KOICHI SAITO, Tokyo University of Science, FERNANDO STEFFENS, IFT, UNESP and Mackenzie University — Effect of bound nucleon internal structure change on nuclear structure functions is investigated based on local quark-hadron duality. The bound nucleon structure functions, calculated for charged-lepton and (anti)neutrino scattering are all enhanced in symmetric nuclear matter at large Bjorken-x (\(x > 0.85\)) relative to those in a free nucleon. This implies that a part of the enhancement observed in the nuclear structure function \(F_2\) (in the resonance region) at large Bjorken-x (the EMC effect) is due to the effect of the bound nucleon internal structure change. However, the x dependence for the charged-lepton and (anti)neutrino scattering is different. The former [latter] is enhanced [quenched] in the region \(0.8 < x < 0.9\) \((0.7 < x < 0.85)\) due to the difference of the contribution from axial vector form factor. Because of these differences charge symmetry breaking in parton distributions will be enhanced in nuclear matter.

\(^1\)Presenter

7:15PM BG.00002 Measurement of inclusive jet yields in polarized \(p + p\) collisions at \(\sqrt{s} = 200\) GeV, MICHAEL MILLER, MIT, STAR COLLABORATION — At RHIC, the STAR detector is uniquely capable of full jet reconstruction in \(p + p\) collisions. The calibration of the jet energy scale and transverse energy resolution are critical to many physics analyses including, but not limited to, extraction of the gluon yields in the transverse energy region 5 < \(E_X\) at RHIC may provide significant additional constraints to previously measured large-\(x\) studies on Cu+Cu collisions and comparison to NLO pQCD calculations.\(^2\) Using detailed shower profile analysis to discriminate between single and merged photons. We will present \(\pi^0\) spectrum up to \(\sim 8\) GeV/c using charged-lepton and (anti)neutrino scattering. These measurements pave the way for ongoing analyses of the higher statistics (\(\sim 5 - 10\) \(p^{-1}\)) data sample from the 2005 RHIC run.

7:30PM BG.00003 The STAR Endcap Electromagnetic Calorimeter - 2005 Operation, J. SOWINSKI, Indiana University, STAR EEMC COLLABORATION — An Endcap ElectroMagnetic Calorimeter (EEMC) has been built and installed on the west side of the STAR detector at RHIC. The EEMC is a Pb-scintillator sampling calorimeter covering the full azimuth for pseudorapidities of 1.1 < \(\eta\) < 2.1. The calorimeter is 21 radiation lengths thick at normal incidence and its 24 layers give a sampling fraction of 5%. The active area is divided into 720 projective towers, each read out by its own phototube to provide deposited energy. A copy of the signal from the first 2 and last layer of the towers are read out by individual channels on multi-anode PMTs as pre- and post-shower detectors. At a depth of \(\sim 5\) radiation lengths there is a shower maximum detector constructed of two planes of crossed triangular scintillator strips (pitch 5mm) each read out by a channel on a MAPMT. All 9360 PMT channels are digitized every 100 ns and buffered awaiting data transfer on receipt of a trigger. The tower energy signals are passed to trigger for decision on the highest tower above a threshold or a summed phi patch (1/6th) above a threshold. The detector was fully instrumented for the first time in the 2005 run. Operation and performance of the detector in the run for triggering, minimum-ionizing-particles and \(\pi^0\) reconstruction will be discussed.

7:45PM BG.00004 High pt \(\pi^0\) measurements in pp collisions at mid-rapidity with PHENIX detector at RHIC, ALEXANDER BAZILEVSKY, Brookhaven National Laboratory, PHENIX COLLABORATION — Hadron production at large transverse momenta in pp collisions provides an important testing ground for QCD and helps to constrain fragmentation mechanism. PHENIX has reported \(\pi^0\) cross section in pp collisions in the pt range 1-13 GeV/c, which is described well by NLO pQCD calculations [1]. In heavy ion collisions, high pt particle production allows us to study the modification of hard scattering processes in high-density medium. Extending the measured pt range is crucial in understanding medium-induced energy loss mechanism. We discuss technique to measure high pt \(\pi^0\)s based on PHENIX capability of triggering on high pt photons. At high pt more than \(\sim 15\) GeV/c two decay photons start merging in the EMCal. Finely granulated EMCal allows us to extend the \(\pi^0\) measurements to pt\(>25\) GeV/c using detailed shower profile analysis to discriminate between single and merged photons. We will present \(\pi^0\) spectrum up to \(\sim 25\) GeV/c measured in Run 2005 pp collisions and comparison to NLO pQCD calculations.

8:00PM BG.00005 Measurement of Lambda polarization in longitudinally polarized proton-proton collisions at $\sqrt{s} = 200$ GeV. QINGHUA XU, LBNL & Shandong University, STAR COLLABORATION — Measurements of Lambda polarization in polarized proton-proton collisions can give insight into polarized fragmentation functions, which are still not well constrained by existing data. Over the past several years, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory has been developing the capability to collide polarized protons. This contribution reports on the measurement of $\Lambda$ polarization in longitudinally polarized proton-proton collisions at $\sqrt{s} = 200$ GeV from the data taken in 2003 and 2004. The $\Lambda$ candidates are reconstructed at mid-rapidity with the Time Projection Chamber (TPC) of the Solenoid Tracker At RHIC (STAR). Their mean momentum fraction $x_F$ is about 8 x 10^{-3} and their mean transverse momentum $p_T$ is about 1.4 GeV/c. The $\Lambda$ polarization is extracted from the asymmetry of counts in intervals of the decay angle in the Lambda rest frame for different helicity states of the colliding proton beams. In this method the detector acceptance largely cancels. Preliminary results for $\Lambda$ polarization will be given.

8:15PM BG.00006 Multiparticle Measurement in Polarized Proton-Proton Collisions at PHENIX, KENICHI NAKANO, Tokyo Institute of Technology, RIKEN, PHENIX COLLABORATION — Polarized deep inelastic lepton-hadron scattering experiments revealed that the contribution of the quark spin to the proton spin is only 20-30%. The remaining component can be carried by the gluon spin and the angular momenta of quarks and gluons. One of the goals of the PHENIX experiment is to obtain the contribution of the gluon spin to the proton spin. With longitudinally polarized proton-proton collisions at RHIC, particles produced with high transverse momentum are measured. The PHENIX experiment has already shown results with single particle production processes. We are analyzing photons and charged particles to measure jet production processes. It will give us information on event structure and higher statistics in higher-transverse-momentum region than that in single particle measurements. We need studies for better jet identification methods with a limited acceptance of the PHENIX Central Arms which cannot detect all particles from jets. In this talk, the status of data analysis and studies with event generators will be presented.

8:30PM BG.00007 Measurement of the double longitudinal spin asymmetry in inclusive jet production in polarized proton-proton collisions at $\sqrt{s} = 200$ GeV. JOANNA KIRYLUK, MIT, STAR COLLABORATION — One of the main objectives of the spin physics program at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory is the precise determination of the polarized gluon distribution in the nucleon over a wide kinematic range. 0.01 < $x_F$ < 0.3, by measurements of double longitudinal spin asymmetries in collisions of polarized protons at $\sqrt{s} = 200$ GeV and $\sqrt{s} = 500$ GeV. This contribution reports on preliminary results for the double longitudinal spin asymmetry $A_{LL}$ in inclusive jet production in polarized proton-proton collisions at $\sqrt{s} = 200$ GeV. The data amount to 0.5 inverse pb and the jet transverse energies are in the range of 5 < $E_T$ < 20 GeV. An outlook of future STAR measurements to determine the gluon polarization in the nucleon will be provided.

8:45PM BG.00008 Measurement of the transverse-spin asymmetries in pp elastic, HIROMI OKADA, Kyoto-Univ./RIKEN, JET COLLABORATION — The single transverse-spin asymmetry (analyzing power $A_N$) for pp elastic scattering is expected to reach a peak of 0.045 in the Coulomb Nuclear Interference (CNI) region at very small momentum transfer $t$ of 0.003 (GeV/c)^2. During the 2004 RHIC run, we completed a measurement of $A_N$ in the CNI region by detecting the recoil protons from pp elastic scattering using a polarized hydrogen gas jet target and the 100 GeV RHIC proton beam. In this talk, we will show the first measurements of the $A_N$ absolute value and shape in the $t$-range from 0.0015 to 0.032 (GeV/c)^2 with a precision better than 0.005 for each $A_N$ data point. The recoil protons were detected with an array of Si detectors. The absolute target polarization as monitored by a Breit-Rabi polarimeter was stable at 0.924 ± 0.018. At the same time, exploiting the polarization of target and beam, we have also measured the double transverse-spin asymmetry ($A_{N\gamma}$). These results allow us to further investigate the spin dependence of elastic pp scattering in the very low $-t$ region.

9:00PM BG.00009 Measurement of the nuclear transparency in $A(e,e'\pi^+)\pi^-$ reactions1, B. CLASIE2, D. DUTTA3, H. GAO2,3, X. QIAN3 — Color transparency is a phenomenon predicted by QCD in which hadrons produced at large $Q^2$ can pass through the nuclear medium with little or no interaction. Results will be presented from E01-107, an experiment that was successfully completed at Hall C at Jefferson Laboratory in 2004, where the pion electroproduction cross section from $Q^2 = 1.1$ to 4.8 (GeV/c)^2 was measured. The nuclear transparency is formed by the ratio of $\langle A_{1}(\sigma_{\gamma}) \rangle$ from the data and $\langle A_{1}(\sigma_{\gamma}) \rangle$ from a model of electroproduction from nuclei that does not include $\pi - N$ final state interactions. A signature of color transparency is the enhancement of the nuclear transparency at large $Q^2$ compared with predictions based on Glauber multiple scattering theory. An effect as large as 40% due to color transparency is predicted in this $Q^2$ range by some models. This experiment will provide the first nuclear transparency data from $\langle e,e'\pi^+\rangle$ reactions and seek unambiguous evidence for the existence of the color transparency effect. This work is supported by the US Department of Energy under contract number DE-FC02-94ER40818 and DE-FG02-03ER41231 and Duke University.

1 On behalf of the Jefferson Laboratory E01-107 collaboration
2 Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, MA 02139, USA
3Triangle Universities Nuclear Laboratory, Duke University, Durham, NC 277

9:15PM BG.00010 Measurement of the Polarization of the Strange-quark Sea in the Proton3, AHMED EL ALALOUFI, Argonne National Laboratory, HERMES COLLABORATION — The polarization of the strange quarks in the proton is of particular interest in understanding the origin of its spin. An explanation of the small net contribution to the proton spin from the quark spins observed experimentally, under the assumption of SU(3) symmetry, implies a significant negative value for this quantity. Such a value would explain the violation of the Ellis-Jaffe sum rule in inclusive deep-inelastic scattering (DIS). The total strange quark helicity density $\Delta S = |\Delta s(x) + \Delta s(\bar{x})|$ carries no isospin. It can extracted from measurements of scattering from deuterium alone, an isoscalar target. Measurements of the inclusive double spin asymmetries probe the helicity density of the non-strange sea. Using semi-inclusive asymmetries for charged kaons as the second data set it is possible to extract $\Delta S$ directly. By measuring the charged kaon multiplicities at HERMES kinematics, the fragmentation functions needed for the extraction can be obtained without resort to other experiments. The only asymmetry assumed is charge-conjugation invariance. Results of a direct leading-order extraction of $\Delta S$ using this approach with DIS data from the HERMES experiment at the HERA accelerator will be presented.

2 Work supported by the U.S. Department of Energy, Office of Nuclear Physics, under contract No. W-31-109-Eng-38

9:30PM BG.00011 Strangeness form factors of the proton: Results from the G0 forward angle measurement, LARS HANNEVIUS1, Caltech, G0 COLLABORATION — The G0 experiment at Jefferson Lab has recently concluded its first phase: a measurement of the parity-violating (PV) asymmetry in polarized electron-proton scattering over a four-momentum transfer range 0.12 < $Q^2$ < 1.0 GeV^2 at a beam energy of 3 GeV. This PV asymmetry, which arises through the interference of the electromagnetic and neutral weak interactions, can be related to the strangeness vector current matrix element $\langle N|\bar{s}g_s|N\rangle$, and thereby provide information about the non-perturbative $\bar{s}s$ sea in the nucleon. In particular, the G0 measurement yields a linear combination of the proton’s strangeness electric and magnetic form factors $G_{E,M}^s$ in each of 18 $Q^2$ bins. In this talk I will give a brief overview of PV electron-proton scattering, the G0 experimental apparatus, the data analysis, and then present results from the G0 forward angle measurement.

1 on behalf of the G0 collaboration
9:45PM BG.00012 Quark model calculation of spin-transfer observables for $pp \to \Lambda\bar{\Lambda}$. MARY ALBERG, Seattle University, University of Washington, ERNEST HENLEY, University of Washington, PETER KUNZ, University of Colorado, LAWRENCE WILLETS, University of Washington — The reaction $pp \to \Lambda\bar{\Lambda}$ provides a test for models of strangeness production. Models of the strangeness production mechanism have been developed in terms of meson-baryon or quark-gluon degrees of freedom. Although both types of model have been successful in reproducing the measurements of PS185 for unpolarized proton targets, their predictions for the spin-transfer observables $D_{\Lambda\bar{\Lambda}}$ and $K_{\Lambda\bar{\Lambda}}$ are in disagreement with recent measurements for a polarized target. We have carried out an improved DWBA calculation of cross sections and spin observables for this reaction using a quark model for the strange-gluon production mechanism. Our initial state interaction is determined by a good fit to $pp$ elastic scattering data in a momentum range corresponding to the $\Lambda\bar{\Lambda}$ production experiment. The reaction mechanism includes effective scalar and vector quark annihilation and creation contributions. The free parameters of the calculation include the strengths of the scalar and vector exchanges, a quark cluster size parameter, and parameters of the unknown $\Lambda\bar{\Lambda}$ interaction. Comparison with the published experimental results from PS185 is made, including both observables and spin density matrices. This work is supported in part by the U.S. National Science Foundation, Award No. 0070942, and the U.S. Department of Energy.

BG.00013 Experimental Study of Duality in SIDIS at JLab, PETER BOSTED, JLAB E00-108 COLLABORATION — Measurements of semi-inclusive deep-inelastic scattering have been made using an unpolarized electron beam of energy 5.5 GeV scattering from both proton and deuteron targets. Measurements were made with $x > 0$ or $x < 0$ detected in coincidence with the electrons. The dependence of hadron kinematic variable was studied for $0.2 < x < 0.5$ and for average $z = 0.55$. Although the electron-pion missing mass $W' < 2$ GeV for these data, they are reasonably consistent (for $z < 0.7$) with expectations from higher energy data assuming factorization of quark densities functions and current fragmentation functions.

Monday, September 19, 2005 7:00PM - 9:00PM — Session BH DNP JPS: Nuclei far from Stability — Ritz-Carlton Hotel Plantation 1

7:00PM BH.00001 First Penning Trap Mass Measurements of Rare Isotopes produced by Fast Beam Fragmentation, G. GOLLEN, NSCL/MSU, D. DAVIES, M. FACINA, J. HUIKARI, E. KWAN, A. PRINKNE, D.J. MORRISSEY, R. RINGLE, J. SAVORY, P. SCHURY, S. SCHWACH, C. SUMITHRARACHCHI, T. SUN — LEBIT is a facility designed for Penning trap mass measurements on rare isotope produced by fast beam fragmentation. LEBIT has now been used to perform a precision mass measurement of the super-allowed $\beta$-emitter $^{38}\text{Ca}$. For this purpose $^{38}\text{Ca}$ was produced via fragmentation of a $^{93}\text{MeV}$ $^{40}\text{Ca}$ beam. After appropriate upgrading of its energy the $^{38}\text{Ca}$ beam was stopped in the NSCL gas cell. A low energy beam was extracted in the form of doubly-charged $^{38}\text{Ca}(H_2O)_n$ molecules. A RFQ mass filter was used to select $(^{38}\text{Ca}-H_2O)^{2+}$ ions, which were transported into the gas-filled RFQ beam accumulator and buncher of LEBIT. Here the water was stripped off in collisions with Ne buffer gas. The resulting $^{38}\text{Ca}^{2+}$ ions were then transferred into LEBIT’s 9.4T Penning trap mass spectrometer, where their mass was measured. This first direct measurement of the mass of $^{38}\text{Ca}$ provides an improved mass value, making this isotope more suitable for contributing to the test of the conserved vector current hypothesis. The experiment is also the first successful demonstration that rare isotopes produced by beam fragmentation at energies of 100 MeV/u can be slowed down and prepared such that precision experiments with low-energy beams are possible.

7:15PM BH.00002 Mass determination of the lowest $T = 2$ state in $^{32}\text{S}$. SMARAJIT TRIMBAK, ALEJANDRO GARCIA, GREGORY HODGES, ERIC ADELBERGER, ERIK SWANSON, SETH HOEY, SKYKOLI SJUE, ANNE SALLASKA, CENPA, UNIVERSITY OF WASHINGTON TEAM — We present data of a recent mass determination of the lowest $T = 2$ state in $^{32}\text{S}$ ($E_x \approx 12$ MeV) with an uncertainty of $0.3$ keV using the $^{31}p(\gamma,\gamma')$ reaction. The state of interest was populated using the resonance at $E_p = 3285$ keV and the decaying gammas of energies $\approx 8124$ keV and 3923 keV were detected using HPGe detectors at $\pm 90^\circ$ and $0^\circ$ to the incident beam. Systematic effects and implications to the Isobaric Multiplet Mass Equation for the $A = 32$ multiplet will be discussed.

1 Weak Interactions Group

7:30PM BH.00003 Decay of $^{47-50}\text{Ar}$ isotopes, UFFE BERGMAN, JOAKIM CEDERKALL, LUIS FRAILE, SERGE FRANCHO, TOMAS FRITIOFF, ULLI KOESTER, THOMAS NILSSON, ISOLDE, CERN, OLIVER ARNDT, IRIS DILLMANN, OLIVER HALLMAN, KARL-LUDWIG KRATZ, BERND PFEIFFER, Institut fur Kernchemie, Universitat Mainz, LAURANT GAUDEFROY, OLIVER SORLIN, ALEXANDRE LISETSKY, NSCL, MSU — Information on beta-decay properties of neutron-rich $^{47-50}\text{Ar}$ was obtained at the ISOLDE mass-separator facility at CERN using isobaric selectivity. This was achieved by a combination of a plasma-ion source with a cooled transfer line and subsequent mass-separation. Most of these beams suffer from intense multi-charged symmetric fission contaminations that cannot be mass-separated from asymmetric fission argon products. The identification of the gamma-ray transitions from $^{47-50}\text{Ar}$ decay was performed by comparing the spectra obtained from direct proton bombardment of the ISOLDE target and those obtained with the neutron converter. In addition, an Electron Cyclotron Resonance Ion Source (ECRIS) installed at ISOLDE was used for purification of the singly-charged $^{48}\text{Ar}$ beam. The obtained data are compared to the result of large-scale shell model calculations and QRPA predictions. Implication of the obtained information for a better understanding of the origin of the $^{48}\text{Ca}/^{46}\text{Ca}$ isotopic anomaly discovered in inclusions from the Allende meteorite is discussed.

1 Institut de Physique Nucleaire d’Orsay

7:45PM BH.00004 Laser Spectroscopic Determination of the Nuclear Charge Radius of $^{6}\text{He}$ and $^{8}\text{He}$. M. POLLEI, L.-B. WANG, K. BAILEY, J.P. GREENE, D. HENDERSON, R.J. HOLT, R.V.F. JANSSENS, C.L. JIANG, Z.-T. LU, T.P. O’CONNOR, R.C. PARDO, K.E. REHM, J.P. SCHIFFER, K.D. TANG, Argonne National Laboratory, G.W.F. DRAKE, University of Windsor — Laser spectroscopic measurements of atomic isotope shifts provide unique access to the nuclear charge distribution of short-lived isotopes. The isotopes of interest for this study are $^{6}\text{He}$ ($t_{1/2} = 807$ ms) and $^{8}\text{He}$ ($t_{1/2} = 119$ ms), which exhibit a loosely bound neutron halo around an $\alpha$-like core. Charge radii measurements of both isotopes provide corraboration for their halo structure measurements of light nuclei. We have performed high-resolution laser spectroscopy on individual radioactive helium atoms captured in a magneto-optical trap. This technique enabled us to accurately measure the isotope shift between $^{6}\text{He}$ and $^{4}\text{He}$ in a selected atomic transition. Based on this result and precision atomic theory calculation of helium, the root-mean-square charge radius of the $^{6}\text{He}$ nucleus could be determined to be $2.056(14)$ fm [1]. Currently, we are working to expand this technique to also measure the nuclear charge radius of $^{8}\text{He}$, and we will report on first results from this experiment. [1] L.-B. Wang et al., PRL 93, 142501 (2004)

1 This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. W-31-109-ENG-38
8:00PM BH.00005 Beta-delay Neutron Isotopes. DAVID MORRISSEY, CHANDANA SUMITHRARACHCHI, DON ANTHONY, PATRICK LOFY, NSCL and Dept. of Chemistry, Michigan State University — Beta-delayed neutrons from the decay of $^{19}$N and most recently $^{22}$N have been measured for the first time using neutron time-of-flight spectroscopy. The nuclei were produced by projectile fragmentation reactions and the decays observed in a batch-mode experiment using plastic scintillators and germanium detectors. The half-lives, total neutron emission probability, and the branching to bound and neutron-unbound states were determined in the present work. The $\beta - \gamma$, $\beta - n$, and $\beta - n - \gamma$ coincidence data were used to construct level schemes for the oxygen isotopes and the two lighter isotopes compare well to the results of other determinations. The results do not compare well to USD shell model calculations.

8:15PM BH.00006 Level assignments of $^{11}$Be through $\beta$-delayed low energy neutron emissions. YOSUKE AKASAKA, T. SHIMODA, K. KAWAI, H. IZUMI, I. WAKABAYASHI, Dept. of Phys., Osaka Univ., Y. HIRAYAMA, H. MIYATAKE, IPNS, KEK, K.P. JACKSON, C.D.P. LEVY, TRIUMF, DEPT. OF PHYS., OSAKA UNIV. COLLABORATION, IPNS, KEK COLLABORATION, TRIUMF COLLABORATION — The low energy neutron emissions from $^{11}$Be were studied in the $\beta^{-}$ and $\beta^{-}n$-$\gamma$ coincidence measurements from a spin-polarized $^{12}$Li$_{gs}$. The spin-parity assignments for the $^{11}$Be states were made based on the fact that the allowed $\beta$-transition from the polarized $^{12}$Li shows $\beta$-decay asymmetry depending on the spin value of the daughter state in $^{11}$Be. The experiment was performed at TRIUMF ISAC, where approximately 55% nuclear-polarized $^{12}$Li beam was available. The $\beta$-decay asymmetries were measured in coincidence with the delayed neutrons from $^{11}$Be and/or the subsequent $\gamma$-rays from $^{10}$Be. In the $\beta^{-}n$ coincidence, very low energy neutrons with $E_n = 73$ (5) keV and 17 (1) keV were observed. From the $\beta$-decay asymmetries in coincidence with the respective $\gamma$-rays, the spin-parity assignments of the neutron and the usual low $^{11}$Be were determined. The $\beta$-decay and/or the subsequent $\gamma$-ray coincidence the level energies of the $^{11}$Be states were determined to be $E_\gamma = 3.951(6)$ and 3.890(1) keV, respectively. The first assignment for the former is consistent with that in the literature, whereas the latter is in contradiction to the previous assignment (3/2+) based on the $^{9}$Be$(t,p)^{11}$Be reaction data.

8:30PM BH.00007 Study of the $\beta$-decay of $^{32}$Na at ISAC/TRIUMF. C. VAMAN, D. BAZIN, A. BECERRIL, A. CHESTER, J. COOK, A. GADE, D. GALAVIZ, T. GLASMACHER, V. MOELLER, W. MUELLER, T. RUSS, A. SCHILLER, K. STAROSTA, NSCL, Michigan State University, C. ANDREOLI, University of Guelph, Canada — $^{32}$Na is investigated at TRIUMF/ISAC. A beam of 2-3 atoms per second, produced by impinging a proton beam on a Tantalum target, was implanted on a tape at the center of the 8π Sceptar array, a combination of 20 Compton-suppressed HPGe detectors and 20 plastic scintillators. The tape transport system removed long-lived daughter products from the array. Additionally, ($\beta$-$\gamma$)-coincidences provided clean-up of the spectrum by removing events unrelated to the $\beta$-decay. Work is in progress in determining $\gamma$-emission schemes, relative intensities, and possible placements of unknown lines.

8:45PM BH.00008 Measurement of the absolute $B(E2;0^+ \rightarrow 2^+_1)$ strength in the $^{106-110}$Sn isotopes via intermediate-energy Coulomb excitation. C. VAMAN, D. BAZIN, A. BECERRIL, A. CHESTER, J. COOK, A. GADE, D. GALAVIZ, T. GLASMACHER, V. MOELLER, W. MUELLER, T. RUSS, A. SCHILLER, K. STAROSTA, NSCL, Michigan State University, C. ANDREOLI, University of Guelph, Canada — $^{106-110}$Sn isotopes at $Z=50$ provide the longest shell-to-shell chain of semi-magic nuclei investigated to date in nuclear spectroscopy. The nearly constant energy of the first excited $2^+_1$ states for isotopes between $N=50$ and $N=82$ is attributed to the fact that the valence nucleons of one kind outside the doubly magic core do not affect the near-spherical nuclear shape. Except for the stable $^{106}$Sn isotopes, the $B(E2;0^+_1 \rightarrow 2^+_1)$ values are sparsely known. An intermediate energy Coulomb excitation experiment was performed at the NSCL to study the first excited $2^+_1$ states in the $^{106-110}$Sn isotopes. The $^{108}$Sn isotopes beams obtained following the fragmentation of $^{124}$Xe and selection with the A1900 fragment analyzer, impinged on a 212 mg/cm2 thick Au target at an energy of 140 MeV/nucleon. Gamma rays were observed using the highly segmented high purity Ge detectors. The particle identification and the determination of the scattering angles were performed with the detector system of the high-resolution S800 spectrometer. This talk presents the results of the $B(E2;0^+_1 \rightarrow 2^+_1)$ excitation strength measurements and a comparison with the shell model predictions for $^{106-110}$Sn isotopes.

Monday, September 19, 2005 7:00PM - 9:30PM — Session BJ DNP JPS: Hadronic Physics: Theory Ritz-Carlton Hotel Hawaii

7:00PM BJ.00001 $\Delta I = 3/2$ kaon weak matrix elements with non-zero total momentum lattice. TAKESHI YAMAZAKI, RIKEN BNL Research Center, THE RIKEN-BNL-COLUMBIA COLLABORATION — We present preliminary results for $\Delta I = 3/2$ kaon decay matrix elements, which is related to CP violation parameter $\epsilon'/\epsilon$, with lattice QCD using domain wall fermions and the DBW2 gauge action at one coarse lattice spacing corresponding to $a^{-1} = 1.3$ GeV. We calculate the elements including two-pion final state interaction on lattice in the non-zero total momentum system, and extract the infinite volume, center-of-mass system decay amplitudes. For extracting the amplitudes, we employ an extension of the Lellouch and Lüscher formula for non-zero total momentum. We compare the result with our previous result calculated with H-parity boundary conditions. We also show the $I = 2 \pi \pi$ scattering phase shift and scattering length.

7:15PM BJ.00002 In-medium $\pi\pi$ correlation induced by partial restoration of chiral symmetry. DAISUKE JIDO, Yukawa Institute for Theoretical Physics, Kyoto University, TETSUO HATSUDA, University of Tokyo, TEIJI KUNIHIRO, Yukawa Institute for Theoretical Physics, Kyoto University — We show that both the linear and nonlinear chiral models give an enhancement of the $\pi \pi$ cross section near the two-pion threshold in the scalar-isoscalar channel in nuclear matter. The reduction of the chiral condensate, i.e. the partial chiral restoration in nuclear matter, is responsible for the enhancement in both cases. We conclude that proper wavefunction renormalization is essential for consistent treatment in the nonlinear chiral model.

7:30PM BJ.00003 I=2 pi-pi Scattering from lattice QCD. MARTIN SAVAGE, University of Washington — I present the results of a fully-dynamical mixed-action lattice QCD calculation of $\pi\pi$ scattering for pions of mass 294, 348 and 491 MeV.

7:45PM BJ.00004 Coupled QCD sum rules for positive and negative-baryon resonances. YOSHIHIKO KONDO, Kokushikan University, OSMU MORIMATSU, Institute of Particle and Nuclear Studies, KEK, TETSUO NISHIKAWA, Dept. of Physics, Tokyo Institute of Technology, YOSHIKO KANADA-ENYO, Institute for Theoretical Physics, Kyoto University — A new approach of the QCD sum rule is proposed in which positive and negative-parity baryons couple with each other. With positive and negative-parity states explicitly taken into account, sum rules are derived by means of the dispersion relation in energy. The method is applied to the nucleon channel and the parity splitting of the nucleon resonance states is studied. It is found that the obtained sum rules have a very good Borel stability. This suggests that the ansatz for the spectral function in the present sum rule approximates the physical spectral better than the lowest pole plus continuum ansatz. The predicted masses of the positive and negative nucleons reproduce the experimental ones fairly well. Especially, the mass difference is extremely close to the experimental value. The other baryon channels are also studied.
8:00PM BJ.00005 Isospin breaking of baryon masses from domain-wall lattice QCD, TAKUMI DOI, RIKEN BNL Research Center, TOM BLUM, Univ. of Connecticut, RIKEN BNL Research Center, MASASHI HAYAKAWA, RIKEN, TAKU IZUBUCHI, Kanazawa Univ., RIKEN BNL Research Center, NORIKAZU YAMADA, KEK — In this talk, we present the domain-wall lattice QCD study of the isospin breaking effect on baryon masses, such as proton/neutron mass difference. Using two-flavor dynamical QCD configurations and quenched QCD configurations, we study the electromagnetic splitting for baryons. We also explore the strong isospin breaking using the difference of mass between up and down quark as inputs which are determined by meson mass spectroscopy.

8:15PM BJ.00006 Light scalar meson nonet at finite density, MAKOTO TAKIZAWA, Showa Pharmaceutical University, MAKOTO OKA, Tokyo Institute of Technology, HIDEKO NAGAIHIO, Research Center for Nuclear Physics (RCNP), Osaka University, SATORU HIRENZAKI, Nara Women’s University — The observed mass spectrum of the light scalar meson nonet seems not to fit the pattern of the flavor SU(3) if one assumes the simple quark-antiquark structure of the scalar mesons. Without introducing the multi-quark structure of the scalar mesons, this problem has partially been solved by the effect of the $U_A(1)$ breaking instanton induced interaction. About 150 MeV mass difference between the $f_0(600)$ and $a_0(980)$ has been obtained in the study of the three flavor version of the Nambu-Jona-Lasinio (NJL) model where the strength of the $U_A(1)$ breaking interaction is determined by the electromagnetic decays of the $\eta$ meson. Since the low-lying scalar mesons are considered as the chiral partner of the Goldstone bosons ($\pi$, $K$, $\eta$), it is interesting to see how the properties of the light scalar meson nonet change at the finite density where the chiral symmetry is partially restored. We shall report the results of our study of the light scalar nonet at the finite density in the three-flavor NJL model.

8:30PM BJ.00007 The Kaon $B$-parameter from Lattice QCD, CHRISTOPHER DAWSON, RIKEN-BNL Research Center — The calculation of the Kaon $B$-parameter is discussed. In particular the use of the Domain Wall Fermion approach to lattice QCD, with preliminary results from the first calculation using 2+1 flavours of dynamical Domain Wall Fermions being presented.

8:45PM BJ.00008 The two Nucleon States in the Chiral Quark-Diquark Model, KEITARO NAGATA, ATSUSHI HOSAKA, Research Center for Nuclear Physics, Osaka University — We study the ground and first excited states of nucleons in a chiral quark-diquark model. We include two quark-diquark channels of the scalar-isoscalar and axialvector-isovector types for the nucleon states. The diquark correlation violate the spin-flavor SU(4) symmetry, generating a nucleon excited state which does not appear in the ordinary quark model in the SU(4) limit. With a reasonable choice of model parameters, the mass of the excited state appears at around 1.5 GeV, which may be identified with the Roper resonance $N'$(1440).

9:00PM BJ.00009 B, absorption cross sections by mesons, RIAN MARSHALL, M.A.K. LODHI, Texas Tech University, DEPARTMENT OF PHYSICS, TEXAS TECH UNIVERSITY, LUBBOCK, TEXAS 79409 TEAM — The $B$, absorption cross sections by $\pi$ and $\rho$ mesons have been examined using gauged SU5 Lagrangian in meson exchange model. Hadron structures have been taken into account by including monopole form-factors. The cross sections peak at threshold energies in the same ranges as those in case of nucleons, calculated earlier.

9:15PM BJ.00010 Dibaryons with $S = -1$ in the bound kaon approach to the Skyrme model, TETSUO NISHIKAWA, Dept. of Phys., Tokyo Institute of Technology, YOSHIHIKO KONDO, Kokugakuin University — Dibaryons with strangeness=−1 are studied in the framework of the bound kaon approach to the Skyrme-soliton model. We explore the possibility of kaon bound states in a SU(2) Skymion background field with $B=2$, where $B$ denotes the baryon number. The kaon binding energy and the total energy are calculated in kaon-nucleon-nucleon channels. We particularly study the $ppK^-$ system, which was predicted to exist as a deeply bound kaonic nucleus by Akaishi and Yamazaki. We will also study the dependence of the kaon binding energy on the distance between the two Skyrmons, and the baryon number density distribution.

Monday, September 19, 2005 7:00PM - 9:45PM — Session BK DNP JPS: Nuclear Theory I Ritz-Carlton Hotel Maui

7:00PM BK.00001 A Mechanism for Formation of Narrow Hadronic Resonances, NAFTALI AUERBACH, Tel Aviv University, VLADIMIR ZELEVINSKY, Michigan State University, ALEXANDER VOLYA, Florida State University — The observation of a narrow peak around the energy of 1540 MeV in the $K+N$ system has caused considerable excitement and research activity. It was suggested that the observed peak represents a pentaquark resonance, the theta particle. Since this initial discovery many different experiments (about 10) have found the peak around this energy. However, in about the same number of experiments (usually using higher energy probes) the theta was not seen. Moreover, the experiments that do observe the theta peak often differ in the energy position of the resonance. The determination of the widths is difficult because of experimental limitations. Indirect considerations suggest that the width is smaller than 1 MeV. Altogether the state of the art in this field is waiting for data of better quality. In this work we discuss a mechanism that could produce narrow resonances due to interference effects. The mechanism suggested by authors in Phys. Lett. B 590 (2004) 45 is of generic nature and can accommodate various models for the states involved. The central point is that since one deals with a many-quark system a large number of many-body states can be formed which interact via various mechanisms including interference through decay. As a result of this interaction a number of narrow states is generated, superimposed on a very wide resonance(s) which makes up the background. This is similar to the formation of giant resonances in nuclear physics.

7:15PM BK.00002 Relativistic Three-Body Equations in a Wavelet Basis, WAYNE POLYZOU, FATHI BULUT, University of Iowa — We show how to use Daubechies’ wavelets to reduce the relativistic Faddeev-Lovelace equations to approximate linear equations with sparse matrices. We transform the equations to a form where the spectator and two-body relative momenta are separated. We use the renormalization group equation for the scaling basis functions [1][2] to accurately and efficiently compute scaling basis matrix elements of the transformed three-body kernel with moving singularities. The wavelet transform provides a fast (O(N)) mapping from the scaling basis to the wavelet basis, where the kernel can be accurately approximated by a sparse matrix.


1Research supported in part by the U.S. Department of Energy, Office of Nuclear Physics contract : DE-FG02-86ER40286
7:30PM BK.00003 The Electric Dipole Form Factor of the Nucleon\textsuperscript{1} \textsuperscript{1} CLAUDIO MAEKAWA, Fundacao Universidade do Rio Grande, Brazil, WILLIAM HOCKINGS, BIRA VAN KOLCK, University of Arizona — Various experiments have attempted to determine if the neutron has a non zero electric dipole moment (EDM). Because this quantity is relatively insensitive to the CKM phase, its observation is likely to represent an effect from other CP-violating quark interactions. The $\theta$ term in QCD, in particular, induces T-odd contributions from the pion cloud to the nucleon EDM. The associated electric dipole form factor (EDFF) is not as readily accessible experimentally, but it is useful in that it gives an important electromagnetic contribution to nuclear Schiff moments, to which atomic effects are sometimes sensitive. We calculate the nucleon EDFF in the model-independent framework of chiral perturbation theory, up to subleading order. We also discuss implications for the deuteron EDM.

7:45PM BK.00004 The T-Violating Effective Chiral Lagrangian \textsuperscript{1} \textsuperscript{1} WILLIAM HOCKINGS, UBIRAJARA VAN KOLCK, University of Arizona — At quark level, there are numerous sources of T violation that generate T-odd interactions among hadrons, with the form of the interactions determined by the chiral symmetry properties of the sources. These sources include the QCD $\theta$ term, the quark electric and chromoelectric dipole moments, and other terms that are formally of dimension six and higher. We present a method to construct the corresponding T-violating effective chiral Lagrangian, in which we eliminate by field redefinitions the terms that would lead to vacuum instability. As an illustration of the uses of this Lagrangian, we present a calculation of the electric dipole form factor of the nucleon in leading order in an expansion in powers of momenta and quark masses.

8:00PM BK.00005 UCN scattering on nano-size targets \textsuperscript{1} VLADIMIR GUDKOV, University of South Carolina — The elastic scattering cross section of ultra-cold neutrons (UCN) on a target (sphere or a bubble in liquid helium) of a nanometer size scale is calculated. Depending on neutron energy and on the size of the target, the scattering of this system can be described by three different scattering regimes. As a consequence, UCN scattering can manifest low-energy, intermediate energy and high energy behavior in terms of a conventional description in collision theory. It is shown that UCN scattering on a nano-size target can have a resonance dependence on the size of the target. Also, under special conditions, the scattering process of UCN has a coherent nature which leads to a significant increase in the value of the cross section.

8:15PM BK.00006 Density Profile of Asymmetric Two-component Fermionic Systems at Infinite Scattering Length \textsuperscript{1} \textsuperscript{1} THOMAS LIU, JOSEPH CARLSON, SANJAY REDDY, Los Alamos National Laboratory — We investigate the properties of asymmetric two-component fermionic systems at strong coupling ($k_f\alpha = \infty$). Density profiles of these systems are calculated at the Thomas-Fermi level. We show that the height of the discontinuity between the superfluid phase and normal phase can be influenced by the value of $\xi$, the proportionality constant in the universal regime. Such a relationship may prove useful in experimentally determining $\xi$. Also, we calculate the specific heat of such systems.

8:30PM BK.00007 Microscopic approach to isospin-asymmetric nuclear matter: recent progress and applications\textsuperscript{1} \textsuperscript{1} FRANCESCA SAMMARRUCA, PLAMEN KRASTEV, University of Idaho — We will present and discuss a variety of recent results from our on-going investigation of effective interactions in dense, isospin-asymmetric hadronic environment within the Dirac-Brueckner-Hartree-Fock framework. These include microscopic isospin-dependent in-medium nucleon-nucleon cross sections, a crucial information for predicting the nucleon mean free path in nuclear matter and thus nuclear transparency. Two-body in-medium cross sections are also useful for transport model simulations of heavy-ion collisions, with symmetry considerations being especially of interest at this time due to the possibility to study collisions of neutron-rich nuclei at RIA energies. Our work in progress extends to neutron star properties and spin polarized neutron matter.

8:45PM BK.00008 Quantum Monte Carlo Lattice Simulation of Thermal Properties of Low-Density Neutron Matter\textsuperscript{1} \textsuperscript{1} TAKASHI ABE, Tokyo Institute of Technology, RYOICHI SEKI, California State University, Northridge and California Institute of Technology — Thermal properties of low-density neutron matter are investigated by nuclear many-body simulation on three-dimensional cubic lattice. Determinantal quantum Monte Carlo calculations are carried out for the Hamiltonian with a coupling constant of the neutron-neutron interaction determined from effective field theory. Method of finite-size scaling is applied to extract thermodynamical information. Phase diagram shows that low-density neutron matter undergoes a phase transition from a superfluid state to normal, as the temperature or the density increases. The results are also compared with the existing mean-field and related calculations.

9:00PM BK.00009 Novel phases of color superconductivity \textsuperscript{1} JEFFREY BOWERS, University of Washington — Cold dense quark matter is a color superconductor. QCD favors Cooper pair that are antisymmetric in flavor, but at densities relevant for compact stars, charge neutrality and the heaviness of the strange quark together imply unequal number densities (and Fermi surfaces) for the different quark flavors. Novel phases have been proposed that accomodate pairing between the mismatched Fermi surfaces. These include homogeneous and isotropic Sarma ("gapless") phases, in which the Fermi sphere occupation is redistributed to allow pairing, and inhomogeneous and anisotropic Larkin-Ovchinnikov-Fulde-Ferrell (LOFF) phases, in which Cooper pairs acquire nonzero total momentum. I investigate the stability of the Sarma phase when it is subjected to a small LOFF fluctuation, i.e. a small spatial variation of the order parameter, with a concomitant charge density wave. These fluctuations lower the free energy of the system when the Coulomb energy of the charge density wave is sufficiently small.

9:15PM BK.00010 Confinement Theory for Hadrons \textsuperscript{1} CARL CASE, SPARTA, Inc. — A dynamic relationship is proposed that leads to chiral symmetry breaking for massless quarks and in cancellation of the color electric field leaving only color magnetic fields acting on hadron quarks. Color superconducting states result giving rise to a color Meissner effect. Quarks are trapped within the color magnetic fields and quantized color magnetic flux bundles are trapped by circulating quarks creating quark-gluon composites that gain mass. The flux quantization introduces a topological defect that generates collective quark-gluon composite energy states corresponding to the various quark flavors. Topological winding numbers serve as quantum numbers for the quark flavors. Up and Down states correspond to a winding number of 1. Strange/Charm and Bottom/Top states correspond respectively to winding numbers of 2 and 3 respectively. The Dirac equation is solved using the Hartree self-consistent field method and the Born approximation. Resulting mass spectra calculations are presented for 30 baryons, 20 mesons and for the proton-neutron mass difference.
9:30PM BK.00011 Applications of Effective Operators within the NCSM. BRUCE R. BARRETT, IONEL STETCU, U. of Arizona, CALVIN W. JOHNSON, San Diego St. U., PETR NAVRATIL, Lawrence Livermore National Laboratory, JAMES P. VARY, Iowa St. U. — The no-core shell model (NCSM) is a powerful many-body method which provides the solution to the Schrödinger equation for a interacting nucleons in a restricted space. Starting from realistic nucleon-nucleon interactions that accurately fit the experimental phaseshifts, we use a unitary transformation approach to obtain an effective interaction in the model space (realistic three-nucleon forces can be also implemented, but we restrict the discussion to two-body forces). The same renormalization procedure can be applied to other operators, obtaining results consistent with the NCSM wave functions. In our presentation we will discuss renormalization of short- and long-range operators, as well as the latest applications of the NCSM to the description of ground- and excited-state properties. I.S. and B.R.B acknowledge partial support by NFS grants PHY0070858 and PHY0244389. The work was performed in part under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48. P.N. received support from LDRD contract 04-ERD-058. J.P.V. acknowledges partial support by USDOE grant No DE-FG-02-87ER-40371, and C.W.J. acknowledges USDOE grant No.DE-FG02-03ER41272.

Tuesday, September 20, 2005 2:00PM - 5:00PM –
Session CA DNP JPS: New Results for Exotic Nuclei in sd-pfg
Ritz-Carlton Hotel Salon 4

2:00PM CA.00001 Exploring the shell structure in very neutron rich pf-shell nuclei through the γ-ray spectroscopy technique. NORI AOI, RIKEN — Rearrangement of the shell structure is one of the prominent features of neutron rich nuclei clarified in the light mass region, such as disappearance of magicity at \( N = 20 \) and \( 20 \), or appearance of a new magic number of \( N = 16 \). A similar phenomenon is anticipated in the heavier mass pf-shell region. For example, a new magic number \( N = 34 \) is predicted in the neutron-rich region [1], while a new region of large deformation is suggested around neutron rich chromium isotopes with \( N \approx 40 \) [2]. The behavior of the magicity at \( 20 \) may be quite small in some of exotic Ne-Na-Mg isotopes leading to (near-)degeneracy of positive and negative parity states, and new magic numbers such as \( N = 32 \), \( 34 \) may emerge in neutron rich Ca-Ti. Theoretical descriptions of these nuclei will be presented in close connection to particular properties of Nucleon-Nucleon interaction.

2:45PM CA.00002 Exotic neutron-rich sd-pf nuclei and nuclear force. MICHIO HONMA, University of Aizu — Recent results of large-scale shell-model calculations will be overviewed for exotic neutron-rich nuclei in the sd-pf region. One of the most exciting findings is the change of shell structures in extreme conditions. For instance, the \( N = 20 \) gap may be quite small in some of exotic Ne-Na-Mg isotopes leading to (near-)degeneracy of positive and negative parity states, and new magic numbers such as \( N = 32 \), \( 34 \) may emerge in neutron rich Ca-Ti. Theoretical descriptions of these nuclei will be presented in close connection to particular properties of Nucleon-Nucleon interaction.

3:30PM CA.00003 Wavefunction-spectroscopy with rare-isotope beams\(^1\). ALEXANDRA GADE, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824 — The nuclear shell model pictures deeply-bound states as fully occupied by nucleons. At and above the Fermi sea, configuration mixing leads to occupancies that gradually decrease to zero. Correlation effects (short-range, soft-core, long-range, and coupling to vibrational excitations) are beyond the effective interactions employed in shell model and mean-field approaches. The picture given above is modified depending on the strength of the correlations. In stable nuclei a reduction of the range, soft-core, long-range, and coupling to vibrational excitations) are beyond the effective interactions employed in shell model and mean-field approaches.

\[^1\]This material is based upon work supported by the National Science Foundation under Grant No. PHY-0110253

4:15PM CA.00004 Structure of the exotic neutron-rich nuclei 42Si, 52Ti, and 54Ti. INGO WIEDEMHOEVER, Florida State University — The modification of magic numbers and the shell structure of very neutron-rich systems is one of the most intriguing subjects to be studied with present and future exotic beam facilities. In a number of recent experiments, the modification of shell structure for both the neutron and proton systems was studied for the very neutron-abundant nuclei \( 52^{\text{Si}} \), \( 54^{\text{Ti}} \), \( 54^{\text{Ti}} \). The excited level structure of \( 52^{\text{Si}} \) shows evidence for a sub-shell closure at \( N = 32 \) [1], while a recent measurement of Coulomb excitation of the \( 2^+ \) in \( 54^{\text{Ti}} \) [2] shows that the sub-shell closure at \( N = 34 \) is weaker than expected. In order to investigate the character of \( 42^{\text{Si}} \), we performed an experiment using a \( 42^{\text{Si}} \) beam, generated in fragmentation of 140 MeV/u \( 44^{\text{Ca}} \) at the Coupled-Cyclotron Facility at the NSCL. This beam was delivered to the target position of the \( S800 \) spectrometer, where secondary reactions occurred. One-proton and two-proton knockout reaction products, \( 41^p \) and \( 42^p \), were identified using the \( S800 \) spectrograph and coincident \( \gamma \) rays were detected with the segmented Germanium array, SeGA, surrounding the \( S800 \) target position. We measured one-proton knockout populating the ground and first excited state of \( 41^p \). The direct reaction character of one-proton [3] knockout and two-proton knockout [4] allows to compare the observed cross-section to calculations using the eikonal-approach. We find large cross sections for the single-proton knockout, corresponding to single-particle spectroscopic factors for the \( 41^p \) = \( 42^p \) + p system. Simultaneously, the measured two-proton knockout cross section corresponds to a \( Z = 14 \) closed shell \( 42^2 \). Both of these aspects support the magic character of \( 42^{\text{Si}} \). [1] R.V.F. Janssens et al. Phys. Lett. B 546 (2002) [2] D.C. Dirac et al. Phys. Rev. C 71, 041302R (2005) [3] Hansin, P.G. & Tostevin, J.A., Direct Reactions with Exotic Nuclei. Annu. Rev. Nucl. Part. Sci. 53, 219-261 (2003). [4] D. Bazin et al. Phys. Rev. Lett. 91 012501 (2003)

Tuesday, September 20, 2005 2:00PM - 4:45PM –
Session CB DNP JPS: Mini-symposium on Chiral and Color Condensation I
Ritz-Carlton Hotel Salon 1
the pairing gap \( \Delta \) plays in the gap equation for a weakly coupled uniform superfluid of three-flavor massless quarks near the transition temperature \( T \), KEI IIDA, RIKEN BNL Research Center — We examine the role that the gap dependence of the pairing interaction alone, while the spectral function vanishes in the vector channel. H \( \omega \) a low-lying collective mode in the particle-hole (vector) channel. In the CFL phase, when the excitation energy, the spectra both for the normal and color-flavor locked (CFL) superfluid phases at zero and finite temperature. In the normal phase, we obtain zero sound as as an analogue of a quasi-particle in the quantum Hall state. We analyze the vortex excitation energy and quark spectrum to discuss the stability of the color ferromagnetic state in comparison with the color superconducting phase. We show a possibility that there exists a color ferromagnetic state in quark matter, in which a color magnetic field is spontaneously generated. The state arises as an analogue of a quasi-particle in the quantum Hall state. We analyze the vortex excitation energy and quark spectrum to discuss the stability of the color ferromagnetic state in comparison with the color superconducting state when the density of quarks is varied. We find a vortex solution in the color ferromagnetic state

We estimate corrections by these effects to the parameters characterizing the fourth-order terms in the Ginzburg-Landau free energy and ensure the stability of superconducting states (CFL and 2SC) of dense quark matter. We find that the color ferromagnetic state is more stable than the color superconducting states of dense quark matter, so that a color magnetic field is generated spontaneously. We compare the free energy of this color ferromagnetic state with the free energies of color superconducting states (CFL and 2SC) of dense quark matter. We find that the color ferromagnetic state is more stable than the color superconducting states of dense quark matter, so that a color magnetic field is generated spontaneously. We compare the free energy of this color ferromagnetic state with the free energies of color superconducting states (CFL and 2SC) of dense quark matter.

We investigate how the soft mode affects the quark properties. The spectral function of a quark shows a several-peak structure at low frequency and momentum. We show that one of the peaks is the plasmino state and the spectral structure is understood in terms of resonant scatterings of a quark off the soft mode. The quasiquark and the plasmino have thermal masses near \( T_c \), which results from the level repulsions between a quark and an antihole and between an antiquark and a hole. Effects of finite density are also presented.

2:30PM CB.00002 Phase Diagram of Quark Matter at Finite Temperature and Density in the Strong Coupling Limit Lattice QCD with \( N_c = 3 \), AKIRA OHNISHI, Div. of Phys., Graduate School of Sci., Hokkaido Univ., NOBORU KAWAMOTO, KOTARO MIURA, TOSHIHIKO OHNUMA, Hokkaido University — Exploring various phases of quark and nuclear matter has recently attracted much attention both from theoretical and experimental sides. For cold baryon rich matter, the first principle lattice QCD simulation is not yet available then it is necessary to invoke some approximate QCD or to apply some effective theories. We study here nuclear matter at finite temperature and density in the strong coupling limit (SCL) lattice QCD. It is already shown that SCL can describe chiral phase transition at finite temperature. At finite densities, we may have diquark condensate, which has color and cannot be an order parameter as it is in lattice QCD. Because of this difficulty, studies are limited to \( N_c = 2 \) case or zero temperature. We have recently developed a way to extract the color singlet combination from diquark condensates. In the presentation, we explain how we can define and extract color singlet order parameter, and discuss color and chiral condensates in dense matter.

3. V. Azcoiti et al., JHEP 0309, 014 (2003).

2:45PM CB.00003 The effects of thermal fluctuations of gauge fields in realistic dense quark matter, TAEKO MATSUURA, University of Tokyo, KEI IIDA, RIKEN BNL Research Center, MOTOI TACHIBANA, Saga University, TETSUO HATSUDA, University of Tokyo — We investigate a high density phase structure of color superconducting quark matter near the boundary with a normal phase using the Ginzburg-Landau free energy. For realistic description, in addition to the effects of nonzero strange quark mass and electric charge neutrality, we take into account the effect of thermal fluctuations of gluons. We show how the gluon fluctuations change the high density phase structure near the boundary from the three successive second-order phase transitions, a modified color-flavor locked phase (ud, ds, and us pairings) → "dSC" phase (ud and ds pairings) → an isoscalar pairing phase (ud pairing) → a normal phase (no pairing), obtained from mean-field calculations.

3:00PM CB.00004 Collective excitations in a superfluid of color-flavor locked quark matter, KENJI FUKUSHIMA, KEI IIDA, RIKEN BNL Research Center — By using the Nambu-Jona-Lasinio (NJL) model in the mean-field approximation, we derive the spectra both for the normal and color-flavor locked (CFL) superfluid phases at zero and finite temperature. In the normal phase, we obtain zero sound as a low-lying collective mode in the particle-hole (vector) channel. In the CFL phase, when the excitation energy, \( \omega \), is smaller than the threshold given by twice the pairing gap \( \Delta (\omega < 2\Delta) \), a phonon corresponding to fluctuations in the U(1) phase of \( \Delta \) appears as a sharp peak in the particle-particle \( (H) \) channel. The excitation energy goes up and asymptotically approaches \( \omega = 2\Delta \) with increasing momentum of the phonon. Above the threshold for pair excitations \( (\omega > 2\Delta) \), zero sound mode breaks up into three peaks. We find that in the long wavelength limit the phonon mode has its spectral weight in the \( H \) channel alone, while the spectral function vanishes in the vector channel.

3:15PM CB.00005 Feedback effects on the pairing interaction in color superconductors near the transition temperature, KEI IIDA, RIKEN BNL Research Center — We examine the role that the gap dependence of the pairing interaction plays in the gap equation for a weakly coupled uniform superfluid of three-flavor massless quarks near the transition temperature \( T_c \). We find that the feedback effects on Landau-damped transverse gluons mediating the pairing interaction alter the gap magnitude in a way dependent on the color structure of the gap. We estimate corrections by these effects to the parameters characterizing the fourth-order terms in the Ginzburg-Landau free energy near the chiral transition, a collective excitation due to the fluctuation of the chiral condensate, called a soft mode, appears. We investigate how the soft mode affects the quark properties. The spectral function of a quark shows a several-peak structure at low frequency and momentum. We show that one of the peaks is the plasmino state and the spectral structure is understood in terms of resonant scatterings of a quark off the soft mode. The quasiquark and the plasmino have thermal masses near \( T_c \), which results from the level repulsions between a quark and an antihole and between an antiquark and a hole. Effects of finite density are also presented.

3:30PM CB.00006 Color Ferromagnetism and Color Superconductivity in Dense Quark Matter, AIICHI IWAZAKI, Professor, Nishogakusha University, OSAMU MORIMATSU, Professor, KEK, TETSUO NISHIKAWA, Research Associate, Tokyo Institute of Technology, MUNEISHA OHTANI, Research Associate, RIKEN — As we have shown, Savvidy vacuum unstable in vacuum becomes stable in dense quark matter, so that a color magnetic field is spontaneously generated. We compare the free energy of this color ferromagnetic state with the free energies of color superconducting states (CFL and 2SC) of dense quark matter. We find that the color ferromagnetic state is more stable than the color superconducting states in a range of baryon chemical potentials accessible in experiments or neutron stars. Although the strength of the color magnetic field is not known, the result holds for a wide range of the magnetic field strength.

3:45PM CB.00007 Vortex excitation and quark spectrum in color ferromagnetic state in cold dense matter, MUNEISHA OHTANI, RIKEN, AIICHI IWAZAKI, Nishogakusha University, OSAMU MORIMATSU, TETSUO NISHIKAWA, KEK — We show a possibility that there exists a color ferromagnetic state in quark matter, in which a color magnetic field is spontaneously generated. The state arises between the hadronic state and the color superconducting state when the density of quarks is varied. We find a vortex solution in the color ferromagnetic state as an analogue of a quasi-particle in the quantum Hall state. We analyze the vortex excitation energy and quark spectrum to discuss the stability of the color ferromagnetic state in comparison with the color superconducting phase.

4:00PM CB.00008 Quark spectrum in QGP near chiral transition, YUKIO NEMOTO, Nagoya Univ., MASAKIYO KITAZAWA, YITP, TEJJI KUNIHIRO, YITP — Near but the critical temperature \( T_c \) of the chiral transition, a collective excitation due to the fluctuation of the chiral condensate, called a soft mode, appears. We investigate how the soft mode affects the quark properties. The spectral function of a quark shows a several-peak structure at low frequency and momentum. We show that one of the peaks is the plasmino state and the spectral structure is understood in terms of resonant scatterings of a quark off the soft mode. The quasiquark and the plasmino have thermal masses near \( T_c \), which results from the level repulsions between a quark and an antihole and between an antiquark and a hole. Effects of finite density are also presented.
4:15PM CB.00009 Renormalization group fixed points and chiral restoration scenarios from generalized hidden local symmetry approach, YOSHIMASA HIDAKA, OSAMU MORIMATSU, Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization, MUNEHISA OHTANI, Radiation Laboratory, RIKEN — There are some proposals for realization patterns of chiral symmetry. In the standard scenario of chiral symmetry, the chiral partner of the pion is the rho meson. Another scenario, Vector Manifestation (VM), has been recently proposed, in which the chiral partner of the pion is the rho meson. We study these chiral restoration patterns from renormalization group approach in the generalized hidden local symmetry (GHLs) model, which includes vector and axial-vector mesons in addition to pions as physical degrees of freedom. We found two types of fixed points corresponding to the standard and VM scenarios. The decay-constant ratio of rho meson to \( A_1 \) becomes unit (\( F_{\rho}/F_{A_1} = 1 \)) in the standard scenario, while in the VM scenario that of pion becomes unit (\( F_{\pi}/F_{\pi} = 1 \)) on the fixed point. We discuss the possibilities of the realization in these scenarios.

4:30PM CB.00010 Condensates in Lattice Landau Gauge QCD, SATADAKA FURUI, Teikyo University, School of Science and Engineering, HIDEO NAKAJIMA, Utsunomiya University, Faculty of Information Science — The running coupling and the Kugo-Ojima parameter c of unquenched lattice Landau gauge are measured and compared with the continuum theory. We used gauge configurations of JLQCD/CP-PACS with Wilson fermion and those of Columbia University and MILC with Kogut-Susskind fermions. Although there exists dependence on the polarization due to asymmetry of the lattice, it is observed that c is consistent with 1. Presence of infrared fixed point of \( \alpha_s \sim 2 - 2.5 \) irrespective of the fermion actions in the continuum and in the chiral limit is suggested. In comparison with pQCD results in \( M_{OM} \) scheme up to the 4-loop level, the MILC data of \( \alpha_s \) in the region 1 \( \sim \) 3 GeV exhibit presence of dimension 2 condensates and dimension 4 condensates with sign opposite to the dimension 2 condensates. We observed that Zwanzigers horizon condition is satisfied within errors. The dimension 2 condensates is interpreted as the square norm of the gauge field which is related to the Zwanziger's horizon condition and the dimension 4 condensates is interpreted as the quark condensates.

Tuesday, September 20, 2005 2:00PM - 4:45PM — Session CC DNP JPS: Mini-symposium on Relativistic Heavy Ions, Jet Quenching

Hotel Salon 2

2:00PM CC.00001 Parton Energy Loss and Jet Tomography: Probing the “Perfect Liquid” at RHIC, JOHN LAJOIE, Iowa State University — Experimental evidence from RHIC strongly suggests that matter having an energy density far in excess of the value required for the creation of a deconfined phase is produced in ultrarelativistic Au+Au collisions at \( \sqrt{s_{NN}} = 200 \) GeV. This matter thermalizes rapidly, is strongly interacting, and displays hydrodynamic properties akin to a fluid with very low viscosity. Studies of the interaction of hard scattered partons with this matter provide an important probe of its properties.

2:30PM CC.00002 Measurement of Neutral Pions in \( \sqrt{s_{NN}} = 200 \) GeV Cu+Cu Collisions with the PHENIX Experiment at RHIC, STEFAN BATHE, University of California at Riverside, PHENIX COLLABORATION — The suppression of high-\( p_T \) hadrons in central Au+Au collisions has been one of the most significant results at RHIC. It has been attributed to energy loss of partons as they traverse the hot and dense medium created in the collision. It is of interest at which system size the suppression commences. This can be and has been studied by varying the centrality of the collision. A continuous increase of the suppression with increasing centrality has been observed with no indication of a sudden onset. A more precise way to measure the system-size dependence of the suppression is to study the particle production in a lighter system like Cu+Cu. In particular, this permits measurement of particle production for a system with different medium properties as compared to Au+Au, even at the same number of underlying binary nucleon-nucleon collisions. In the 2005 run, PHENIX sampled a total of 3.06 nb\(^{-1}\) Cu+Cu collisions at \( \sqrt{s_{NN}} = 200 \) GeV, providing the possibility of comparing particle production at high \( p_T \) in Cu+Cu and Au+Au. The PHENIX result on neutral pion production in Cu+Cu will be presented.

2:45PM CC.00003 Neutral pion production in \( \sqrt{s_{NN}}=200\text{GeV} \) Au+Au collisions at RHIC-PHENIX, TADAAKI ISOBE, Univ. of Tokyo, PHENIX COLLABORATION — The suppression of neutral pions at high transverse momentum in central Au+Au collisions compared to the yield in p+p collision scaled by the number of underlying nucleon-nucleon collisions in Au+Au has been one of the most intriguing observations at RHIC. The observed suppression is interpreted as a consequence of the energy loss of initially hard-scattered partons traversing the hot and dense matter produced in central Au+Au collisions. In Run 4 PHENIX recorded the integrated luminosity of 0.24 nb\(^{-1}\) of \( \sqrt{s_{NN}}=200 \) GeV Au+Au collisions, which allows us to extend the measurement of neutral pions to high transverse momentum. We present the PHENIX Run 4 results on neutral pion production in \( \sqrt{s_{NN}}=200\text{GeV} \) Au+Au collisions.

3:00PM CC.00004 Measurement of Direct Photons in \( \sqrt{s}=200\text{GeV} \) p+p, KENSUKE OKADA, RIKEN-BNL Research Center, RHIC-PHENIX COLLABORATION — Direct photon measurements in p+p collisions provide a superb test of the precision of perturbative QCD, because the dominant partonic process for direct photon production is gluon-quark scattering and no hadronic fragmentation process is involved. Direct photons are also expected to be a good probe of the proton gluon-spin structure which can be accessed in polarized-proton collisions at RHIC. With its high-granularity electromagnetic calorimeter, the PHENIX experiment is well suited to identify backgrounds of hadronic decay. The high energy photon trigger plays an important role. In addition, along with the charged tracking system, we can do a photon isolation test, which direct photon events are supposed to pass. In this talk, we will present the direct photon cross section measurement in p+p at mid-rapidity.

3:15PM CC.00005 Measurement of Direct Photons in \( \sqrt{s_{NN}}=200\text{GeV} \) d+Au Collisions at RHIC-PHENIX, HISAYUKI TORII, RIKEN, PHENIX COLLABORATION — The measurement of direct photon production at large transverse momentum in hadron interactions is a good test of QCD. Because the direct photon production in Au+Au collisions happens through the fundamental interactions of partons in Au-nuclei and do not interact strongly with the surrounding medium, direct photon production is an important probe in the search of the Quark Gluon Plasma. The partons in Au-nuclei are known to have a different behavior than in protons. To understand such nuclear effects on the partons in Au-nuclei, it is crucial to measure direct photons in p+p and d+Au collisions. This analysis uses the PHENIX electromagnetic calorimeters and triggering system for the detection of photons at high \( p_T \). In this talk, we will present the invariant yield of direct photons in \( \sqrt{s_{NN}}=200\text{GeV} \) d+Au collisions at PHENIX. We will present comparison with results in p+p collisions and prediction of a pQCD calculation. We also want to show the centrality dependence of direct photon production in d+Au collisions.
1. H. Witala, et al., Phys. Rev. Lett., the presentation, an overview of recent advances of 3NF study via few-nucleon systems will be given. In particular, the results of Nd for the spin observables are not always explained by addition of the 3NFs. To describe these spin observables, theoretical approaches, such as addition of 3NFs other NN forces and 2π observables. Cross section data for elastic neutron–deuteron (pd) scattering at intermediate energies have been performed intensively at RIKEN, RCNP, KVI and IUCF and provided precise data of various observables. Cross section data for elastic pd scattering have shown large disagreement between data and rigorous Faeddeev calculations with modern NN forces. Combination of these NN forces and 2π exchange type 3NFs removes this discrepancy and leads to a good description of the measured cross sections. However spin observables are not always explained by addition of the 3NFs. To describe these spin observables, theoretical approaches, such as addition of 3NFs other than 2π exchange types, and/or relativistic treatment, and completely new approach based on chiral effective field theory are now in progress. Measurements in the region where the above processes become prominent. In this talk, photon contributions from various processes will be discussed based on the latest photon measurement.

3:45PM CC.00007 Single electron measurement from heavy flavor decays in d+Au and Au+Au collisions at √sNN = 200 GeV1, FUKUTARO KAJIHARA, Center for Nuclear Study (CNS), Graduate School of Science, University of Tokyo, PHENIX COLLABORATION. The heavy quark measurement has an important role in the investigation of extremely hot and dense matter created in relativistic heavy ion collisions. The heavy quark production may be affected by final state interactions such as their energy loss in the dense medium. On the other hand, the energy loss is predicted to be smaller than that of light quarks with high transverse momentum due to their heavy mass. The measurement of heavy quarks may indicate the flavor dependence of energy loss. For precise heavy quark measurements, the evaluation of conventional cold nuclear effects is essential. In the relativistic p+p and p+A collisions, we can study those effects since high energy density matter is not formed. Measured inclusive electrons can be categorized into two groups. The first group consists of “photonic” electrons mainly from π0 and η Dalitz decays and photon conversion. The second is termed “non-photonic” electrons. The semi-leptonic decays of charm and beauty are the dominant sources of the second group. We present the non-photonic electron measurement in the d+Au and Au+Au collisions at √sNN = 200 GeV by the RHIC-PHENIX experiment.

4:00PM CC.00008 Fragmentation function and partonic kT at √sNN=200 GeV1, JAN RAK, UNM, PHENIX COLLABORATION. Measurements of modifications to jet properties gives detailed information on the interactions of the outgoing parton with the dense nuclear medium and thereby on the nature of the QCD matter produced in heavy-ion collision. The method of leading high-pT particle azimuthal correlations is used for an analysis of the fragmentation function properties, parton intrinsic momentum kT and jet transverse fragmentation momentum jT in pp, CuCu and AuAu collisions at √sNN=200 GeV. The sensitivity of combined analysis of single-inclusive and high-pT trigger associated pT distributions to the relative abundance of quark and gluon jets will be discussed.

1 for the PHENIX collaboration

4:15PM CC.00009 Study of hadronic jet shape modification in hot QCD matter with the PHENIX detector at RHIC, PAUL CONSTANTIN, Los Alamos National Lab, PHENIX COLLABORATION. It is a well established fact now that the hot QCD medium formed in central AuAu collisions at √sNN = 200 GeV at RHIC suppresses the high transverse momentum hadrons from jets by inducing gluon radiation. Preliminary results on the angular distribution of hadrons within jets obtained via di-hadron correlations also show strong modifications of jet shapes due to the interaction with this medium. We present a high precision study of hadronic jet shape parameters in AuAu collisions with the di-hadron azimuthal correlation method in the intermediate (1-7 GeV/c) transverse momentum region.

4:30PM CC.00010 Study of Jet Fragmentation Using High-pT Photon Triggered Events in PHENIX, MATTHEW NGUYEN, SUNY Stony Brook, PHENIX COLLABORATION. In high-energy, central Au+Au collisions it is well-known that the pT distribution of hadrons associated with jet fragmentation is modified with respect to p+p collisions. The pT distribution of photons produced in hard collisions, however, is not modified. Using the presence of a high-pT direct photon to identify hard collisions, we have obtained a sample of jets in a manner which is not biased by the mechanism which alters the hadron spectrum. We discuss a method for tagging direct photons in the PHENIX detector. We present distributions of jets properties indirect photon-tagged Au+Au, Cu+Cu, and p+p collisions and their dependence on centrality and reaction plane orientation.

Tuesday, September 20, 2005 2:00PM - 5:00PM — Session CD DNP JPS: Mini-symposium on New Aspects of Nuclear Forces I Ritz-Carlton Hotel Salon

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2:00PM CC.00001 Exploring Three Nucleon Forces via Few Nucleon Systems, KIMIKO SEKIGUCHI, RIKEN — A main interest of nuclear physics is to understand the forces acting between nuclear constituents. Few nucleon systems offer good opportunities to investigate these forces. A recent topic of present day few-nucleon system studies is to explore the properties of three-nucleon forces (3NFs) acting in systems with more than A=2 nucleons. Indication of 3NF for the three-nucleon scattering was first pointed out in the cross section minima for nucleon–deuteron (Nd) elastic scattering at intermediate energies (E/A ~ 100 MeV) by Witala et al.1 in 1998. Since then experimental studies of elastic proton–deuteron (pd) and neutron–deuteron (nd) scattering at intermediate energies have been performed intensively at RIKEN, RCNP, KVI and IUCF and provided precise data of various observables. Cross section data for elastic pd scattering have shown large disagreement between data and rigorous Faeddeev calculations with modern NN forces. Combination of these NN forces and 2π exchange type 3NFs removes this discrepancy and leads to a good description of the measured cross sections. However spin observables are not always explained by addition of the 3NFs. To describe these spin observables, theoretical approaches, such as addition of 3NFs other than 2π exchange types, and/or relativistic treatment, and completely new approach based on chiral effective field theory are now in progress. Measurements for the Nd–breakup and radiative capture processes are also underway to provide a solid basis to test current and/or future coming theoretical approaches. In the presentation, an overview of recent advances of 3NF study via few-nucleon systems will be given. In particular, the results of Nd elastic scattering and the Nd breakup reactions obtained at RIKEN will be discussed.

2:30PM CD.00002 Neutron-Helium-3 Analyzing Power at 3.14, 4.05, and 5.54 MeV$^1$, J.H. ESTERLINE, A.S. CROWEL, C.R. HOWELL, R.A. MACRI, S. TAJIMA, W. TORNOW, Duke University & TUNL, B.J. CLOWE, N.C. Central University & TUNL, R.S. PEDRONI, N.C. A&T State University & TUNL, G.J. WEISEL, Penn State Altoona & TUNL — In the interest of resolving differences between calculations and measurements in three-nucleon analyzing powers, the four-nucleon system is being examined due to its sensitivity to the relevant nucleon-nucleon phase shifts. Consequently, the analyzing power for polarized neutron-helium scattering has been measured at Triangle Universities Nuclear Laboratory (TUNL) over a wide angular distribution for incident neutron energies of 3.14, 4.05, and 5.54 MeV. These data were obtained with neutrons generated by the polarization-transfer reactions T(p,n)$^3$He for 3.14 MeV neutron energy and D(d,n)$^3$He for the higher energies, with neutron polarizations in the range of 0.3 to 0.5, increasing with neutron energy. Statistical uncertainties in the analyzing power were found in preliminary analysis to be less than 0.03 at the cross section minima, corresponding to values of analyzing powers in excess of 0.6. The data are compared to rigorous calculations based on the Yukovobys equations, with which they are in marked disagreement, and existing proton-triton data corrected for the Coulomb barrier.

3:00PM CD.00004 Spin correlation parameter $C_{yy}$ of $^3$He backward elastic scattering at intermediate energy, KICHIHI HATAKANA, YOHEI SHIMIZU, ALEXANDER KOBUSHKIN, TATSUYA ADACHI, KUNIHIRO FUJITA, HIROAKI MATSUBARA, YASUHIRO SAKEI, YOSHIHIRO SHIMBARA, YUJI TAMAEHIGE, ATSUSHI TAMAI, MAKOTO UCHIDA, RCNP, Osaka University, KEISUKE ITHO, Saitama University, TAKAHIO KAWABATA, YOSHIKO SASAMOTO, KIJI SUDA, TOMOHIRO UESAKA, TAKASHI WAKUI, CNS, University of Tokyo, TAKASHI KUDOY, HITOMI OHI, KENSHI SAGARA, HIROHISI OSID, MIYUOHE TAKAYAMA, RCNP, Kyushu University, HIROUKI OKAMURA, CYRIC, Tohoku University — For several decades considerable efforts have been performed to investigate the structure of the lightest nuclei at short distances between constituent nucleons. Large part of these investigations consists of studies of elastic backward proton-nucleon scattering (EBS). At present there is no theoretical model which quantitatively describes the existing data, even for the simplest reaction, pd EBS. Recently there have been several theoretical attempts to understand the pd EBS which is studied in much less detail than pd EBS. We have measured the cross section and spin correlation parameter $C_{yy}$ of $^3$He EBS at 200, 300 and 400 MeV. Experimental results are compared to theoretical predictions with two-nucleon pair exchange in the triplet and singlet spin states, pion-exchange and direct mechanism.

3:15PM CD.00005 Relativistic effects in the 3N continuum, HENRYK WITAL, JACEK GOLAK, Institute of Physics, Jagiellonian University, PL-30059 Krakow, Poland, WALTER GLOECKLE, Institut fuer theoretische Physik II, Ruhr-Universitaet Bochum, D-44780 Bochum, Germany, HIROYUKI KAMADA, Department of Physics, Faculty of Engineering, Kyushu University, Institute of Technology, Kitakyushu 804-8550, Japan — We solved the three-nucleon (3N) Faddeev equation including relativistic features. Those features are relativistic kinematics, boost effects and Wigner spin operators. As dynamical input a relativistic nucleon-nucleon interaction exactly on-shell equivalent to the AV18 nucleon-nucleon potential has been used. The effects of Wigner rotations for elastic scattering observables were found to be small. The boost effects are significant at higher energies. They diminish the transition matrix elements at higher energies and lead in spite of the increased relativistic phase-space factor as compared to the nonrelativistic one to rather small effects in the cross section, which are mostly restricted to the backward angles.

3:30PM CD.00006 Two-and three- body breakup of $^3$He at low energies$^1$, W. TORNOW, A.P. TONCHEV, J.H. ESTERLINE, C.R. HOWELL, Duke University and TUNL, H.J. KARWOWSKI, UNC and TUNL, J.H. KELLEY, NCSU and TUNL, J. LI, S.F. MIKHAILOV, I.V. PINAYEV, Y.K. WU, Duke University and DFELL, W. WITAL, Jagiellonian University — We report on measurements of the two-body breakup cross section of $^3$He for gamma-ray energies between 8 and 16 MeV, and of the analyzing power of the kinematically incomplete three-body breakup at 15 MeV. The monoenergetic gamma-ray beams were produced via Compton backscattering of FEL photons from high-energy lasers at the High-Intensity Gamma-ray Source at Duke University. The target consisted of a high-pressure gas scintillator. The data are compared to rigorous three-nucleon calculations using realistic nucleon-nucleon and three-nucleon interactions.

4:00PM CD.00008 Neutron-deuteron scattering and the three-nucleon force, M. CHATTENEE, T. AKDogan, W.A. FRANKLIN, J.L. MATTHEWS, MIT, M.A. KOVASH, U. Kentucy, P.A.M. GRAM, S.A. WENDER, LANL, M. YULY, Houghton Coll. — Differential cross sections for neutron-deuteron elastic scattering were measured at six angles between 65 and 130 degrees (center-of-mass) for incident neutron energies in the range 140 to 240 MeV. A liquid deuterium target was exposed to the pulsed neutron beam provided by the LANSE/WNR facility at the Los Alamos National Laboratory. Scattered neutrons and recoil deuterons were observed in coincidence using time-of-flight techniques and an array of plastic and CsI scintillation detectors. With liquid hydrogen in the target, elastic neutron-deuteron scattering cross sections were measured to aid in normalization of the neutron-deuteron data. The results will be compared with theoretical predictions including three-nucleon forces and with the results of previous measurements.
Three-nucleon tensor force effects in nucleon-deuteron scattering\textsuperscript{1}, SOUCHI ISHIKAWA, Hosei University — The introduction of three-nucleon (3N) forces arising from the exchange of two pions among three nucleons (2PE-3NF) is known to get rid of the discrepancies between experimental data and only two-nucleon force (2NF) calculations for the 3N binding energies and nucleon-deuteron (ND) differential cross sections. On the other hand, we have shown that tensor components of the 2PE-3NF give undesirable contributions to tensor analyzing powers (TAP’s) in ND elastic scattering at energies below the three-body breakup threshold. We made a phenomenological 3NF that reproduces the TAP’s by inversing the sign of a tensor component in a 2PE-3NF simulated 3N potential, which consists of scalar and tensor forces in spin space with Gaussian form factors. In this work, we examine 3NF effects of ND scattering observables at energies above the three-body breakup threshold. Our calculations show that the tensor-inverted 2PE-3NF model is also successful in reproducing some polarization observables at higher energies, which are not reproduced by 2NF and 2PE-3NF.

Three-body forces are, though small, very important in nature. The effect of these forces has far-reaching consequences in many fields of physics. A relatively good understanding of most phenomena in nuclear physics has been arrived at by only considering two-nucleon forces. However, high precision data emerging are revealing the shortcomings of these forces. At KVI, a program has been set up to study the effects of three-nucleon forces in elastic proton-deuteron scattering. High-precision cross sections, analyzing powers and spin-transfer coefficients have been measured at various incident proton or deuteron beam energies between 100 and 200 MeV for a large range of scattering angles. Calculations based on two-body forces only are clearly unable to predict the data. The inclusion of three-body forces brings the results generally closer to the data. However, there are still clear deficiencies in the calculations. The result of these recent measurements along with several calculations will be discussed. Furthermore, future plans to study the break-up reaction in the same system for an almost 4p geometry will be outlined.

\textsuperscript{1}KVI, Groningen, The Netherlands

\textbf{Tuesday, September 20, 2005 2:00PM - 4:45PM — Session CE DNP JPS: Mini-symposium on Nuclear Moments II} Ritz-Carlton Hotel Amphitheatre

\textbf{2:00PM CE.00001 Towards better understanding of the Recoil-In-Vacuum technique: hyperfine interactions and their variation with element and ion charge state for application to g-factor measurements in ps lifetime nuclear levels.} NICHOLAS STONE, Oxford University and University of Tennessee — The recoil-in-vacuum (RIV) method for excited state nuclear g-factor measurements in the ps lifetime range has been shown recently to offer attractive possibilities for application with RIBs combined with modern detector arrays. In the recent work, as in all prior RIV studies, the magnetic hyperfine fields acting at the nuclei of the recoiling ions have been treated empirically, calibrated using states of known lifetime and g-factor. It is now a matter of clear importance to establish how these fields vary with element and ionization state [dependent on beam energy and target thickness] in order to discover how the RIV approach may be best utilized. The ability to calculate lifetimes and hyperfine fields in complex electronic levels has advanced markedly with modern computational techniques. Physics ideas contributing to the selection of the electronic states of importance will be discussed and first evidence for the value of a-priori calculations presented. In collaboration with Jiřina Rikovska Stone, Oxford University and the University of Maryland; Charlotte Froese Fischer, Vanderbilt University.

\textbf{2:30PM CE.00002 Monte-Carlo Shell Model calculations of Xe, Ba isotopes} NORITAKA SHIMIZU, TAKAHARU OTSUKA, TAKAHIRO MIZUSAKI, MICHIO HONMA, University of Toyko — We discuss the low-lying quadrupole collective states of Xe, Ba isotopes around $\Lambda = 134$ microscopically based on the Monte-Carlo shell model (MCSM). The MCSM enables us to apply the nuclear-shell-model calculation to the study of medium-heavy nuclei. The magnetic moments and several other values of these isotopes provided by the MCSM reproduce experimental values well, and show some features of gradual transition between spherical vibrator and triaxial deformation.

\textbf{2:45PM CE.00003 Magnetic field of a mixed-symmetry state of Zr nuclei} V. WERNER, WNSL, Yale University, N. PIETRALLA, Stony Brook, SUNY, N. BENZCZER-KOLLER, G. KUMBARTZKI, E. STEFANOVA, Rutgers University, C. FRANSEN, P. VON BRENTANO, Universität zu Köln, Germany, H. AI, R.F. CASTEN, A. HEINZ, E.A. MCCUTCHEON, D.A. MEYER, J. QIAN, E. WILLIAMS, R. WINKLER, WNSL, Yale University, R.B. CAKIRLI, WNSL and Istanbul University, Turkey, C.R. FITZPATRICK, WNSL and University of Surrey, U.K., G. GÜRDAL, WNSL and Clark University — Mixed-symmetric states are quadrupole collective states with anti-symmetric parts in their pn wave function. Breaking of the proton-neutron (pn) symmetry was discussed for $^{92}\text{Zr}$ within the IBM-2, the shell model (SM), and the quasiparticle phonon model (QPM). The models differ in quantifying the pn symmetry breaking, which leads to substantial differences in the predictions for the g factor of the one-phonon $2_1^+$ state with predominantly mixed-symmetry character. The g factor of this state is difficult to measure due to its short lifetime. First measurements in Zr isotopes have been performed at WNSL using the transient field technique. Results will be compared to model predictions. Work supported by USDOE grants DE-FG02-91ER-40609, DE-FG02-05NA25929, and DE-FG02-88ER40417. U.S. NSF (RU and SB), and DFG under Br 799/12-1.
3:00PM CE.00004 Nuclear g-factor measurements for the 2\(^+\) states of radioactive Te isotopes by the recoil-in-vacuum technique\(^1\)  
C.R. BINGHAM, M. DANCHEV, Tennessee, N.J. STONE, Oxford and Tennessee, J.R. STONE, Oxford and Maryland, C.L. TIMLIN, Oxford, A.E. STUCHBERGY, ANU, Canberra, C. BAKTASH, J. BEENE, A. GALINDO-URIBARRI, C.J. GROSS, J. PAVAN, D.C. RADFORD, ORNL, N. BENCZER-KOLLER, G. KUMBARTZKI, Rutgers, J. DUPAK, BRNO, C. BARTON, N.V. ZAMFIR, Yale — Coulomb excitation of the first excited state of radioactive ion beams has been carried out at HRIBF by scattering the RIBs from C foils and observing the recoiling C ions and de-excitation gamma rays of the RIB\(^2\). This method also yields an angular correlation of the emitted gamma ray with respect to the direction of C recoil. In Coulomb excitation the nuclear spin is initially oriented by the reaction, yielding strong angular correlation of the emitted gamma ray with respect to the direction of C recoil. As the RIB recoils into the vacuum downstream from the thin target, the angular correlation is attenuated due to de-orientation of the spin resulting from its precession about the total angular momentum of the ion. The attenuation of the angular correlation depends on \(g^2\) and the mean life of the state. The experimental results for \(^{132}\)Te will be presented and the g-factors of \(^{132,134,136}\)Te will be discussed.

\(^1\)Work supported by the U. S. Department of Energy.


3:15PM CE.00005 Short-lived excited-state g factors of fast 38,40S fragments.\(^1\)  
A.D. DAVIES, NSCL/Michigan State University, A.E. STUCHBERGY, The Australian National University, A. BECERRIL, C.M. CAMPBELL, J.M. COOK, D.C. DINCA, A. GADE, S.N. LIDDICK, P.F. MANTICA, W.F. MUELLER, H. OLLIVER, J.R. TERRY, B.E. TOMLIN, K. YONEDA, NSCL/Michigan State University, P.M. DAVIDSON, A.N. WILSON, The Australian National University — The transient field technique for measuring short-lived excited-state magnetic dipole moments generally requires ion velocities comparable to \(v/\gamma = c/137\) or lower, which, at face value, would preclude the study of the wide range of isotopes available at fragmentation facilities. However, stringent testing of nuclear models far from stability can be realized with g-factor measurements on these isotopes, once the experimental challenges are overcome. Measurements performed at the NSCL’s Coupled Cyclotron Facility have extended the transient field technique to radionuclides produced in in-flight fast fragments. The high velocity transient field technique was applied to intermediate-energy beams of 38S and 40S. The signs of their first-excited 2\(^+\) state g factors were obtained, and with a parametrization of the transient field strength at high velocities, the g-factor magnitudes were extracted. Results, experimental details, and future outlook will be presented.

\(^1\)Work supported by National Science Foundation Grant PHY01-10253 and the ANSTO Access to Major Research Facilities Program.

3:30PM CE.00006 Doppler-broadened lineshapes from Coulomb-excitation of fast fragment beams: implications for g-factor and lifetime measurements, ANDREW STUCHBERGY, The Australian National University, ANDREW DAVIES, NSCL Michigan State University — Doppler-broadened lineshapes were observed in a recent measurement of the g factor of the first 2\(^+\) state in 38S (see the contribution of A.D. Davies et al.). Beams of the neutron-rich isotope were produced by fragmentation and delivered at 40 MeV/nucleon onto a target consisting of Au and Fe layers, 355 mg/cm\(^2\) and 110 mg/cm\(^2\) thick, respectively. The beam ions were Coulomb excited and subjected to the transient field during transit through the Fe layer. Since the transit time through the target layers is of the order of the lifetime of the 2\(^+\) state (5 ps), about half of the nuclei decay whilst slowing in the target. The gamma-ray spectra therefore show Doppler-broadened lines. A computer code has been developed to interpret and analyze these lineshapes. The implications for the g-factor measurement and the potential for future applications to lifetime measurements will be discussed.

3:45PM CE.00007 New developments for the measurements of magnetic moments of sub-ps states using RIB-projectile excitation and transfer reactions, GERFRIED KUMBARTZKI, NOEMIE BENCZER-KOLLER, Rutgers University — It is intrinsically difficult to measure nuclear moments reliably and with sufficient accuracy especially for short-lived excited states of rare isotopes. The application of projectile excitation using transient hyperfine fields for the magnetic interaction is an established method. The latest developments of the technique and results for stable and radioactive projectiles will be discussed. In addition to the Coulomb excitation of the projectiles on carbon targets, the transfer of an alpha particle to the projectile leads to probe ions, some radioactive, which are otherwise not accessible as beams, thus extending the reach of the method.

4:00PM CE.00008 Study of neutron rich nuclei by CYRIC new cyclotron, TSUTOMU SHINOZUKA, MASAKI FUJITA, AKIYOSHI YAMAZAKI, MIFUYU UKI, TOMOKAZU SUZUKI, YUJI MIYASHITA, NOZOMI SATO, MITSUHARU OHGUMA, Cyclotron and Radioisotope Center, Tohoku University, Sendai, HIROKAZU TAMAURA, TAKESHI KOIKE, YUSUKE MIURA, SARI KINOSHITA, YUE MA, KOTARO SHIROTORI, Department of Physics, Tohoku University, Sendai — The AVF cyclotron at CYRIC has been replaced from K=50 MeV AVF cyclotron, which accelerates heavy ions up to Ar with ECR ion source and high intensity protons with negative Hydrogen ion source. All of the missions for replacement is almost completed. The several experiments for nuclear spectroscopy of unstable nuclei with the new cyclotron has been planned and partly advanced.

- Development of RF Ion Guide Isotope Separator toward to 78Ni
- Moment measurements with 6 clover detectors by \(\gamma-\gamma\) angular correlation for low excited states of neutron rich nuclei.
- In-beam gamma ray measurements with 6 clovers and 14 single Ge detectors (Hyperball 2)

The details of developments and several experimental results will be presented.

4:15PM CE.00009 Nuclear Moments of the Neutron-Deficient Lanthanum Isotopes by Collinear Laser Spectroscopy, H. IIMURA, M. KOIZUMI, M. MIYABE, M. OBA, T. SHIBATA, N. SHINOHARA, Japan Atomic Energy Research Institute, Y. ISHIDA, Institute of Physical and Chemical Research (RIKEN), T. HORIGUCHI, Hiroshima International University, H.A. SCHUESSLER, Texas A&M University — The hyperfine-structure-splitting constants and isotope shifts of the 6s\(^2\) 5d\(^6\) 3D\(^1\) (\(\lambda=538\) nm) and 5d\(^2\) 5p\(^2\)d\(^6\) 1D\(^2\) (\(\lambda=548\) nm) transitions of singly charged lanthanum ion have been measured by collinear laser-ion-beam spectroscopy for the neutron-deficient isotopes 153La, 155La, and 158La. The magnetic moments and quadrupole moments of the ground states of these isotopes have been determined from the measurements. The ratio of the magnetic dipole coupling constants A(138)/A(139) of the level 5d6p 3D\(^1\) has shown a -0.35(23)% hyperfine anomaly with respect to the NMR ratio of the nuclear g factors. These moments and the changes in the mean-square nuclear charge radii determined from the isotope shifts are compared with theoretical predictions. Work to measure more neutron-deficient lanthanum isotopes is in progress by our laser spectroscopy collaboration at the ISAC facility at TRIUMF.
4:30PM CE.00010 New laser spectroscopic method for the measurement of nuclear moments. TAKESHI FURUKAWA, Dept. of Physics, Osaka University, YUKARI MATSUKO, The Institute of Physics and Chemical Research (RIKEN), ATSUSHI HATAKEYAMA, Institute of Physics, University of Tokyo, YOSHIMITSU FUKUYAMA, TOHRI KOBASHI, RIKEN, HIDEAKI IZUMI, TADASHI SHIMODA, Dept. of Physics, Osaka University — We propose here a versatile method to measure the nuclear moments of unstable nuclei through laser spectroscopic detection of atoms trapped in superfluid helium (He II). This method takes advantage of the optical pumping of atoms in He II and the “laser-microwave double resonance method.” It enables us to determine the moments, hitherto difficult to be measured by other methods, of unstable nuclei far from the stability line. For the development of this method, we have been studying optical pumping of impurity atoms in He II. The electronic spin relaxation time of the atoms in He II is the key quantity for the success of optical pumping, but no result of the measurement has been reported so far. We have measured the spin relaxation time $T_1$ of Cs atoms in He II. This success is due to special care to cope with a serious decrease in the number of Cs atoms in the observation region caused by the large convection in introducing the atoms with laser sputtering technique. The measured relaxation time of $T_1=2.24(19)$ s is extraordinary long, which encourages us to take advantage of He II as a suitable environment for trapping unstable nuclei and for performing laser spectroscopy for the measurement of nuclear moments.

Tuesday, September 20, 2005 2:00PM - 5:00PM — Session CF DNP JPS: Nuclear Astrophysics I Ritz-Carlton Hotel Plantation 3

2:00PM CF.00001 S-factors of capture reactions important for astrophysics from ab initio wave functions. PETR NAVRATIL, CHRISTIAN FORSSEN, ERICH ORMAND, Lawrence Livermore National Laboratory, CARLOS BERTULANI, University of Arizona, ETIENNE CAURIER, IRES CNRS Strasbourg — Nuclear structure of $^4$He, $^6$He, $^7$Be, $^8$B, $^{11}$Be and $^{11}$Be is studied within the ab initio no-core shell model (NCSM). Starting from realistic inter-nucleon interactions, wave functions for these nuclei are obtained in basis spaces up to $12\hbar\Omega$ and then used to calculate cluster form factors (overlap functions) for the bound states of $^8$B with $^7$Be+p, $^7$Be with $^3$He+$t$-He and $^{11}$Be with $^{10}$Be+n as a function of the separation between the two interacting clusters. Due to the use of the harmonic oscillator basis, the overlap functions have incorrect asymptotics. To fix this problem, we perform a least-square fit of Woods-Saxon potential solutions to the NCSM overlap functions in the range from 0 fm up to about 4 fm under the constraint that the experimental separation energy is reproduced. The corrected overlap functions are then used for the $^7$Be(p,$\gamma$)$^8$B, $^3$He(x,$\gamma$)$^4$He and $^{10}$Be(n,$\gamma$)$^{11}$Be S-factor calculations. Support from the LDRD contract No. 04-ERD-058 as well as partial support from the DOE grants SCW0498 and DE-FG02-04ER41338 is acknowledged.

2:15PM CF.00002 Study of the $^{11}$Be(n,$\gamma$)$^{12}$Be reaction and strong E1 transitions in $^{11}$Be using ab initio wave functions. CHRISTIAN FORSSEN, PETR NAVRATIL, ERICH ORMAND, Lawrence Livermore National Laboratory, ETIENNE CAURIER, IRES CNRS Strasbourg — We present calculations of $^{11}$Be(n,$\gamma$)$^{12}$Be which is a possible breakthrough reaction in the primordial nucleosynthesis of inhomogeneous Big Bang scenarios. We employ ab initio nuclear structure information from a recent study performed in the framework of the no-core shell model (NCSM). Cluster form factors are extracted from the NCSM wave functions and corrected to reproduce the known asymptotics. These overlaps are then used to build a potential model calculation of the capture reaction and we find a large contribution from direct $p$-wave capture which has important consequences for the predicted reaction rate. Our corrected cluster form factors can also be used to compute the extraordinarily strong E1 transition between the two bound states in $^{11}$Be under the approximation that it is a pure single-particle transition. We find a significant improvement compared with our previous result which was obtained with NCSM $\lambda$-body wave functions expanded in the harmonic oscillator basis. Support from the LDRD contract No. 04-ERD-058, and from U.S. Department of Energy, Office of Science, (Work Proposal Number SCW0498) is acknowledged.

2:30PM CF.00003 New Approach to M1 Cross Section for D(gamma,n) via the D(7Li,7Be) Reaction. S. NAKAYAMA, University of Tokushima, T. YAMAGATA, Konan University, H. AKIMUNE, Y. ARIMOTO, I. DAITO, H. EJIRI, H. FUJIMURA, Y. FUJITA, M. FUJIWARA, K. FUSHIMI, M.B. GREENFIELD, H. KOHRI, N. KOORI, K. TAKAHISA, T. TAKEUCHI, M. TANAKA, K. YONEHARA, H.P. YOSHIDA — The n-p capture cross section is inferred via the “detailed balance” of the deuteron photodisintegration by using the gamma-d cross section from the analogous B(GT) distribution. The results are in agreement with in evaluations of nucleosynthesis in the early universe. In this contribution we present a new method to deduce the M1 gamma-d cross section as a function of excitation energy in the deuteron by using the charge-exchange spin-flip (CESF) reaction. The CESF reaction of (7Li,$^7$Be) at 65 MeV was used to deduce the distribution of the B(M1) reduced matrix elements for the photodisintegration of the deuteron from the analogous B(GT) distribution. The results are in agreement with recent photodisintegration measurements and effective field calculations.

2:45PM CF.00004 Neutrino-nucleus reactions in a supernova environment. FUTOSHI MINATO, KOICHI HAGINO, NOBORU TAKIGAWA, Department of Physics, Tohoku University, A. BABA BALANTEKIN, Physics Department, University of Wisconsin — There is a suggestion that the neutrino induced fission in the supernova environment may alter the r-process pattern for the element abundance. In order to assess the role of temperature in the neutrino induced fission, we perform thermal RPA calculations for neutrino-nucleus interactions. Advantages of this method are that it can be easily applied to heavy nuclei and that excitations to the continuum states can be included exactly. We will systematically discuss how the temperature affects the reaction rate, and its implication for the neutrino induced fission.

3:00PM CF.00005 Shock propagation in prompt supernova explosion and the MSW effect of neutrino. SHIOU KAWAGOE, TOSHIKATA KAJINO, The Graduate University for Advanced Studies and National Astronomical Observatory of Japan, KAZUISHI YOSHIHARA, HIDEYUKI SUZUKI, Faculty of Science and Technology, Tokyo University of Science, KOHSUKE SUMIYOSHI, Numazu College of Technology, SHOICHI YAMADA, Faculty of Science and Engineering,Waseda University — The MSW effect of supernova neutrino is the focus of recent neutrino astrophysics. It is still an open question how the shock wave propagation affects the neutrino oscillation. Using an implicit Lagrangian code for general relativistic spherical hydrodynamics, we succeeded in numerical simulations of breakout of shock wave propagation through the stellar envelope. We first discuss our successful result of shock wave propagation which is generated by adiabatic collapse of iron core and compare with non-adiabatic collapse. Secondly, we apply this model to the neutrino oscillation and calculate survival probabilities of three light-neutrino families. We discuss how the flux and energy spectrum of each neutrino species can change due to the MSW effect.
3:15PM CF.00006 Active-Sterile Neutrino Transformation: Consequences for Supernova Nucleosynthesis
JOSHUA BEUN, North Carolina State University; REBECCA SURMAN, Union College; GAIL MCLAUGHLIN, North Carolina State University; WILLIAM HIX, Oak Ridge National Laboratory — We consider a fourth, sterile neutrino and study the implications for core collapse supernovae. In particular, we consider the effect of such an additional neutrino on the nucleosynthesis which occurs in the neutrino driven wind. We present calculations of neutrino flavor transformation coupled to a nuclear reaction network. We comment on the prospects for obtaining the r-process elements in this scenario.

3:30PM CF.00007 General Relativistic Instability in Supermassive Objects: Neutrinos and Nuclear Physics
CHAD KISHIMOTO, GEORGE FULLER, University of California, San Diego — We discuss the general relativistic instability in very high mass stellar objects. The high entropy electron-positron plasma in these stars serves as an engine for efficient production of neutrinos and antineutrinos of all flavors, with ~ 5% of the rest mass of the star converted to neutrinos during its collapse to a black hole. We examine the influence of these prodigious neutrino and antineutrino fluxes on the evolution of the nuclear component in these objects.

3:45PM CF.00008 Two-Dimensional Simulations of Core-Collapse Supernovae: The Role of Anisotropic Neutrino Radiation
HIDEKI MADOKORO, RIKEN — We have carried out two-dimensional numerical simulations of core-collapse supernovae. Special attention was paid to the role of anisotropic neutrino radiation on the explosion dynamics. It was revealed (Shimizu et al. 2001, Astrophys. J. 552, 756; Madokoro et al. 2003, Astrophys. J. 592,1035; Madokoro et al. 2004, Publ. Astron. Soc. Japan 56, 663) that a small amount of anisotropy in the neutrino flux can increase explosion energies to a large extent when total neutrino luminosity was fixed and the profile of the neutrino flux was assumed. In the previous talk, we showed our first results starting from the onset of core-collapse. It was confirmed that collapse, bounce and shock formation were correctly reproduced in our simulations. Neutrino heating and cooling were, however, omitted due to difficulty of treating neutrino transport in multi-dimensional calculations. In this talk, our new results are shown in which the effects of neutrino heating and cooling are approximately included. Especially we will discuss the origin of anisotropic neutrino radiation, the degree of anisotropy, and the effects of anisotropic neutrino emission on the explosion mechanism.

4:00PM CF.00009 Phase diagrams of nuclear “pasta” investigated by QMD simulation
HIDETAKA SONODA, Dept. Phys., Univ. Tokyo; RIKEN, GENTARO WATANABE, NORDITA; RIKEN, KATSUHIKO SATO, Dept.Phys., Univ. Tokyo; RESCEU, KENJI YASUOKA, Dept. Mech. Eng., Keio Univ., TOSHIAKU EBISUZAKI, RIKEN — At subnuclear densities, such as in the inner crust of neutron stars and in the core of supernovae, it is pointed out that nuclei can adopt nonspherical shapes like rods or plates due to competition between the Coulomb energy and the nuclear surface energy. These nonspherical nuclei are referred to as nuclear “pasta.” We are studying these exotic phases by using Quantum Molecular Dynamics (QMD), which is a dynamical method and does not impose any assumptions on shapes of nuclei. Previous works investigated phase diagrams of nuclear matter at subnuclear densities by using a certain phenomenological QMD model Hamiltonian. But phase diagrams are influenced by various nuclear parameters such as surface energy, incompressibility, and properties of pure neutron matter. We noticed uncertainties of these nuclear parameters are essential and studied phase diagrams of nuclear pasta in the ranges of these uncertainties by QMD simulation.

4:15PM CF.00010 Properties of Nuclear and Neutron Matter in the Nonlinear σ-ω-ρ Dirac-Hartree-Fock Approximation
HIROSHI UECHI, Osaka Gakuin Junior College — A self-consistent relativistic Dirac-Hartree-Fock (DHF) approximation in a nonlinear σ-ω-ρ mean-field model is discussed by employing conditions of the theory of conserving approximations. The approximation is applied to Fermi-liquid properties of nuclear matter and properties of neutron stars in order to produce the effective mass of nucleon, $M^*/M = 0.7$, incompressibility $\sim 250$ MeV, symmetry energy $a_1 \sim 30$ MeV, the maximum mass of neutron star $M_{\text{max}}/M_\odot = 2.5$, by adjusting coupling constants of nonlinear interactions. The results of nonlinear σ-ω-ρ Hartree approximation (NHA) and the linear Hartree (σ-ω) approximation (LHA) are listed in the table.

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<thead>
<tr>
<th>Parameter</th>
<th>NHA</th>
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<td>$M^*/M$</td>
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<tr>
<td>$m^*/m$</td>
<td>1.00</td>
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<tr>
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<tr>
<td>$a_1$ (MeV)</td>
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Since nonlinear self-interactions of mesons are renormalized as effective masses of mesons by self-consistency and strictly restricted by coupled equations of motion for mesons and baryons, the validity of nonlinear self-interactions of mesons would be examined by analyzing nuclear experimental data and properties of neutron stars.

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4:30PM CF.00011 Two-body Weak Interactions Using Correlated Basis Theory
SHANNON COWELL, JOSEPH CARLSON, LANL — In the last several decades it has become clear that neutrino interactions play an important role in many astrophysical environments from the dynamics of core-collapse supernovae to the cooling of neutron stars. Simulations of such processes require an accurate description of neutrino interactions with nucleon matter at a variety of temperatures, proton fractions and densities. Many previous calculations of the relevant neutrino cross sections are inconsistent, using empirical effective interactions together with bare weak operators. We address this inconsistency using correlated basis theory (CBT) which allows for a systematic definition of both effective interactions and effective weak operators. Previous CBT calculations of the one-body weak processes relevant in core collapse supernova have shown that short range correlations are important in both the effective interactions and operators. For example, neutrino mean free paths calculated using CBT and TDA are a factor of 2-4 larger than the simple non-interacting Fermi gas. In this talk, we will discuss the CBT two-body weak operators relevant for the highly asymmetric matter of neutron stars.

4:45PM CF.00012 Influence of Interstellar Neutrals as an Atmosphere on Charged Particle Flux in the Heliosphere
M.A.K. LODHI, Dept. Physics, Texas Tech University; THOMAS WILSON, NASA, Johnson Space Center - KR, ABEL DIAZ, Dept. Physics, Texas Tech University — It has been shown that the charged particle flux in the Earth’s trapped radiation belts is a bi-variant function of energy and atmospheric density [1,2], where the density is modulated by variation in activity of the Sun during its solar cycle. This result was derived from a regression algorithm technique used in nuclear physics for studying momentum-dependent potentials. A dynamic background of atmospheric neutrals, then, has a definite effect upon charged-particle flux and fluence and contributes to energy losses primarily due to multiple neutral and Coulomb scattering. Cosmic-ray flux is not merely a function of energy, but rather is a two-dimensional surface depending upon density of atmospheric neutrals as well. We extend this result to the Sun’s heliosphere where the source of atmospheric neutrals is the Local Interstellar Medium (LISM) of the Galaxy. The Sun’s activity once again modulates density in the heliosphere via the solar wind’s heliopause, while inhomogeneities in the LISM affect the neutral density as the heliosphere moves through it. As to be expected, the low-energy cosmic-ray flux is bi-variant in energy and density of neutrals. Anomalous cosmic rays naturally participate in this picture.

Tuesday, September 20, 2005 2:00PM - 5:00PM
Session CG DNP JPS: Electromagnetic Interactions | Ritz-Carlton Hotel Plantation 2
2:00PM CG.00001 A Study of the Spin Dependence of Pion Electro-Production near the Δ-
Excitation Region. YUAN XIAO, Bates Linear Accelerator Laboratory, Laboratory of Nuclear Science, MIT, BLAST Collaboration — The BLAST collaboration recently finished an experiment measuring the spin dependence of pion electro-production near the Δ-excitation region. The experiment used the polarised electron beam from the MIT-Bates Linear Accelerator Facility and a target of vector polarized atomic hydrogen produced by an Atomic Beam Source (ABS). The polarized hydrogen was injected into an internal target cell on the South Hall Electron Storage Ring. Data for various kinematics and different reaction channels were collected simultaneously by the BLAST (Bates Large Acceptance Spectrometer Toroid) detector. By flipping the target spin direction and the electron beam helicity, asymmetries were constructed from the measured rates with different spin combinations. The resulting asymmetries were obtained for longitudinal and transverse target spin orientations (with respect to the momentum transfer direction) and cover an invariant mass (W) range of 1.1 to 1.4 GeV/c². With less background and fewer assumptions than results from other inclusive channels, this spin depend study of the exclusive channels, pion electro-production near the Δ-excitation region, will cast light on the spin structure of protons. Preliminary experimental results of spin-correlated parameters and a comparison between the experiment and a unitary isobar model (MAID) will be presented.

2:15PM CG.00002 Progress in 3N Response Functions Using the LIT Technique. EDWARD TOMUSIAK, University of Victoria, VICTOR EFRON, Kurchatov Institute, WINFRIED LEIDEMANN, GIUSEPPINA ORLANDINI, University of Trento — Our earlier results[1] for the longitudinal response functions of ³He and ³H began to display frame dependence at q=500 MeV/c. This is a manifestation of the non-relativistic framework of our calculations. We have found a method of extending such calculations to regions of higher q while drastically reducing the frame dependence. The method hinges on the choice of a particular frame and/or the details of the kinematical input. Results for the longitudinal response will be shown for q up to 700 MeV/c. In addition we will show our results for data for the transverse response functions of the trinucleons.

3:00PM CG.00003 Magnetic moment of the Delta(1232)-resonance in chiral EFT. VLADIMIR PASCALUTSA, MARC VANDERHAEGHEN, William and Mary/ Jefferson Lab — The Δ(1232)-isobar is the most distinguished and well-studied nucleon resonance. However, such a fundamental property as its magnetic dipole moment (MDM) has thus far escaped a precise determination. The problem is generic to any unstable particle whose lifetime is too short for its MDM to be measurable in the usual way through spin precession experiments. A measurement of the MDM of such an unstable particle can apparently be done only indirectly, in a three-step process, where the particle is first produced, then emits a low-energy photon which plays the role of an external magnetic field, and finally decays. In this way the MDM of Δ⁺ is accessed in the reaction p⁺ → π⁺ pγ while the MDM of Δ⁻ can be determined using the radiative pion photoproduction (γp → π⁺π⁻γ). In this paper we will present a new chiral effective field theory calculation of the radiative pion photoproduction (γp → π⁺π⁻γ) in the Δ-resonance region. This work is aimed at a model-independent extraction of the Δ⁺ magnetic moment from new precise measurements of this reaction. It also predicts the chiral behavior of Δ’s magnetic moment, which can be extrapolated to the recent lattice QCD results to the physical point.

3:15PM CG.00006 Separated Structure Functions in K⁺Λ and K⁺Σ⁰ Electroproduction. DANIEL S. CARMAN, Ohio University, CLAS COLLABORATION — Data analysis from an extensive program of kaon electroproduction from the proton utilizing electron beams from 2.5 to 5.7 GeV is presently underway in Hall B at Jefferson Lab. Cross sections for the K⁺Λ and K⁺Σ⁰ final states have been measured using the CLAS spectrometer. The data reported here were collected at beam energies of 2.6 and 4.2 GeV and span a range of kinematics in W from threshold to 2.5 GeV, Q² from 0.5 to 2.5 GeV²/c⁴, while covering nearly the full center-of-mass angular range for the kaon. As part of this analysis, the structure functions σL, σT, σLT, σLT, and σL have been extracted from the c-dependent differential cross sections. These structure functions have strong sensitivity to disentangle the resonant contributions in the s, t, and u reaction channels from the non-resonant strength. Differences in the production dynamics for the Λ and Σ hyperons will be discussed and the data will be compared with available theoretical calculations for these processes. These measurements are part of the larger N³ program of CLAS.

3:30PM CG.00007 Measurement of σT, σL, and the ratio σL/σT in kaon electroproduction
using CLAS. BRIAN RAUE, Florida International University, CLAS COLLABORATION — Measurements of the differential cross section d²σ/dQ² for p(e, e′K⁺Λ)/Σ⁺ have been done using the CEBAF Large Acceptance Spectrometer (CLAS) at Jefferson Lab. The data were taken with beam energies of 2.567, 4.056, and 4.247 GeV and covered the kinematical ranges of 0.5 < Q² < 2.5 GeV² and W from threshold up to 2.5 GeV. The overlap in Q² and W for the different beam energies allows a separation of the longitudinal and transverse contributions to the unpolarized cross section. The separation was done using both the Rosenbluth technique and a simultaneous c – φ fit. These results cover a wide range of cosθK⁺ and are the first to include measurements away from cosθK⁺ = 1. The results of this analysis will be compared to previous results obtained by Rosenbluth separations as well as results obtained from hyperon transferred polarization measurements at 2.567 GeV. We will also show comparisons to current theoretical descriptions of kaon electroproduction and discuss the implications.
3:45PM CG.00008 Photoproduction of neutral kaons on deuterons in the threshold region. KYO TSUKADA, Tohoku Univ., NKS COLLABORATION — Until now, the investigation of kaon photo- electro-production have been carried out in p(γ, K⁺), p(γ, K⁺)Σ⁰ and p(γ, K⁺)Σ⁺ reactions among six isospin channels. However, no data have been measured for the other three channels on a neutron. The elementary processes of strangeness photoproduction are far from well understood. It is believed that measurements of these three strangeness production channels provide much information on the strangeness photoproduction mechanism. In particular, the η(γ, K⁰)Λ reaction is expected to play an essential role since it is unique in the sense that no charge is involved. Therefore, we carried out the experiment of the d(γ, K⁰) reaction in the threshold region, Eγ = 0.8 ~ 1.1 GeV. K⁰'s were measured in π⁺π⁻ decay mode by Neutral Kaon Spectrometer (NKS) which we installed in the Laboratory of Nuclear Science of Tohoku University (LNS-Tohoku). K⁰ momentum spectra were compared with theoretical spectra calculated assuming representative isobar models. The present experiment demonstrated a usefulness of neutral kaon detection for the investigation of photo strangeness production reaction.

4:00PM CG.00009 Λ photoproduction on the neutron. PAWEL NADLE-TURONSKI, The George Washington University, CLAS COLLABORATION — Of the two elementary γn → Λn reactions, the γp → K⁺Λ channel has been studied extensively, but for γn → K⁰Λ there are no data at all. It is very important to measure the cross section for this latter process because this production channel is one of the main reaction channels that can be used to identify missing N* resonances. 1 We have measured exclusive K⁰Λ photoproduction by detecting all four charged particles from the K⁰ decay and the Λ → π⁻τ⁰ decay. The free neutron βDecay Experiment at the SNS. The proposed method relies on the measurement of the proton time-of-flight distribution using a pair of large area Silicon detectors. The design calls for systematic uncertainties of a few parts in a thousand. We address the practical issues related to a MC simulation of events at all. It is very important to measure the cross section for this latter process because this production channel is one of the main reaction channels that can be used to identify missing N* resonances. We have measured exclusive K⁰Λ photoproduction by detecting all four charged particles from the K⁰ decay and the Λ → π⁻τ⁰ decays and reconstructing the invariant masses of both strange particles. The experiment was performed in Hall B at Jefferson Lab using tagged photons having energy up to 3.6 GeV and a liquid deuterium target. Events where the proton is a spectator were clearly identified. The recoil polarization of the lambda was also measured. 1 T. Mart and C. Bennhold, Phys. Rev. C 61, 012201 (2000)

4:15PM CG.00010 η electroproduction at high momentum transferred with CLAS, MAURIZIO UNGARO, KYUNGSEON JOO, UCONN, CLAS COLLABORATION — This analysis presents high quality angular distributions of the p(e,e'p)η reaction for full coupled-channel analysis purpose. The c.m. differential cross section dσ/dΩ in the centre of mass will be extracted, and the unpolarized σ₁, σ₁, σ₁, LT, TT, LT will be calculated. The measurement of the polarized longitudinal-transverse structure function I will provide new and useful information for untangling the N* states and to probe the interference between resonant and non-resonant processes. The CLAS spectrometer was used to detect the scattered electrons and final state protons, and the η's were reconstructed by the missing mass technique. The angular distributions are obtained over the 4π c.m. solid angle. The beam polarization was ~70%. Preliminary data will be discussed.

4:30PM CG.00011 Measurement of the π⁻-meson polarizabilities via the γp → γπ⁻n reaction , D.L. HORNDICE, Mount Allison University, Sackville, NB, R. BECK, D. KRAMBRICH, M. ROST, TH. WALCHER, Institut für Kernphysik der Johannes-Gutenberg-Universität Mainz, S.N. CHEREPNYA, L.V. FIL'KOV, V.L. KASHEVAROV, P.N. Lebedev Physics Institute Moscow, I. GILLER, M. MOINESTER, Tel-Aviv University, A2 COLLABORATION, TAPS COLLABORATION — An experiment on the radiative π⁻-meson photoproduction from the proton (γp → γπ⁻n) was carried out at the Mainz Microtron MAMI in the kinematic region 537 MeV < Eγ < 817 MeV, 140° ≤ θγπ⁻ ≤ 180°. The π⁻ meson polarizabilities have been determined from a comparison of the data with the predictions of two different theoretical models. Validity of the models has been verified by comparing the predictions with the present experimental data in the kinematic region where the pion polarizability contribution is negligible and where the difference between the predictions of the two models does not exceed 3%. Results will be presented and discussed.

4:45PM CG.00012 Longitudinal and Transverse Response Functions from Kaon Electroproduction off Hydrogen. PETE MARKOWITZ, FIU, KAON COLLABORATION, HALL A COLLABORATION — Exclusive H(e,e'K)Λ data were taken in 2001 - 2002 in Hall A at the Thomas Jefferson National Accelerator Facility during experiment E89-108. Electrons and kaons were detected in coincidence with the two High Resolution Spectrometers (HRS) in Hall A. The kaon arm was specially equipped with two aerogel Čerenkov threshold detectors, designed to separately provide pion and proton particle separation thus allowing kaon identification. Data were taken close to η=1.5π, or a minimum angle between the kaon and the virtual photon, θγK<0. This talk presents the final results of a Rosenbluth separation of the cross section and the longitudinal and transverse responses. The data have been compared to calculations using various kaon electromagnetic form factors. Longitudinal and transverse responses show separate sensitivity to varying the form factor at the kinematics of the experiment. This comparison constrains the kaon form factor, albeit in a model dependent fashion.

Tuesday, September 20, 2005 2:00PM - 4:30PM - Session CH DNP JPS: Neutron Decay and Electroweak Physics Ritz-Carlton Hotel Plantation 1

2:00PM CH.00001 Simulation of the “little α” Neutron Beta Decay Experiment at the SNS. EMIL FRLEZ, University of Virginia — We present the GEANT4 Monte Carlo simulation of an experimental apparatus being developed to measure the electron-antineutrino correlation in the free neutron beta decay (“little α”) at the SNS. The proposed method relies on the measurement of the proton time-of-flight distribution using a pair of large area Silicon detectors. The design calls for systematic uncertainties of a few parts in a thousand. We address the practical issues related to a MC simulation of ~10⁹ events in the 4π hermetic magnetic spectrometer. We discuss modeling the required precision of the electromagnetic field maps, p-e coincidence trigger efficiencies, TOF timing spreads due to neutron beam size and position, charged particle detector energy thresholds and backscattering processes.

2:15PM CH.00002 Polarized Neutron β-decay: the Proton Asymmetry and Recoil-Order Currents. SKY SJUE, ALEJANDRO GARCIA, University of Washington — We present an analytic calculation of the proton asymmetry from polarized neutron β-decay, including recoil-order effects. The differential decay rate in terms of electron energy and proton direction follows, parametrized in terms of the most general Lorentz-invariant hadron current coupled to a left-handed lepton current. Implications for experimental efforts to measure recoil-order currents are discussed.

2:30PM CH.00003 Performance of the beta-spectrometer for a precision measurement of the neutron beta-decay asymmetry. JUNJIA YUAN, BRADLEY PLASTER, BRADLEY FILIPPONE, California Institute of Technology, TAKEYASU ITO, University of Tennessee, JEFFERY MARTIN, University of Winnipeg, UCNA COLLABORATION — A precise value for the neutron beta-decay asymmetry will be extracted from measurements of the angular correlation between the neutron spin and the direction of emission of the decay electron in polarized ultracold neutron decay. Ultracold neutrons polarized via transport through a 7.0 Tesla field will be directed into the center of our beta-spectrometer, consisting of a 10-cm diameter, 3-m long open-ended decay trap situated within a highly-uniform 1.0 Tesla solenoidal field. Spiraling decay electrons will be detected at both ends of the decay trap in identical detector arrays consisting of a multi-wire proportional chamber backed by plastic scintillator. Initial results of various performance tests of our beta-spectrometer and electron detector system will be presented.
2:45PM CH.00004 Measurement of Electron Backscattering for Neutron $\beta$-Decay. J.W. MARTIN. Physics Department, University of Winnipeg, M.J. BETANCOURT, B.W. FILIPPONE, T.M. ITO, J. YUAN, California Institute of Technology, S.A. HOEDEL, Princeton University, A.R. YOUNG, North Carolina State University — Electron backscattering from the surfaces of detectors complicates accurate beta spectroscopy in nuclear beta-decay experiments. For example, an upcoming measurement of the beta-asymmetry in neutron decay (the UCNA experiment at Los Alamos) will require an understanding of backscattering at the 20% level. The beta-asymmetry, when combined with the neutron lifetime, can be used to extract the standard model parameter $V_{ud}$, governing weak transitions between $u$ and $d$ quarks. The existing measurements of electron backscattering are not detailed enough in the relevant energy range to make assessments of models of electron transport. We report on recent progress of measurements of electron backscattering at normal incidence from low Z bulk targets in the energy range 40 to 120 keV. The total backscattered fraction, and the energy and angular distributions of the backscattered electrons were measured for scattering from beryllium, silicon, and scintillator targets. In particular, the scintillator target data presented several additional interesting systematic effects which have now been characterized. Accuracy better than the experimental requirement has been achieved. The measurements have been compared with electron transport models based on the Geant4 and Penelope Monte Carlo codes.

3:00PM CH.00005 Neutron Beam Polarization with $^3$He Polarizing and Modulating Cells. ROBERT COOPER, TIMOTHY CHUPP, University of Michigan, THOMAS GENTILE, NIST. Gaithersburg, FRED WIETTELDT, Tulane University — Precision experiments with polarized neutrons provide data on beta-decay correlation coefficients and particle physics of neutron decay. They rely upon large numbers of decays to achieve the desired level of statistical precision. High flux polychromatic neutron sources are used. This presents difficulties in characterizing the properly weighted polarization for all neutron wavelengths in the beam spectrum. Time of flight with a chopped beam typically characterizes the spectrum and wavelength dependent polarization. Our approach uses the well-known properties of a $^3$He polarizer with an added thin $^3$He cell to modulate the polarization. With the appropriate combination of thick and thin detectors, the beam polarization can be estimated with high precision. This real-time measurement properly weights the polarization by the decay probability (i.e. the capture-flux polarization), but does require precise knowledge of the thin $^3$He cell properties. This alternative can provide a check on beam-mixing methods.

3:15PM CH.00006 Search for Radiative Beta-Decay of the Neutron. J.S. NICO, M.S. DEWEY, T.R. GENTILE, H.P. MUMM, A.K. THOMPSON, National Institute of Standards and Technology. B.M. FISHER, F.E. WIETTELDT, Tulane University, E.J. BEISE, K. KIRILUK, University of Maryland, J. BYRNE, University of Sussex, T.E. CHUPP, R.L. COOPER, University of Michigan — Beta decay of the neutron into a proton, electron, and antineutrino is occasionally accompanied by the emission of a photon. Despite decades of detailed experimental studies of neutron beta-decay, this rare branch of a fundamental weak decay has never been measured. An experiment to study the radiative beta-decay of the neutron is currently being developed for the N690 fundamental physics beam line at the NIST Center for Neutron Research. The experimental approach looks for electron-photon coincidences followed by a delayed proton. The need for a large solid-angle photon detector that can operate in a strong magnetic field and at low temperature has led us to employ a photon detector consisting of scintillating crystals coupled to avalanche photodiodes. A single silicon detector is used for registering both electron and proton events. The apparatus has been installed at the NG6 beam line and initial measurements have begun. Analysis of the data indicate that electron-proton rates are as expected and photon background rates are acceptable.

3:30PM CH.00007 Progress toward a measurement of parity violation in $\vec{p} + p \rightarrow d + \gamma$. ROB MAHURIN, University of Tennessee, Knoxville, NPDGamma Collaboration — The weak part of the nucleon-nucleon interaction produces small parity-violating asymmetries in the gamma rays emitted during polarized neutron capture. The asymmetry for capture on hydrogen is directly related to the nucleon-pion coupling, without complication from nuclear structure, and has an estimated size $5 \times 10^{-9}$. With its installation in fall 2005 of a liquid parahydrogen target at the Los Alamos Neutron Science Center, the NPDGamma collaboration can begin to measure this asymmetry directly. I will report the status of the target system and the run plan for the next year, and discuss our plans to achieve our design sensitivity $5 \times 10^{-9}$ using the higher flux at the Spallation Neutron Source.

3:45PM CH.00008 Measurement of Parity Violation in Radiative Neutron Capture. MIKAYEL DABAGHYAN, University of New Hampshire, NPDGamma Collaboration — The NPDGamma experiment aims to measure parity violating directional gamma-ray angular correlations to test the $V-A$ description of the weak interaction. The open geometry of the trap allows for electron-photon coincidences followed by a delayed proton. The need for a large solid-angle photon detector that can operate in a strong magnetic field and at low temperature has led us to employ a photon detector consisting of scintillating crystals coupled to avalanche photodiodes. A single silicon detector is used for registering both electron and proton events. The apparatus has been installed at the NG6 beam line and initial measurements have begun. Analysis of the data indicate that electron-proton rates are as expected and photon background rates are acceptable.

4:00PM CH.00009 Precision $\beta$-decay studies in a RFQ ion trap. N. SCIELZO, A. LEVAND, G. SAVARD, I. TANIHATA, B. ZABRANSKY, Argonne National Laboratory, J. CLARK, H. SHARMA, K. SHARMA, Y. WANG, Argonne National Laboratory and U. of Manitoba, A. HECHT, Argonne National Laboratory and U. of Maryland — A linear RFQ ion trap has been constructed and brought online at Argonne for precise measurements of $\beta$-decay angular correlations to test the $V-A$ description of the weak interaction. The open geometry of the trap allows for electron-photon coincidences followed by a delayed proton. The need for a large solid-angle photon detector that can operate in a strong magnetic field and at low temperature has led us to employ a photon detector consisting of scintillating crystals coupled to avalanche photodiodes. A single silicon detector is used for registering both electron and proton events.

4:15PM CH.00010 $\Sigma^+ \rightarrow p\mu^+\bar{\nu}_\mu$ in the Standard Model. GERMAN VALENCIA, Iowa State University — The HyperCP collaboration has recently reported the observation of three events for the mode $\Sigma^+ \rightarrow p\mu^+\bar{\nu}_\mu$. They have suggested that new physics may be required to understand the implied decay rate and the observed $M_{\mu\mu}$ distribution. Motivated by this result, we re-examine this mode within the Standard Model. The result is long distance dominated and we estimate it with the aid of chiral perturbation theory.

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**Tuesday, September 20, 2005 2:00PM - 5:00PM**

**Session CH DNP JPS: Instrumentation**  
Ritz-Carlton Hotel Hawaii

2:00PM CH.00001 Particle identification in the Time Projection Chamber at SPring8/LEPS. TAKAHIRO SAWADA, HISAKO FUJIMURA, YUJI KATO, TAKASHI NAKANO, MASAYUKI NIYAMA, LEPS Collaboration — We study $\Lambda(1405)$ photoproduction from $C$, $CH_2$, and $Cu$ nuclei with Time Projection Chamber (TPC) detector at the SPring-8/LEPS beamline. The photon beam with 1.5-2.9 GeV is produced by backward Compton scattering laser photon from 8 GeV stored electron. Particle identification (PID) is allowed by $dE/dx$ and momentum measurements with TPC. A good PID capability, that is good $\pi/p/K$ separation, is crucially important in order to exclude background contribution caused by miss particle identification. In this talk, the current status of the PID will be presented.
2:15PM CJ.00002 The Digital Data Acquisition System for SeGA at the NSCL\textsuperscript{1}. C. VAMAN, T. GLASMACHER, K. STAROSTA, P. MANTICA, NSCL, Michigan State University — At the National Superconducting Cyclotron Laboratory (NSCL) the work for implementation of a \textasciitilde{}664 channel Digital Data Acquisition System (DDAS) for the Segmented Germanium Array (SeGA) detectors, was started. The most significant gain in performance for SeGA can be achieved with implementation of gamma-ray tracking and resulting identification of the position of the first gamma-ray interaction. The identification of the first gamma-ray interaction position for in-beam experiments results in reduced Doppler broadening of gamma-ray peaks and improved experimental sensitivity. For these improvements to be possible, digitization of the data from the Ge detectors has to be digitized right after preamplification and processed in real time. The talk will present some of the technical solutions and the current status of the project.

\textsuperscript{1}This work is supported by the U.S. National Science Foundation under the Grant No. Phy0420778

2:30PM CJ.00003 The Silicon Tracker Upgrade for the Phenix Muon Arms. GERD KUNDE, Los Alamos National Laboratory, PHENIX COLLABORATION — A proposed upgrade to the Phenix muon arms is a four station precision silicon vertex tracker which would be placed before the muon arm absorbers. This silicon tracker will greatly extend the physics reach of the muon arms. The capability to detect displaced single muon tracks and displaced vertices of muon decay will greatly impact the open charmed open beauty detection and allow to directly measure the beauty quark production via the J/ψ/ψ' decay branch. The four station tracker will use a mini-strip silicon detector geometry in umbrella shape to cover the muon arm acceptance. Measurements pertaining to the quark gluon plasma, shadowing in d-A and delta-G in p-p will be discussed and the readout concept will be presented.

2:45PM CJ.00004 Time of Flight System for the PHENIX high-pt Detector Upgrade. HUGO VALLE, Vanderbilt University, PHENIX COLLABORATION — The PHENIX experiment has observed enhanced proton/pion ratios in central Au+Au collisions as compared to the expectation from parton fragmentation. The measurements have been done using the scintillator based Time-of-Flight (TOF) detector in the PHENIX East arm, which allowed π/K and K/p separation up to pt = 2.5 and 4 GeV/c respectively. Particle identification (PID) to higher pt (> 8 GeV/c) is needed to better characterize the hadron production mechanism at intermediate and high-pt and differentiate between competing theoretical descriptions. The PHENIX detector is being upgraded with a high-pt PID system. A cost-effective TOF system based on Multi-gap Resistive Plate chambers (MRPC) is being implemented as part of this upgrade. The MRPC-TOF will provide high-resolution timing measurement in the PHENIX West arm. It will supplement the PID provided by the Aerogel and Ring Imaging Cerenkov Counters, and the goal is to provide seamless particle identification in the range 0.2 < pt < 9 GeV/c. Three different prototypes were installed and operated during RUNS of RHIC. The details on the MRPC design, the electronics chain and the first results obtained in \sqrt{s}_{NN} = 200 GeV Cu+Cu collisions will be presented.

3:00PM CJ.00005 Physics motivation for the Nose-Cone Calorimeter Upgrade to the PHENIX Forward Spectrometers. KENNETH BARISH, UC Riverside, PHENIX FORWARD UPGRADE COLLABORATION — The nose-cone calorimeter upgrade to the PHENIX forward spectrometers aims to add capabilities at forward rapidity in order to: (a) significantly extend the acceptance for high p\_T jet-photon measurements (jet tomography) in A+A collisions, (b) increase our capabilities to measure the production quarkonium states in A+A collisions by giving sensitivity to the \chi_{c} through the J/ψ + γ channel and by providing a trigger with increased rejection for \psi → µµ, (c) study nucleon structure in nuclei at high parton densities in p+A collisions through the measurement of photons and neutral pions in the forward region, and (d) significantly extend the kinematic reach of PHENIX's Δγ measurement for the prompt photon channel. The nose cone calorimeters, which will cover 0.9 < |η| < 3.0, will be tungsten-silicon sampling calorimeters with an electromagnetic and shallow hadronic compartment. They will expand PHENIX's kinematical coverage for jets, inclusive neutral pions, electrons, and photons to forward rapidity and are designed to take advantage of the highest luminosity p+p, d+A, and A+A collisions. In this talk, we will discuss the physics motivation of the upgrade.

3:15PM CJ.00006 PHENIX Silicon Vertex Tracker. ROBERT PAK, Brookhaven National Laboratory, PHENIX COLLABORATION — The Phenix detector at RHIC will be upgraded with a silicon vertex tracker, greatly enhancing the capability to investigate the hot and dense nuclear matter formed in heavy ion collisions as well as significantly improving measurement of the proton spin structure in polarized proton-proton collisions. The vertex tracker will allow direct measurement of heavy quark production by providing the displacement of decay vertices from the primary interaction point. W-bosons in polarized proton-proton collisions. W-bosons can be detected in PHENIX through the appearance of a high-energy muon in one of the two existing muon arms. With this new system a precise measurement of the flavor structure of the quark polarizations in the proton can be made via the observations of electrons, and photons to forward rapidity and are designed to take advantage of the highest luminosity p+p, d+A, and A+A collisions. In this talk, we will discuss the vertex tracker design, its anticipated performance and ongoing R&D program together with the physics motivation of the device.

3:30PM CJ.00007 Calorimetry for the PHENIX Forward Upgrade. VASILY DZHORDZHADZE, University of California Riverside, PHENIX COLLABORATION\textsuperscript{1} — The PHENIX muon program can be sufficiently extended by addition of the calorimetry in the forward direction. The Tungsten calorimeters with silicon pixel readout and fine segmentation are proposed to achieve the goal. The proposed calorimeter will cover a rapidity range of 0.9-3.0, increasing the coverage of the muon system (1.2 < |η| < 2.4). The calorimeter will comprise of two parts: electromagnetic and hadronic, with high resolution position (150 mkm) detectors placed inside. This will extend PHENIX's kinematical coverage for photons, π\^0, electrons and jets at forward rapidity. It will greatly extend high p\_T jet-photon measurements in A+A collisions, will increase the capabilities to measure the production of quarkonium states in A+A collisions by giving sensitivity to the χ_{c} through the J/ψ + γ channel and study nucleon structure in nuclei at high parton densities in p+A collisions through the measurement of gamma rays and π\^0s in the forward region. The calorimeter will provide a good pion rejection, fast trigger and improve muon momentum resolution. In this talk we discuss the calorimeter design, its anticipated performance and ongoing R&D program together with the physics motivation of the device.

\textsuperscript{1}RHIC Experiment at BNL

3:45PM CJ.00008 Physics Capabilities of the PHENIX Muon Trigger Upgrade. RUSTY TOWELL, Abilene Christian University, PHENIX COLLABORATION — While significant progress has been made in understanding the structure of the nucleon, many important questions remain including the origin of the proton spin. Plans have been made to develop a new state-of-the-art trigger system for the PHENIX muon arms. With this new system a precise measurement of the flavor structure of the quark polarizations in the proton can be made via the observations of W-bosons in polarized proton-proton collisions. W-bosons can be detected in PHENIX through the appearance of a high-energy muon in one of the two existing muon spectrometers. The trigger upgrade is based on fast resistive plate counter stations. This talk will describe the proposed upgrade and some of the physics results that can be expected.

4:00PM CJ.00009 Read out system for Drift Chamber using ASD chip . KEISUKE YAWATA, Tohoku University, NKS2 COLLABORATION — For make clear the strangness photo-production process, γ + n → K^0 + Δ reaction is very important. For research this reaction, we are now constructing Neutral Kaon Spectrometer. And in this spectrometer, we designed a large cylindrical Drift Chamber. Since the Drift Chamber is operated in a huge background from γ → e^+e^- conversion, the integration time of an amplifier should be small. Therefore, we study a property of an ASD chip with the integration time of 16nsec (which has not been used for Drift Chamber). In this talk, I will talk about result of ASD chip research and the readout system of Drift Chamber.
4:15PM CJ.00010 First results from the Silicon Strip Detector of the STAR experiment, JOERG REINNARTH, LILIAN MARTIN, JONATHAN BOUCHET, STAR, STAR COLLABORATION. A new Silicon Strip Detector (SSD) has been recently installed in the central part of the STAR experiment at RHIC. The detector enhances the tracking capabilities of the STAR experiment in this region by providing information on the positions of hits and on the ionization energy loss of charged particles. Specifically, the SSD improves the extrapolation of tracks in the Time Projection Chamber to the hits found in the Silicon Vertex Tracker. Innovative solutions for electronics, connections and mechanics required to fulfill the constraints of the STAR environment will be presented. The intrinsic performances of the SSD, its impact on the STAR physics capabilities and the significant improvement of the reconstruction efficiency of short-lived particles will be detailed.

2005 DE-FG02-91ER-40609, DE-FG02-88ER-40417, DE-FG03-03NA-00081, DE-FG02-05ER-41379, and DE-FG52-05NA-25929.

4:30PM CJ.00011 Improved Focal Plane at SASSYER, RYAN WINKLER, A. HEINZ, J. QIAN, H. AI, R.F. CASTEN, E. NOVITSKI, E.A. MCCUTCHEAN, D.A. MEYER, V. WERNER, E. WILLIAMS, Yale University, R.B. CAKIRLI, Istanbul University and Yale University, C.R. FITZPATRICK, University of Surrey, UK and Yale University, G. GURDAL, Clark University and Yale University, C. BEUSAUNG, B. CRIDER, R. RAABE, University of Richmond — The gas-filled recoil select separator SASSYER (Small Angle Separator System at Yale for Evaporation Residues) is designed for the investigation of heavy evaporation residues produced in weak reaction channels. The detection systems around the target position as well as the focal plane are undergoing improvement. Until now, a solar cell array with 30 x 1 x 1 cm$^2$ detectors was used for the detection of recoils and served, together with several germanium detectors, as a setup for isomer-decay tagging (IDT). The redesigned focal plane will consist of a Parallel Grid Avalanche Counter (PGAC) that will be used in transmission together with two 6 x 4 cm$^2$ Double-sided Silicon Strip Detectors (DSSDs) with a 1 mm pitch covering the entire focal plane. A dedicated vacuum chamber allows for the positioning of clover detectors in close geometry. Here recoil-decay tagging, isomer-decay tagging and alpha-gamma coincidence measurements can be performed. The setup and first experimental results will be presented. This work has been supported by US DOE grants DE-FG02-91ER-40609, DE-FG02-88ER-40417, DE-FG03-03NA-00081, DE-FG02-05ER-41379, and DE-FG52-05NA-25929.

4:45PM CJ.00012 An upgraded strangeness photo-production experiment near the threshold region at LNS-Tohoku, HIROYUKI KOURA, Advanced Science Rerearch Center, JAERI — We present a chart of nuclear decay modes for alpha decay, beta decay, proton emission, of nuclei, which is given not by proton emission, but by fission. H. Koura, et al., Prog. Theor. Phys. 61, 1974. We also calculate total half-lives in the "island of stability for the superheavy nuclei" and obtain an alpha-decay-dominant nucleus with the longest half-life on the beta-stability line in an order of 100 year with a certain ambiguity. We also estimate nuclei beyond the superheavy regions and will discuss the limit of existence as compared with NKS especially at forward angles. The estimated acceptance of NKS2 are twice (ten times) for K$^0$ + + n, and 100 to 160, around N ≈ 100 and N ≈ 160, from Z ≈ 108 and N ≈ 160. In 2003 to 2004, we have taken data by Neutral Kaon Spectrometer (NKS) at LNS-Tohoku (see Kyo Tsukada’s talk in detail). We are now constructing a new spectrometer (NKS2) to upgrade experiments of neutral kaon photo-production. The new spectrometer NKS2 covers larger acceptance as compared with NKS especially at forward angles. The estimated acceptance of NKS2 are twice (ten times) for K$^0$ (→ Λ) than that of NKS. With this advantage, we expect simultaneous measurements of K$^0$ and Λ. Additionally, we plan a Lambda polarization measurement and many strangeness production channels in γ + n and γ + p. In this talk, we show the current status of the experiment, and explain our goal in detail.

Tuesday, September 20, 2005 2:00PM - 4:45PM — Session CK DNP JPS: Nuclear Structure Theory Ritz-Carlton Hotel Maui

2:00PM CK.00001 Comparison of Potential Energy Surfaces for Fission and Fusion in Hartree-Fock and Macroscopic-Microscopic Models, LUDOVIC BONNEAU, PETER MOLLER, Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87544 — In the macroscopic-microscopic model we calculate the nuclear potential energy versus five different shape coordinates for complete spaces, that is for all possible combinations of these shape coordinates, basically a 5-dimensional "cube." Its structure, in particular saddle points and ridges are determined by use of a water immersion technique. In HF calculations the energies are calculated subject to a number of constraints, for example quadrupole moment and reflection asymmetry, but others are possible. In this approach it is less straightforward to locate saddle points and ridges, than in the other model. However, valleys and minima are fairly easily obtained. We discuss some of these important issues and what we have learned by comparing results of the two approaches.

2:15PM CK.00002 The Nuclear Born–Oppenheimer Method and Nuclear Rotations, NOUREDINE ZETTILI, Jacksonville State University, AL — We want to discuss the application of the nuclear Born–Oppenheimer (NBO) method to the study of nuclear rotations and collective motion. This application is illustrated on permanently deformed (non-spherical) nuclei that are axially-symmetric and even, but non-closed shell nuclei. We will focus, in particular, on the derivation of expressions for the energy and for the moment of inertia. Using trial functions in which the intrinsic structure is described in a mean-field approximation, we then show that the NBO formalism—a truly quantum mechanical description—yields the Thouless-Valantin formula for the moment of inertia and that this moment of inertia increases with angular momentum, in agreement with experimental data. We will show that the NBO formalism is well equipped to describe low-lying as well as high lying rotational states. In addition, we establish a connection between the NBO method and the self-consistent Cranking (SCC) model, which is known to be successful in reproducing vast amounts of experimental data ranging from low-lying rotational states to high angular momentum states.

2:30PM CK.00003 Fission properties of superheavy nuclei and a limit of existence of nuclei, HIROYUKI KOURA, Advanced Science Research Center, JAERI — We present a chart of nuclear decay modes for alpha decay, beta decay, proton emission, and spontaneous fission ranging from light nuclei to superheavy ones between neutron and proton drip lines with the use of a phenomenological atomic mass formula [1] to estimate decay rates of the above ones. The standard deviation of this mass formula from known masses is 0.67 MeV, and below 0.4 MeV from K$^0$ + + Λ in high angular momentum states.

2:45PM CK.00004 The effect of Dirac sea and tensor coupling of omega meson in SU(2) chiral sigma model. SETSUO TAMENAGA, Research Center for Nuclear Physics (RCNP), AKIHIRO HAGA, Nagoya Institute of technology, YOKO OGAWA, Research Center for Nuclear Physics (RCNP), Osaka University, HIROSHI TOKI, Research Center for Nuclear Physics (RCNP), Osaka University — The chiral sigma model provides good saturation property for nuclear matter and produces the magic number 28 by pionic correlation in finite nuclei. However, the magic number appears at $N=18$ instead of $N=20$, which seems due to the incompressibility being too large ($K=650$[MeV]). We take the relativistic Hartree approximation (RHA) for the nucleon propagator with chiral symmetry. However this ordinary approach remains arbitrary and the total effective potential has the instability. We propose a new chiral symmetric renormalization (NCSR) method, which includes the higher-order counter terms of sigma and pi mesons. With this renormalization scheme, we can remove both arbitrariness and divergence, and obtain a stable potential. It is also known that the incompressibility decreases around 300[MeV] in SU(2) chiral sigma model with higher-order terms. In this model s-state level locates at a good place as we expect. However the effective mass (0.85M) is too large. Therefore it is impossible to produce the magic number 20 due to the small spin-orbit splitting of d-state despite of good incompressibility. We discuss the effect of Dirac sea (NCSR and Derivative expansion) and tensor coupling for omega meson in order to solve the problem at $N=20$.

3:00PM CK.00005 Refinement of Approximate Energy Expressions for Nuclear Matter by Taking into Account Tensor Correlations. KAZUNORI TANAKA, KAZUMASA EBINUMA, MASATOSHI TAKANO, Waseda University — Approximate energy expressions are refined for infinite zero-temperature nuclear matter by taking into account tensor correlations. They are explicitly expressed as functionals of spin-isospin-dependent radial distribution functions, tensor distribution functions and spin-orbit distribution functions, and can be used conveniently in the variational method. Before this refinement, nuclear matter energies calculated with this variational method were too low, possibly due to insufficiency of the expressions for the kinetic energy caused by noncentral correlations. Compared with the expectation values of the Hamiltonian, the two-body cluster terms are found to be included completely in the previous energy expressions, while the three-body cluster terms are not included sufficiently. Therefore, in this study, the main parts of the three-body-cluster kinetic-energy terms composed of the central and the tensor correlations are added to the previous expressions, as the first step of the refinement. The Euler-Lagrange equations are derived from the refined energy expressions and numerically solved for neutron matter with the AV18 potential. The results are considerably improved.

3:15PM CK.00006 The Spin Cut-off Factor of Nuclear Level Density. AZIZ BEHKAMI, MEHDI SOLTANI, Shiraz University, Physics Dept., MEHMET KILDIR, MEHRDAD GHLAMI, Middle East Technical University — Since detailed at high resolution ($h/\hbar$) and transfer reaction data has become available, we have initiated a systematic investigation of the data in order to deduce the parameters involved in the model calculations, in particular the spin cut-off factor. It is difficult to determine experimentally the spin cut-off factor $\sigma$. We have attempted to obtain $\sigma$ near the ground state by fitting $f(J)$ to the experimental spin distribution for various nuclei with $\chi^2 = \sum_i \left( n_i f_i(J) - n_i f(J) \right)^2$ where $F_k = \sum_j n_j f(J)$ and $n_j$ being the number of levels of spin $J$ in nuclide $k$ which has the spin window $J^1$ and $J^2$. In addition the energy and mass dependence of the spin cut-off factor have been investigated using the microscopic model of BCS and reliable values for the spin cut-off factor which is often used in equilibrium decay calculations have been obtained. The energy dependence of the effective moment of inertia determined from the deduced spin cut-off factor, $\sigma^2 = (3s_f f / h^2)^2 / T$ for all nuclei under study will also be presented and discussed.

3:30PM CK.00007 Zero-point energy corrections in self-consistent calculations with density-dependent forces. WALID YOUNES, Lawrence Livermore National Laboratory — Zero-point energy (ZPE) corrections appear naturally in the Gaussian-overlap approximation to the generator-coordinate method, and play a critical role in microscopic calculations of fission. These corrections are obtained through different prescriptions in the literature, and in a seminal paper by Girod and Grammaticos [1], a useful relationship was derived between ZPE corrections calculated with matrix elements of the angular-momentum operator and those of the multipole-moment operator. The derivation assumed a linearly-constrained Hamiltonian, and neglected re-arrangement terms arising from the density dependence of the effective interaction. Both methods of calculating ZPE corrections will be compared as a function of deformation for realistic calculations in heavy nuclei.

1 This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48

3:45PM CK.00008 Cluster Variational Calculations of the Equation of State for Infinite Nuclear Matter. HIROAKI KANZAWA, KAZUNORI TANAKA, MASATOSHI TAKANO, Waseda University — We report variational calculations of the equation of state (EOS) for neutron matter and symmetric nuclear at zero temperature. We assume the Jastrow-type wave functions with spin-isospin-dependent central, tensor and spin-orbit correlation functions. With the two-body cluster approximation, the energies per nucleon are expressed in the terms of the correlation functions. Since the obtained saturation point of symmetric nuclear matter is not in good agreement with the empirical one, additional three-body cluster terms are included in the previous energy expressions, while the three-body cluster terms are not included sufficiently. Therefore, in this study, the main parts of the three-body-cluster kinetic-energy terms composed of the central and the tensor correlations are added to the previous expressions, as the first step of the refinement. The Euler-Lagrange equations are derived from the refined energy expressions and numerically solved for neutron matter with the AV18 potential. The results are considerably improved.

4:00PM CK.00009 The study of the effect of the tensor force using the charge- and parity-projected Hartree-Fock method. SATORU SUGIMOTO, Kyoto University, KIYOMI IKEDA, The Institute of Physical and Chemical Research (RIKEN), HIROSHI TOKI, RCNP, Osaka University — The tensor force is very important in nuclear structure. It is known that the tensor force plays the decisive role in the binding mechanism of nuclei. Recently we proposed the mean-field-type framework which can take into account the correlation induced by the tensor force by introducing single- particle states with parity and charge mixings. Because the total wave function made from such single-particle states does not have good parity and a charge number, the parity and charge projections are performed. By taking a variation of the total energy calculated with the observed ZPE corrections on the same footing. In this talk, the results in [1] are generalized to the case of density-dependent interactions and quadratic cut-off factor, $\sigma = (3s_f f / h^2)^2 / T$ for all nuclei under study will also be presented and discussed.

Work supported by the shiraz university research council through grant No. GR-Sc-52.

4:15PM CK.00010 The elusive 1st excited state in 229Th. PETER MOLLER, ANNA C. HAYES, Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87545 — Several different approaches have been proposed and implemented to find the 1st excited state in 229Th which from systematics and other considerations has been postulated to be located just a few eV above the ground state. One possibility is to populate states in 229Th and study the alpha-decays from the gs and isomer to 225Ra and observe the different alpha-decay half-lives and associated decay energies. Another intriguing possibility is to study the beta decay from 229Ac into 229Th and observe the beta-decays to both the isomer and the gs of Th229. We summarize briefly the current experimental status and review the different theoretical issues associated with interpreting the different approaches.
4:30PM CK.00011 Testing the predictive power of nuclear-structure models against new experimental data. PETER MOLLER, Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM 87545 — Nuclear masses are of paramount importance in studies and modeling of nuclear reactions since the reaction Q values can be obtained from the masses involved. Reliable mass models are of paramount importance to provide masses to nuclear data bases for nuclei for which no experimental masses are available. A key question is: Are the masses calculated for nuclei in unknown regions reliable? We argue that when evaluating mass models one needs in addition to address 1) if the basis of the model is sound, 2) if it is general enough to provide additional nuclear structure quantities, not just nuclear masses, and 3) if the model is global so that it is possible to calculate these properties for any or almost any nucleus with proton number Z and neutron number N. Using the above starting points we comment on several different mass models that are currently in use, in particular we compare the model deviations from measured masses in the Audi 2003 evaluations and to α-decay energies from the heaviest elements and discuss the different physics of the models.

Tuesday, September 20, 2005 7:00PM - 10:00PM — Session DÄ DNP JPS: Nuclear Baryon Interactions Ritz-Carlton Hotel Salon 4

7:00PM DA.00001 Measurements of the Spin Structure of the Deuteron. MICHAEL KOHL, BLAST Collaboration, MIT-Bates Linear Accelerator Center Middleton, MA 01949 — As a spin-1 object composed of two nucleons, the deuteron exhibits a spin structure that can be probed by elastic and quasielastic electron scattering through single and double polarization observables. Such measurements of spin-dependent electron scattering from deuterium have been carried out recently at the MIT-Bates Linear Accelerator Center with the Bates Large Acceptance Spectrometer Toroid (BLAST). The experiment uses a longitudinally polarized (>65%) electron beam in combination with an isotopically pure, highly-polarized (>70%) internal target of vector- and tensor-polarized deuterium. BLAST consists of a toroidal magnetic spectrometer with the two in-plane sectors symmetrically equipped with detectors, which allows for simultaneous measurement of the inclusive and exclusive reaction channels in elastic and quasielastic kinematics. Due to its D-wave content, the deuteron has an elastic quadrupole form factor. Unpolarized elastic scattering only provides a combination of the charge and quadrupole form factor, their separation requires a spin observable such as the tensor analyzing power T20, which is determined with BLAST from the single-spin asymmetry in elastic electron scattering from tensor-polarized deuterium. While the small D-wave component modifies the nucleon momentum distribution only little, the corresponding tensor single-spin and vector double-spin asymmetries ATd and AV ed in exclusive deuteron electrodissociation are much more sensitive to nucleons in the D-state. In the quasifree limit, AT d vanishes and AV ed is determined by the form factors of the free nucleon. The above sets of polarization observables have been measured with small statistical and systematic errors and are compared with recent theoretical calculations.

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7:45PM DA.00002 Electromagnetic Meson Production Reaction in the Resonance Region. TORU SATO, Department of Physics, Osaka University — Properties of N+ and meson-baryon dynamics in the resonance energy region are of fundamental importance to understand how non-perturbative dynamics of quark and gluon are realized in nucleon resonances. The N+ properties can be extracted by investigating the recent precise and systematic data of meson production reactions with GeV photon and electron. However, it is a non-trivial problem to connect data and QCD predictions and reaction theory of meson production will play an important role. In this talk, recent development of the theoretical study on meson production reaction and the N+ properties will be discussed.

8:30PM DA.00003 Probing Nucleon-Nucleon Correlations via the (e,e’p) and (e,e’pN) Reactions. DOUGLAS HIGINBOTTOM, Jefferson Lab — Probing nucleon-nucleon correlations has proven to be difficult due to competing mechanisms, such as final state rescattering and two-body currents, which can produce the same final state as one would expect from correlations. Recent A(e,e’p) and A(e,e’pN) measurements have sought to minimize the effects of competing mechanisms by going to special kinematics. For example going to kinematics where the particle with most of the kinetic energy is parallel to the momentum transfer vector, going to high momentum transfers, and/or going to large Bjorken x. The results of these measurements will be presented along with state-of-the-art theoretical calculations.

9:15PM DA.00004 Spectroscopy of Λ hypernuclei. HIROKAZU TAMURA, Tohoku University — Spectroscopy of Λ hypernuclei has recently become one of the most valuable tools for the experimental investigation of strangeness nuclear physics. Following the pioneering pikr spectroscopy experiments at the BNL AGS in the 1970’s, excitation spectra have been measured using this reaction for a wide variety of Λ hypernuclei with the superconducting kaon spectrometer(SKS) at the KEK 12 GeV PS. More recently, Λ hypernuclear spectroscopy was carried out for the first time using the eek reaction and the continuous electron beam at the Thomas Jefferson National Accelerator Facility (Jefferson Lab). This reaction will be further explored using a new high-resolution kaon spectrometer (HKS) installed at Jefferson Lab. At the same time, precision γ-ray spectroscopy with a germanium detector array (Hyperball) has been successfully performed for p-shell Λ hypernuclei at the KEK 12 GeV PS and at the BNL AGS. Quantitative information on Λ hypernuclear structure as well as strengths of the spin-dependent hyperon- nucleon interaction in the p-shell region were derived. In this talk, the progress of Λ hypernuclear spectroscopy, reaction spectroscopy and γ-ray spectroscopy, and their future prospects are presented.
In this presentation we also discuss the characteristics of reactions mechanisms of breakup reactions with halo nuclei.

Target, where Coulomb breakup is dominant, we have observed strong E1 transition strengths at an intermediate state. We show the relative energy spectrum of to proceed through Research Facility. Secondary beam of to study its nuclear response, such as the three-body related discrete resonance and the continuum. The experiment was performed at the RIKEN Accelerator Center for Nuclear Study, University of Tokyo, YASUHIRO TOGANO, SYOKO KAWAI, Rikkyo Univ., RIPS COLLABORATION — Inelastic proton scattering of NATSUMI ENDO, MITSUHISA KITAYAMA, Tohoku University, TAKEO ONISHI, HOOIJIN ONG, Univ. of Tokyo, SUSUMU SHIMOURA, MITSURA TAMAKI, ...

The relative-energy spectrum of $^{14}$Be + 2n system was extracted using invariant-mass method. In the spectrum we found a narrow peak in the unbound region of $^{13}$Be. We also show the angular distribution of this transition in order to determine the spin/parity of the state.

Nuclear and Coulomb breakup of the Borromean nucleus $^{11}$Li, TAKASHI NAKAMURA, R301N COLLABORATION — We have performed kinematically complete measurements of breakup reactions of $^{11}$Li with a $^{12}$C and with a Pb target at about 70 MeV/nucleon at the radioactive beam facility RIPS at RIKEN. Due to the loosely-bound nature of this nucleus, the breakup reactions will provide useful knowledge on the ground and low-lying states of $^{11}$Li, as well as on the subsystems such as $^{10}$Li and di-neutron correlation. In the breakup with the C target, where nuclear interaction dominates over the Coulomb interaction, the knock-out reaction becomes important. Therefore, the $^{10}$Li nucleus is produced as an intermediate state. We show the relative energy spectrum of $^{10}$Li, which is important in understanding the structure of $^{11}$Li. In the breakup with the Pb target, where Coulomb breakup is dominant, we have observed strong EL transition strengths at $E_{\text{EL}} \simeq$ 0.3 MeV, which was missing in the previous experiments. In this presentation we also discuss the characteristics of reactions mechanisms of breakup reactions with halo nuclei.

We also discuss a possible connection between the strong di-neutron correlation and the BCS-BEC crossover phenomenon. Becomes comparable to or a little shorter than the average inter-neutron distance in a wide interval of densities corresponding to the neutron skin and the halo. This soft di-neutron mode appears also in the octupole multipolarity. In order to put these results in a wider context, we look into the superfluid low-density neutron/nucleus. It is thus interesting to study such low excited state in $^{11}$Be, in discussing the change of shell structure and the effect of neutron halo. The experiment was performed at the RIKEN Accelerator Research Facility. The secondary $^{12}$Be beam was produced and identified using RIPS beam line. The $^{14}$Be was broken up into $^{12}$Be and two neutrons by the carbon target. These decay particles were measured and identified using magnetic spectrometer and neutron detectors. The relative-energy spectrum of $^{14}$Be + 2n system was extracted using invariant-mass method. In the spectrum we found a narrow peak in the unbound region of $^{13}$Be. We also show the angular distribution of this transition in order to determine the spin/parity of the state.

8:15PM DB.00005 A new look at the $\beta$-decay of $^{11}$Li¹, FRED SARAZIN, CALEB M. MATTOON, Colorado School of Mines, 8PI COLLABORATION — Following the development of a more intense $^{11}$Li beam at ISAC/TRIUMF, the study of the $\gamma$ spectrum, following the $\beta$-decay of $^{11}$Li, was re-investigated with the 8pi spectrometer, an array of 20 Compton-suppressed HPGe detectors. The addition of an inner array of plastic scintillators allowed data-taking in $\beta$-$\gamma$ coincidences, which significantly improved the signal to background ratio. Since most of the decay strength is observed to proceed through $\beta$-delayed one-neutron emission, the $\gamma$-spectrum is dominated by the decay of bound excited states of $^{10}$Be. These transitions exhibit characteristic Doppler-broadened line shapes, due to the recoiling effect induced by the neutron emission. Analysis of these line shapes and results from the new experiment will be presented.

¹Work partially supported by DOE

8:30PM DB.00006 The structure of $^6$He studied by the proton inelastic scattering at 70 A MeV, YOSHIKO HASHIMOTO, TAKASHI NAKAMURA, MASAHIRO SATO, TSUYOSHI KONDO, TAKASHI SUGimoto, NOBUYuki MATsui, TOSHIMi OKUMURA, TAKUMI NAKABAYASHI, MAKAYUKO SHINOHARA, Tokyo Institute of Technology, TOSHIo KOBAyASHI, HIDEAKI OTSU, YOEHI MATsUDA, Natsuki Endo, MitsuhiSa Kitayama, Tohoku University, TAKEO ONISHi, HOoJIi Ngi, Univ. of Tokyo, Suzumi Shimoura, MitsuMaru TakiMi, Center for Nuclear Study, University of Tokyo, YasuhiRO TOganO, Syoko Kawai, Rikkyo Univ., RIPS COLLABORATION — Inelastic proton scattering of the neutron-rich helium isotope $^6$He has been studied in inverse kinematics at 70 MeV/nucleon. $^6$He is a loosely bound Borromean nucleus. It is thus interesting to study its nuclear structure and its decay properties. The experiment was performed at the RIKEN Accelerator Research Facility. Secondary beam of $^6$He was produced and separated by the RIKEN Projectile Fragment Separator (RIPS). $^6$He bombarded a liquid hydrogen target. The momentum vectors of all the outgoing particles, $^4$H and two neutrons, were determined event by event. $^4$He was bent by a dipole magnet and was detected with a plastic scintillator hodoscope and drift chambers. The neutrons were detected by two walls of scintillator hodoscope. In this talk, we present the invariant mass spectrum of $^4$He and discuss its structure.

8:45PM DB.00007 Tensor-correlated shell and cluster models and their applications to He isotopes, TAKAYuki MIY0, RCNP, Osaka University, KIYOSHI KAT0, Hokkaido University, HIROS1 T0Ki, RCNP, Osaka University, KIY0MI IKEDA, RIKEN — We investigate the effect of the tensor correlation (TC) in light nuclei. TC is mainly the correlation of proton-neutron pair and also related to the cluster correlation. In previous studies, we have extended the model space of $^4$He from $(0s)^4$ to $(0s)^4 + (0p)^2(0p)^2$ in order to incorporate TC in model space description. We have also shown that TC produces about a half of the LS splitting in $^4$He (Prog.Theor.Phys.113(2005)783), and contributes to the breaking of the shell closure in $^{11}$Li(last JPS meeting). Here, these results depend on the amount of TC in nuclei. Then, in this talk, we examine how much our model represents TC. To do this, we extend the model space for $^4$He as follows; (1) we mix the sd shell in addition to the $0s+0p$ shells, (2) we improve the single particle wave function from the harmonic oscillator basis to the one expanded with a finite number of the Gaussian bases. Again, we solve the “tensor-correlated $^4$He cluster”+$\pi$ problem to see the coupling effect between TC and a valence neutron.

7:00PM DB.00002 Pairing, Phase Transitions and Nuclear Level Densities, STEFAN ROMBOUS, KRIS VAN HOUCKE, KRIS HEYDE, Ghent University — In a nuclear medium two protons or two neutrons can form a bound pair. Together with the average interactions with other nucleons this leads to the mean-field plus pairing Hamiltonian as a schematic model for correlations in nuclei. This Hamiltonian can be solved exactly even in large model spaces, using algebraic techniques or using quantum Monte Carlo methods (QMC). We will highlight two recent developments: the extension of the exactly solvable Richardson-Gaudin models to a more general separable pairing interaction, and a new QMC algorithm which is free of sign problems also for odd particle numbers. Combining algebraic solutions at low excitation energies with QMC results at high energies, we obtain accurate estimates of nuclear level densities, particularly in the region where a pairing phase transition might occur. Furthermore we can now evaluate symmetry-projected level densities, for specific parity and angular momentum. Results for Fe and Sn isotopes will be presented.

1Work partially supported by DOE

7:30PM DB.00001 Di-neutron correlations in weakly bound and low density many-nucleon systems, MASAYUKI MATSUO, Niigata University — The correlations in nuclei often lead to spatial clusterizations. In the present talk we shall demonstrate this in connection with the pair correlation. A spatial correlation of the di-neutron type, which has been discussed originally for the two-neutron halo nuclei, may emerge rather generally in a wide class of neutron many-body systems, including the low density nuclei/neutron matter and the medium-mass neutron-rich nuclei containing several weakly bound neutrons. We shall also discuss that the systems with the di-neutron correlation exhibit characteristic modes of excitation. Our analysis is based on the coordinate-space HFB method for the description of the correlated ground state, and the continuum QRPA for the excitations modes. The HFB model predicts that neutron Cooper pairs e.g. in $^{11}$Li, that contains six weakly bound neutrons above the N=50 gap, exhibit strong spatial correlation at short relative distances <2-3fm. The continuum QRPA suggests that the soft dipole excitation in this nucleus is characterized by a motion of the di-neutrons present in the skin region. The soft di-neutron mode appears also in the octupole multipolarity. In order to put these results in a wider context, we look into the superfluid low-density neutron/nucleus. It is thus interesting to study such low excited state in $^{11}$Be, in discussing the change of shell structure and the effect of neutron halo. The experiment was performed at the RIKEN Accelerator Research Facility. Secondary beam of $^{12}$Be was produced and identified using RIPS beam line. The $^{14}$Be was broken up into $^{12}$Be and two neutrons by the carbon target. These decay particles were measured and identified using magnetic spectrometer and neutron detectors. The relative-energy spectrum of $^{14}$Be + 2n system was extracted using invariant-mass method. In the spectrum we found a narrow peak in the unbound region of $^{13}$Be. We also show the angular distribution of this transition in order to determine the spin/parity of the state.
9:00PM DB.00008 Pairing correlations in deformed nuclei close to the neutron drip line, MASAYUKI YAMAGAMI, RIKEN — Study of pairing correlations in nuclei close to the neutron drip line is an extensively investigated subject currently. The presence of loosely-bound neutrons and the coupling to the nearby continuum enhance di-neutron correlations [1]. On the other hand, pairing correlations cause the change of the spatial structure of quasiparticle wave functions, and the correlations among the resultant two-quasiparticle states of low- $\ell$ neutrons lead to the large transition strength of the low-frequency shape oscillations in neutron drip line nuclei [2]. At present, however, these studies are restricted only for spherical nuclei. In my talk, by solving Hartree-Fock-Bogoliubov equation in coordinate space allowing axially symmetric deformation, the pairing effects in deformed neutron drip line nuclei is analyzed paying special attention to neutrons with small $\Omega$, that is the projection of the single-particle angular momentum along the symmetry axis, in connection with the possibility of neutron halos in medium mass and heavier neutron-rich nuclei.


9:15PM DB.00009 Structure of $^{17}_B$ studied by the inelastic scattering on proton, M. SHINOHARA, T. NAKAMURA, Y. SATOU, Y. KONDO, T. SUGIMOTO, N. MATSUI, T. OKUMURA, Y. HASHIMOTO, T. NAKABAYASHI, Tokyo Tech, T. KOBAYASHI, H. OTSU, Y. MatsuDA, N. ENDO, M. KITAYAMA, Tohoku Univ., H. SAKURAI, T. ONISHI, H.J. ONG, Univ. of Tokyo, S. SHIMOURA, M. TAMAKI, CNS, Y. TOGANO, S. KAWAI, Rikkyo Univ., RIPS COLLABORATION — The structure of the neutron-rich isotope $^{17}_B$ has been investigated using the $^{17}_B+p$ inelastic scattering at approximately 60 MeV/nucleon. We focus on extracting the deformation parameters independently for protons and neutrons for $^{17}_B$ by using the transition to the first excited state at 1.07(1) MeV. The phenomenon of different shapes in proton and neutron distributions was suggested for the neighboring nucleus $^{16}_C$. A comparison of the inelastic cross section of the current proton target with the one obtained in the previous $^{17}_B+C$ experiment makes it possible to determine independently proton and neutron deformations. The experiment was performed using the RIPS beam line at RIKEN. A $^{17}_B$ beam delivered from the RIPS bombarded a liquid hydrogen target. The $\gamma$ rays emitted from the first excited state of $^{17}_B$ were detected by forty-eight NaI(Tl) scintillators. We have obtained the cross section and the angular distribution for the transition to the first excited state. We compare the present result with the one with the carbon target.

9:30PM DB.00010 Pairing Energies of the High-Spin Isomers in N=83 Isotones, A. ODAHARA, Nishinippon Inst. of Tech, Japan, Y. GONO, RIKEN, Japan, T. FUKUCHI, Rikkyo Univ, Japan, Y. WAKABAYASHI, Kyushu Univ., CNS, University of Tokyo, H. SAGAWA, Univ. of Aizu, Japan, W. SATULA, Univ. of Warsaw, Poland, W. NAZAREWICZ, Univ. of Tennessee, Oak Ridge Nat. Lab., USA — High-spin isomers in $^{N=83}$ isotones have been systematically studied. Excitation energies of these isomers locate between 8.5 and 9.0 MeV. Their spins and parities are 49/2$^+$ and 27$^+$ for odd and odd-odd nuclei, respectively. Life times range between ~10ns and ~1µs. High-spin isomers have stretch coupled configurations resulting from the breaking of a neutron magic 82 core, such as $[\nu(f_{7/2}h_{9/2})_{1/2}]\pi_{11/2}^2\pi_{9/2}^2$ for odd nuclei and $[\nu(f_{7/2}h_{9/2})_{1/2}^2\pi_{11/2}^2]\pi_{9/2}^2$ for odd-odd nuclei. These high-spin isomers have oblate shapes and are called to be high-spin shape isomers. The proton pairing correlations of high-spin isomers are empirically extracted for the first time by using the excitation energies of these isomers as well as binding energies, based on the odd-even mass difference. The experimental pairing correlations of high-spin isomers are found to be almost the same as those of the ground states in $^{N=83}$ isotones.

Theoretical studies of the excitation energies and the pairing correlations of high-spin isomers are also performed and compared with the experimental data.

Tuesday, September 20, 2005 7:00PM - 10:30PM
Session DC DNP JPS: Mini-symposium on Structure Changes of Asymmetric Nuclear Systems
Ritz-Carlton Hotel Salon 2

7:00PM DC.00001 Properties of Excited States in Exotic Nuclei Probed by Direct Reactions, SUSUMU SHIMOURA, CNS, University of Tokyo — Direct reactions have been commonly used to populate excited states having characteristic quantum numbers depending on the probes such as proton, deuteron, alpha, Coulomb field, and so on. In RI-beam experiments, these probes are prepared as experimental target and excited states of beam or beam-like nucleus are identified by measuring all the decay products including $\gamma$-rays where the invariant masses are reconstructed to determine the excitation energies. It is noted that the Doppler-shift correction of the $\gamma$-ray from the moving nucleus is equivalent to reconstruct the invariant mass of the $\gamma$ and the residual nucleus. The combination of the inverse kinematics and the invariant mass spectroscopy has several advantages to overcome poor energy resolutions, weak intensities and a poor purity of RI beams. One of the advantages in an experimental point of view is that physical probe can be chosen depending on the probes such as proton, deuteron, alpha, Coulomb field, and so on. In our experiment, the large transition strength of the low-frequency shape oscillations in neutron drip line nuclei is reconstructed by using the transition to the first excited state at 1.07(1) MeV. The phenomenon of different shapes in proton and neutron distributions was suggested for the neighboring nucleus $^{16}_C$. A comparison of the inelastic cross section of the current proton target with the one obtained in the previous $^{17}_B+C$ experiment makes it possible to determine independently proton and neutron deformations. The experiment was performed using the RIPS beam line at RIKEN. A $^{17}_B$ beam delivered from the RIPS bombarded a liquid hydrogen target. The $\gamma$ rays emitted from the first excited state of $^{17}_B$ were detected by forty-eight NaI(Tl) scintillators. We have obtained the cross section and the angular distribution for the transition to the first excited state. We compare the present result with the one with the carbon target.

7:30PM DC.00002 Lifetime measurement of $^{12}_Be(2^+)$. NOBUAKI IMAI, Institute of Particle and Nuclear Study, KEK, R324N COLLABORATION — We have measured the lifetime of the first 2$^+$ state of $^{12}_Be$ in flight via the Doppler-shift attenuation method (DSAM). This is the first application of DSAM to the intermediate-energy unstable nucleus beam. The lifetime is inversely proportional to the $B(E2)$ value, which relates to the quadrupole deformation of charge distribution. It was suggested that the magic number of $N=8$ disappeared in $^{12}_Be$. Besides, the large matter deformation was inferred from the proton inelastic scattering. The measurement of $B(E2)$ will provide further understanding of the exotic structure. The detail of the experimental method and the result will be presented.

7:45PM DC.00003 Ground State Wave Function of $^{12}_Be^+$, W.A. PETERS, T. BAUMANN, N. FRANK, J.-L. LECOUYER, A. SCHILLER, M. THOENESSEN, K. YONEDA, MSU/NSCL, P. DEYOUNG, G. PEASLEE, Hope College, J. BROWN, Wabash College, K. JONES, Rutgers University, B. LUTHER, Concordia College, W. ROGERS, Westmont College — Spectroscopic factors are important quantities in establishing the shell structure in nuclei. We measured the spectroscopic factor for the neutron knockout reaction of a $^{12}_Be$ beam into the neutron unbound $d_{5/2}$ state of $^{11}_Be$ using neutron-fragment coincidence measurements. The secondary $^{12}_Be$ beam was produced from a 120 MeV/nucleon $^{16}_O$ beam from the Coupled Cyclotron Facility at the NSCL. The $^{10}_Be$ fragments were detected and identified using the MSU/FSU sweeper magnet while the neutrons were detected by the Modular Neutron Array (MoNA). From the reconstructed invariant mass spectra the relative contributions from different states in $^{11}_Be$ can be extracted.

This work was supported by the National Science Foundation Grant No. PHY-01-10253.
8:00PM DC.00004 Gamma Spectroscopy of $^{13}$B via Proton Transfer Reaction at 50 MeV/nucleon, SHINSUKE OTA, Kyoto University, R337N COLLABORATION — We have investigated proton single particle states in $^{13}$B via a proton transfer reaction on $^{12}$Be at 50 MeV/nucleon. A candidate was found at the excitation energy of 4.8 MeV in $^{13}$B whose spin and parity was deduced to be 1/2$^+$ from a Distorted Wave Born Approximation (DWBA) analysis of the observed angular distribution of the differential cross sections. The experiment was performed in RIKEN Accelerator facility with RIKEN Projectile-fragment Separator (RIPS). A $^{12}$Be beam bombarded a liquid helium target of 120 mg/cm$^2$-thickness. Gamma rays from excited states on $^{13}$B were detected with six Germanium detectors, a part of Gamma-Ray detector Array with Position and Energy sensitivity (GRAPE) located at upstream of the target. The incident and outgoing particles were identified event-by-event by measuring their velocities and energies. In this talk, we report the detail of experiment and data analysis, and discuss about the single-particle nature of the observed state.

8:15PM DC.00005 Measurement of Proton Transfer Reaction for Single-Particle States in $^{23}$F, S. MICHIMASA, N. AOI, H. BABA, M. KUROKAWA, T. MINEMURA, T. MOTOBAYASHI, S. TAKEUCHI, Y. YANAGISAWA, A. YOSHIDA, RIKEN, S. SHIMOURA, M. TAMAKI, S. KUBONO, A. SAITO, CNS, Univ. of Tokyo, H. IWASAKI, H.I. ONG, H. SAKURAI, Univ. of Tokyo, S. OTA, Kyoto Univ., N. IWASA, Tohoku Univ., S. KANNO, K. KURITA, E. TAKESHITA, Rikkyo Univ., M. NOTANI, ANL — We have studied excited states in neutron-rich $^{23}$F using a one-proton transfer reaction onto $^{22}$O at 35 MeV/nucleon. The experiment was performed at RIKEN Accelerator Facility, where an intense RI beam bombarded a liquid helium target in inverse kinematics. Incident and outgoing particles were identified for tagging the secondary reaction channel, and de-excitation $\gamma$ rays from reaction products were detected by an array of 150 NaI(Tl) scintillators (DAL12) surrounding a secondary target in order to identify excited states of reaction products. In addition to the transfer reaction, we could simultaneously measure the inelastic scattering of $^{23}$F at 41.5 MeV/nucleon and the neutron-knockout reaction of $^{24}$F at 36 MeV/nucleon, because the RI beam contained several nuclei around $^{23}$F and induced several reactions which populated excited states in $^{23}$F. We identified proton single-particle states in $^{23}$F by comparing population strengths in the different reactions. In the present talk, we will report details of the experiment and discuss the proton shell structure in neutron-rich $^{23}$F.

8:30PM DC.00006 New Coulomb Excitation Measurement of $^{18}$Ne, KAZUNARI YAMADA, RIKEN, RIKEN-TOHOKU-UNIV.-RIKYO-IPN ORSAY-SAITAMA-UNIV.-TIT-UNIV. OF TOKYO-CNS-KYOTO-UNIV.-ANL-KYUSHU-UNIV COLLABORATION — Reduced transition probability $B(E2; 0^+ \rightarrow 2^+)$ of $^{18}$Ne has been measured by the intermediate-energy Coulomb excitation. The previous work on Coulomb excitation measurement$^1$ reported a $B(E2)$ value that remarkably disagreed with two lifetime measurements$^{2,3}$. The present study is aimed at providing a new Coulomb excitation data with a precise angular distribution to clarify if the discrepancy is accidental or due to the reaction mechanism. A secondary $^{16}$Ne beam at 54 MeV produced by RIPS in RIKEN irradiated a lead target. De-excitation $\gamma$ rays were measured by an array of 68 NaI(Tl) detectors surrounding the lead target in coincidence with the incident beam and scattered particles. The $B(E2)$ value was extracted with the help of DWBA analysis, where the nuclear excitation component was constrained from $B(E2)$ of $^{16}$O, the mirror of $^{18}$Ne, assuming the isospin symmetry.

References

8:45PM DC.00007 Search for the First Excited State of $^{24}$O, N. FRANK, P.G. HANSEN, X.-L. LECOUEY, W.A. PETERS, A. SCHILLER, C. SIMENEL, J.R. TERRY, M. THOENNESSEN, K. YONEDA, NSCL/MSU, P. DEYOUING, NSCL/NSF, J. BROWN, Wabash College, J. HINNEFELD, IUSB, R. HOVES, Marquette University, R.A. KRYGER, Molecular Separation Specialists, B. LUTHER, Concordia College — The location of the first $2^+$ excited state of $^{24}$O is important evidence for the doubly magic nature of this nucleus predicted by shell model calculations. Previous searches for the first excited state of $^{24}$O utilizing in-beam $\gamma$-ray spectroscopy have been unsuccessful indicating that the state is located above the neutron separation energy. We populated states in $^{24}$O by two-proton knockout from a beam of $^{26}$Ne. Neutrons were detected by the Modular Neutron Array MoNa in coincidence with $^{23}$F fragments detected by the MSU/FSU sweeper magnet and detected in a set of charged-particle detectors. The decay energy and thus the location of unbound excited states can be reconstructed from the measured energies and angles of the $^{23}$F fragments and the neutrons.

$^3$This work was supported by the National Science Foundation Grant No. PHY-01-10253

9:00PM DC.00008 Two-neutron knockout reaction to final levels in the $T_z = -2$ nuclei $^{24,25}$Si, and $^{32,34}$Ar, KENICHI YONEDA, P.G. HANSEN, D. BAZIN, B.A. BROWN, C.M. CAMPBELL, J.M. COOK, D.C. DINCA, A. GADE, T. GLASMACHER, T.E. HOAGLAND, J.L. LECOUEY, W.F. MUELLER, H. OLLIVER, B.M. SHERILL, J.R. TERRY, NSCL, Michigan State University, P.G. HANSEN, J.L. LECOUEY, W.F. MUELLER, H. OLLIVER, B.M. SHERILL, J.R. TERRY, NSCL, Michigan State University, P.D. COTTLE, K.W. KEMPER, R. REYNOLDS, B.T. ROEDER, Florida State University, J.A. TOSTEVIN, University of Surrey, UK — Two-proton knockout from a neutron-rich nucleus has recently been shown$^1$ to proceed as a direct reaction. While the inclusive and partial cross sections could be understood in a simple theory, a more precise description can be based on a scheme that combines the full shell-model two-nucleon spectroscopic amplitudes with eikonal reaction theory$^2$. We report here a first attempt to investigate the analogous two-neutron knockout from a proton-rich nucleus at energies around 100 MeV/nucleon. The projectiles $^{20}$Si, $^{30}$Si, and $^{34}$Ar lead to products that have a $2^+$ level as the only bound excited state, and are thus well suited for an accurate test of the theory. The experiment carried out at the NSCL observed this gamma peak in coincidence with the projectile residues in all three cases. The partial cross sections to the $0^+$ and $2^+$ levels will be discussed and compared with theory. This work was supported by NSF grants PHY-0110253, PHY-9875122, PHY-0244453, and PHY-0342281.


9:15PM DC.00009 Study of neutron-rich A∼30 nuclei in multi-nucleon transfer reactions, MATHIS WIEDEKING, Lawrence Berkeley National Laboratory, P. FALLOn, E. RODRIGUE-VIEITEZ, R.M. CLARK, M. CROMAZ, M. DESCOVICH, I-Y. LEE, M-A. DELEPLANQUE, A.O. MACCHIAMELLI, F.S. STEPHENS, D. WARD, Lawrence Berkeley National Laboratory, M.P. CARPENTER, Argonne National Laboratory, D. CLINE, R. TENG, C.Y. WU, University of Rochester — The structure of neutron-rich s-d-f shell nuclei has been investigated through multi-nucleon transfer in the $^{208}$Pb($^{36}$S,$\gamma$) reaction at 230 MeV. Gamma-radiation from the reactions was detected using GAMMASPHERE$^1$. Mass identification of the target-like and projectile-like products as well as an event-by-event Doppler-shift correction was possible by utilizing the excellent spatial and timing resolution of the heavy-ion counter CHICO$^2$. The level schemes of several nuclei are significantly expanded. The measurements are compared to shell-model calculations to test the current understanding and to provide new information on the neutron-proton interaction in neutron-rich s-d-f shell nuclei.

9:30PM DC.000010 Neutron Knockout from $^{30,32}$Mg and $^{26,28}$Ne at Intermediate Energies

J.R. TERRY, B.A. BROWN, C.M. CAMPBELL, J.A. CHURCH, J.M. COOK, A.D. DAVIES, D.C. DINCA, T. GLASMACHER, P.G. HANSEN, H. OLLIVER, B.M. SHERILL, Michigan State University, Natl. Superconducting Cyclotron Lab (NSCL), D. BAZIN, J. ENDERS, A. GADE, J.L. LECOEURY, W.F. MUELLER, K. YONEDA, NSCL, J.A. TOSTEVIN, Univ. of Surrey — The nuclides $^{30,32}$Mg and $^{26,28}$Ne have been studied by single-neutron knockout at the Coupled Cyclotron Facility at Michigan State University. These nuclides span a transitional region between the suspected pronounced sub-shell closure of $N=16$ sub-shell closure and the island of inversion around $^{27}$Na. The aim of this study is to directly observe and quantify the extent of pf intruder configurations in this region. For $^{26}$Ne with 16 neutrons, present results are in good agreement with USD shell model calculations. An upper limit of 0.2 is placed on the $3/2^-$ spectroscopic factor in the residue $^{29}$Ne, in good agreement with the predicted enhanced sub-shell closure at $N=16$. However, for $^{28}$Ne with 18 neutrons, USD calculations predict a strong population of the $3/2^-$ ground state and a single $1/2^-$ excited state is the residue $^{29}$Ne while observation reveals that the $1/2^-$ strength is shared by two states at 765 and 885 keV. For the magnesium isotopes, preliminary results are available for $^{30}$Mg. Beta-decay work for $^{29}$Mg suggests a negative parity assignment for the two levels at 1094.5 and 1430.6 keV, both of which have been populated in the present work. Details of the analysis and further results will be discussed.

9:45PM DC.00011 In beam $\gamma$-ray spectroscopy via $^{32}$Mg($p,\alpha\gamma$)reaction, TOSHIKAI FUKUI, Kyoto University, RARF R373N COLLABORATION — It is well known that $^{32}$Mg nucleus exhibits a disappearance of magic number at $N=20$. While the spin and parity of the first excited state are known, those of the higher excited states have not been determined. In order to investigate level structure of $^{32}$Mg, an alpha inelastic scattering on $^{32}$Mg was performed at RIKEN. The alpha inelastic scattering is a good probe in determining the spin and parity of an excited state because of the selectivity in exciting natural parity states. The alpha beam of $^{32}$Mg at ~42MeV/nucleon bombarded a liquid He target. The ejectile was identified event-by-event with TOF-de-E method. The scattering angle of ejectile was measured by sets of parallel plate avalanche counters. Gamma rays from the ejectile were detected by the 17 position sensitive Ge detector array (GRAPE). Gamma rays from the first and the higher excited states in $^{32}$Mg were clearly observed. Angular distributions of differential cross section are compared with DWBA calculation. We will present the result of the analysis and discuss the collectivity of $^{32}$Mg.

10:00PM DC.00012 In-beam gamma-ray studies of neutron-rich N~20 nuclei in fragmentation reactions.

E. RODRIGUEZ-VIEITEZ, R.M. CLARK, M. CROMAZ, M.A. DELEPLANQUE, M. DESCOVICH, P. FALLON, I.Y. LEE, A.O. MACCHIAVELLI, F.S. STEPHENS, D. WARD, M. WIEDEKING, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, S.G. PRUSSIN, University of California, Berkeley, CA 94720, D. BAZIN, C.M. CAMPBELL, J.M. COOK, D.C. DINCA, A. GADE, T. GLASMACHER, W.F. MUELLER, K. YONEDA, Michigan State University, East Lansing, MI 48824 — Neutron-rich sodium, neon, and fluorine nuclei were produced in a two-step fragmentation/knockout experiment conducted at Michigan State University. A 140 MeV/A 45Ca primary beam bombarded a Be target to produce a “cocktail” of secondary beams ($^{28}$Na/$^{30}$Mg/$^{32}$Al and $^{30}$Mg/$^{32}$Al/$^{34}$Si). The secondary beams underwent fragmentation/knockout reactions on a second Be target located at the center of the Segmented Germanium Array (SegA), which was used to measure the prompt gamma-ray decays tagged to specific fragments detected at the S800 focal plane. New high quality data on a range of nuclei were obtained, e.g. $^{30,31}$Na, $^{28,29,30}$Ne, and $^{25,26}$F. In $^{30}$Na, for example, we observed seven gamma-ray transitions and the statistics allowed us to study the gamma-gamma coincidences. These data will provide new information on the structure of these exotic nuclei and specifically will promote the collective degrees of freedom and the strong n-p spin-isospin interaction.

10:15PM DC.00013 Proton inelastic scattering on $^{34}$Si and $^{32}$Mg.

S. SATOSHI TAKEUCHI, RIKEN, RIKKYO UNIVERSITY COLLABORATION, CNS, UNIVERSITY OF TOKYO COLLABORATION, UNIVERSITY OF TOKYO COLLABORATION, TOKYO INSTITUTE OF TECHNOLOGY COLLABORATION, KEK COLLABORATION — The inelastic scattering of $^{34}$Si and $^{32}$Mg on a liquid hydrogen target was measured in inverse kinematics at energy of about 64 MeV/nucleon. In combination with B(E2) values obtained from Coulomb excitation experiments, information on the collective motions of the protons and neutrons can be studied separately. Experiment was performed at the RIPS beam line in RIKEN. A recently developed time-of-flight spectrometer and a NaI(Tl) array (DALI2) were used for particle identification of scattered particles and for $\gamma$-ray detection, respectively. De-excitation $\gamma$ rays from known $2^+$ states and other higher states are clearly observed in $\gamma$-ray spectra for both nuclei. Deduced (p, p') cross sections from ground state to the $2^+$ states are compared with those of the Coulomb excitation to study the neutron and proton quadrupole matrix elements.

References

Tuesday, September 20, 2005 7:00PM - 10:00PM
Session DD DNP JPS: Mini-symposium on Strongly Interacting Quark Matter
Ritz-Carlton Hotel Salon 1

7:00PM DD.00001 Event anisotropy in high-energy heavy-ion collisions at RHIC.

SHINICHI ESUMI, Inst. of Physics, Univ. of Tsukuba — The high $p_T$ suppression and the baryon/meson scaling of the nuclear modification factor as well as the quark number scaling of the measured elliptic flow parameter at intermediate $p_T$ region are the most exciting findings in high-energy heavy-ion collisions at RHIC. This observation is one of the strongest evidences to support the formation of quark gluon plasma (QGP). The detailed study on event anisotropy and analysis of azimuthal particle correlation especially as a function of $p_T$, centrality, particle species, collision system size and beam energy would enable us to understand the mechanism of the observed scaling behavior. The results of such systematic study will be shown and the possible origin of the elliptic flow will be investigated and discussed.

7:30PM DD.00002 Rapidity Dependence of Pion Elliptic Flow at RHIC.

S.J. SANDERS, E. JOHNSON, U. Kansas, H. ITO, Brookhaven National Lab., BRAHMS COLLABORATION — The measured elliptic flow ($v_2$) of identified particles as a function of $p_T$ and centrality at RHIC suggests the created medium in Au+Au collisions achieves early local thermal equilibrium that is followed by hydrodynamic expansion. These measurements of identified particle $v_2$ have been limited, however, to a narrow region about mid-rapidity. Charged-hadron $v_2$ measurements show a significant reduction at forward pseudorapidities. It is not known if this $\eta$ dependence is a general feature of elliptic flow, or reflects other changes in the particle spectra in going to the forward region. The BRAHMS experiment provides unique capabilities to measure $v_2$ at forward rapidities. Using the BRAHMS multiplicity array to determine the $v_2$ event plane, identified particle elliptic flow can be measured using the BRAHMS spectrometers, with $0 \leq \eta \leq 3.4$. This talk will discuss pion elliptic flow at $\eta = 0, 1.2, 3.4$ from Run 4 Au+Au collisions at $\sqrt{s_{NN}}=200$ GeV. In addition, the $p_T$ integrated flow for charged hadrons obtained using the multiplicity array will be presented. This work was supported by the Office of Nuclear Physics of the U.S. Department of Energy.
The azimuthal anisotropy of electrons from heavy flavor decays in $\sqrt{s_{NN}} = 200$ GeV Au-Au collisions by PHENIX . SHINGO SAKAI, University of Tsukuba, PHENIX COLLABORATION — The azimuthal anisotropy of particle emissions is a powerful tool to study the early stage of ultra-relativistic nuclear collisions. Previous measurements of $v_2$ for hadrons made of light quarks, such as pions and kaons, are consistent with the quark coalescence model, which assumes that hadrons derive their $v_2$ from the quarks that form them. This suggests that the $v_2$ already develops in the partonic phase for hadrons made of light quarks. In addition if the $v_2$ of heavy flavor is non-zero, it would suggest partonic level thermalization and very high density at the early stage of the collisions. In this presentation, we will show the azimuthal anisotropy of heavy flavor by measuring the electron $v_2$ from semi-leptonic charm decays in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in RHIC-RUN4 and compare with several theoretical predictions.

Measurement of single electron azimuthal angular anisotropy $v_2$ from Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV, WEIJJANG DONG, University of California, Los Angeles, STAR COLLABORATION — We present results of $v_2$ measurement for single electrons/positrons covering a pT range from 1.5 to 6 GeV/c. These electrons are mostly from semi-leptonic decays of heavy quark mesons whose pT range covers approximately from 3 to 12 GeV/c. The elliptic flow parameter $v_2$ in this pT range addresses two important physics issues: the hadronization of bulk partonic matter and the energy loss of heavy quarks in the dense medium created in nucleus-nucleus collisions at RHIC. A Constituent Quark Number(CQN) scaling in $v_2$ has been observed in hadrons of light quarks, which has been interpreted as features of hadronization of bulk partonic matter through quark coalescence or recombination. If the heavy quark $v_2$ follows the same CQ scaling as light quarks, it implies that these heavy quarks may have become a part of the bulk partonic matter through dynamic evolution in the medium and its hadronization mechanism is similar to that of light quarks. At pT above the recombination region, the energy loss is one possible dynamics to create azimuthal angular anisotropy. The measurement of $v_2$ for heavy quark mesons will complement the measurement of nuclear modification factor in determining the heavy quark energy loss.

Measurement of Non-photonic Electron Anisotropic Flow in $\sqrt{s_{NN}}=200$ GeV Au-Au Collisions, ANDREW ROSE, Lawrence Berkeley National Laboratory, STAR COLLABORATION — In order to understand the partonic EOS of matter created at RHIC, we need to study both the collective of the produced matter and the degree of thermalization. Anisotropic flow measurements have already demonstrated the development of partonic collectivity at RHIC [1]. The next step is to address the issue of thermalization. Since the masses of the heavy flavor quarks are much larger than the possible excitation of the system created in the collision, their collective motion could be used to indicate the thermalization of light flavors (u-d, s quark hadrons). It has been shown that the information of charm hadron flow can be extracted from their semi-leptonic decay in the region pT > 2GeV/c [2]. In this talk, we report the STAR preliminary results of non-photonic electron $v_2$ from 200GeV Au+Au collisions. The data is from the high statistics run IV at RHIC. Both STAR TPC and the TOF tray were used in the analysis to identify electrons. A systematic comparison of the electron $v_2$ with both hadronic $v_2$ results and theory predictions will be discussed. [1] Phys. Rev. Lett. 86 (2001) 402 [2] X. Dong et al., Phys. Lett. B(2004); Ko et al., Phys. Rev. C(2004)

Heavy Quarkonia in Quark-Gluon Plasma, CHEUK-YIN WONG, Physics Division, Oak Ridge National Laboratory & University of Tennessee, Knoxville, TN — Does the Q-Q potential from lattice gauge data yield a J/$\psi$ dissociation temperature ~1.6 $T_c$, as in lattice spectral function analysis? Is there a strong coupling between a static Q and Q in their color-singlet states in the quark-gluon plasma? From a variational principle, we find the color-singlet Q-Q potential to be $f_{p}^2F_{1}+(1-f_{p})U_{1}$, where $F_{1}$ is the lattice gauge color-singlet free energy, $U_{1}$ the internal energy. $f_{p} = 3/(3+a(T))$, and $a(T)$ is the equation of state. We find that J/$\psi$ dissociates spontaneously above 1.56 $T_c$, while $\chi_c$ and $\psi'$ are unbound in the quark-gluon plasma. Our analysis lends support to the theoretical result that J/$\psi$ is bound up to ~1.6 $T_c$. However, J/$\psi$ has a binding energy ~0.04 GeV at 1.13 $T_c$, indicating that the coupling between a static Q and Q in their color-singlet states is quite weak in the quark-gluon plasma. For details, please browse http://www.arxiv.org/pdf/hep-ph/0408020.

Study of J/$\psi$ at high temperatures in anisotropic lattice QCD, HIDEAKI IIDA, NORIYOSHI ISHII, Tokyo Institute of Technology, HIDEO SUGANUMA, Kyoto University — The high-temperature J/$\psi$ mode above the QCD critical temperature $T_c$ is studied using anisotropic quenched lattice QCD. We aim to clarify whether the J/$\psi$ state above $T_c$ is a localized resonance state or a c-$\bar{c}$ scattering state. We investigate c-$\bar{c}$ modes for 1.1$T_c < T < 2.1T_c$ using the O(aT)-improved Wilson quark action at $\beta = 6.10$ with renormalized anisotropy $a_s/a_t = 4$. To distinguish localized states and scattering states, we calculate the c-$\bar{c}$ correlators on finite lattices with different spatial boundary conditions, i.e., the periodic and the anti-periodic boundary condition. (Note that the c-$\bar{c}$ threshold is raised up in the anti-periodic boundary condition.) As a result, almost no energy difference is found for the lowest J/$\psi$ mode between the periodic and the anti-periodic boundary conditions at for 1.1$T_c < T < 2.1T_c$. This fact indicates that the lowest J/$\psi$ mode can survive as a localized state even above $T_c$ in quenched QCD.

Multiplicity Fluctuations in Au+Au Collisions from PHOBOS, ZHENGWEI CHAI, Brookhaven National Lab, PHOBOS COLLABORATION — We will present the first PHOBOS results on inclusive charged particle multiplicity fluctuations in Au+Au collisions at 200GeV in the pseudo-rapidity range -3.0 to +3.0. Most dynamical models predict characteristic particle correlations, which can be long range and/or short range, leading to non-statistical dynamic fluctuations. The dynamic fluctuations results as a function of mean pseudo-rapidity and the bin size, are compared to model calculations. The measured dynamic fluctuations are expected to provide useful insights into both short-range and long-range effects in the heavy ion collisions.
Combining this with the Gavai, et al., [hep-lat/0412036] definition of the specific heat per particle, a simple relationship is obtained:

\[ c_v / T^3 = \frac{\langle n \rangle}{\langle N_{tot} \rangle} F_{pp} \]

\[ F_{pp} \] is measured with a fraction in the event-by-event average of the total particles produced, a purely geometrical factor representing the fractional acceptance, \( \sim 1/20 \) in PHENIX. The Gavai, et al. prediction that \( c_v / T^3 = 15 \) corresponds to \( F_{pp} \sim 0.35\% \), which may be accessible in PHENIX by measurements of \( M_{pp} \) in the range \( 0.2 \leq p_T \leq 0.6 \) GeV/c.

9:30PM DD.00010 Present and future measurements on hadronization in strongly interacting partonic matter at RHIC and RHIC-II. HELEN CAINES, Yale University, R2D EXPLORATORY WORKING GROUP TEAM

The recent RHIC results establish the necessity for a detailed investigation of the matter formed in heavy-ion collisions at 200 A GeV. In particular, di-jet and gamma-jet measurements with particle identification (PID) out to large momenta are required in order to study experimentally the hadronization process from partonic degrees of freedom and to continue the search for possible evidence of the restoration of chiral symmetry. We will show recent particle identification single hadronic measurements for a future large acceptance \((-3 < \eta < 3, \phi = 2\pi)\) experiment at RHIC-II with hadron, muon and gamma PID capabilities out to 20-30 GeV/c, tracking detectors, and EM and hadronic calorimetry in a large solenoidal magnetic field (1.5 T).

1P. Steinberg et al., nucl-ex/0503002.

9:45PM DD.00011 Direct Photons at RHIC-II. GABOR DAVID, Brookhaven National Laboratory — Starting with a quick survey of the latest direct photon results from RHIC we will attempt to make realistic predictions how the detector and luminosity upgrades of RHIC-II can improve upon our understanding of photon production at all momenta. We will argue that in order to fully understand and disentangle the various mechanisms, constrain free parameters in theories and - very important! - to actually map out the transition from nuclear matter to sQGP the RHIC-II upgrades will be essential in part by making rare probes more accessible but also by opening up the possibility of an expedited species/energy scan.

Tuesday, September 20, 2005 7:00PM - 9:45PM –
Session DE DNP JPS: Mini-symposium on Pentaquarks 1
Ritz-Carlton Hotel Amphitheater

7:00PM DE.00001 Pentaquarks: do they exist or not? KENNETH HICKS1, Ohio University — Pentaquarks, if they exist as narrow resonances, would provide a new testing ground for non-perturbative QCD. After an initial round of positive evidence for a strangeness \( S = +1 \) resonance at about 1535 MeV, called the \( \Theta^+ \), there is a growing body of null results by high-statistics experiments. In addition, constraints from older KN scattering data suggest that the width of the \( \Theta^+ \) resonance must be uncomfortably narrow (<1 MeV) if it has spin 1/2. This has led some people to pronounce the \( \Theta^+ \) to be “dead”. However, the body of evidence is not yet complete. Several new experiments specifically designed to search for the \( \Theta^+ \) in different reaction channels have yet to announce their results. Furthermore, it is possible that the \( \Theta^+ \) could exist with spin 3/2, as suggested by recent lattice gauge calculations, which allows for a more reasonable resonance width. In any case, convincing evidence for the \( \Theta^+ \) is still lacking, and we should be skeptical about its existence at the present time.

2supported by the NSF

7:30PM DE.00002 \( \Theta^+ \) Search with \( \gamma n \rightarrow pK^0 L^- \) at Jefferson Lab. NATHAN BALTZELL, DAVID TEDESCHI, University of South Carolina, CLAS COLLABORATION — Two photoproduction experiments in search of the \( \Theta^+ \) pentaquark have been conducted by the CLAS Collaboration in the last year at Jefferson Lab. Although the one on hydrogen has already reported finding zero evidence, theoretical estimates suggest that photoproduction on the neutron is an order of magnitude more likely. The other experiment by CLAS, with a deuterium target, has analyzed a variety of final states produced off the neutron. This talk will present an analysis in search of the possible reaction \( \gamma n \rightarrow \Theta^+ K^- \), with the pentaquark’s decay to \( pK^0 \). Produced with a tagged photon beam of endpoint energy 3.6 GeV, the \( pK^0 \) final state is completely reconstructed by detecting the \( \pi^+ \pi^- \) decay of the neutral kaon and using missing mass for the proton. With well defined strangeness, no charged meson background, and a fully reconstructed final state, this channel is an important place to look for the \( \Theta^+ \).

7:45PM DE.00003 Search for \( \Theta^+ \) via \( \pi^- p \rightarrow K^- X \) reaction near production threshold. KOJI MIWA, Kyoto University, KFK-PS E522 COLLABORATION — We have searched for \( \Theta^+ \) via \( \pi^- p \rightarrow K^- X \) reaction using 1.87 and 1.92GeV/c \( \pi^- \) beam at the K2 beamline of KFK-PS 12GeV Proton Synchrotron. We irradiated 2.9 \times 10^9 and 3.0 \times 10^9 \pi^- beam to the SCIFI and the polyethylene targets respectively at beam momentum 1.87GeV/c. At 1.92GeV/c, 7.4 \times 10^9 \pi^- beam was attenuated to only polyethylene target. In the missing mass spectrum at beam momentum 1.92GeV/c, a bump was found at 1530MeV/c^2 which is consistent with the mass reported by several experiments. The statistical significance of this bump, however, was only 2.5-2.7\sigma (preliminary). Therefore we derived the upper limit of \( \Theta^+ \) production cross section via \( \pi^- p \rightarrow K^- \Theta^+ \) reaction and obtained 4.1\,\text{nb} (preliminary) at 90% confidence level assuming that \( \Theta^+ \) was produced isotropically in the center of mass system.
8:00PM DE.00004 Search for $\Theta^+$ via $p(K^+, \pi^+)$ reaction at KEK-PS-E559 , TOSHIYUKI TAKAHASHI, KEK, SEISHI DAIKAKU, Kyoto Univ., KEN’ICHI IMAI, Kyoto Univ., KOJI MIWA, Kyoto Univ., TOMOFUMI NAGAE, KEK, DAISUKE NAKAJIMA, Univ. of Tokyo, SIN’YA SAWADA, KEK, MASASHI HAYATA, Kyoto Univ., KEK-PS-E559 COLLABORATION — The E559 aims to investigate the $\Theta^+$ via the $p(K^+, \pi^+)$ reaction using a liquid $H_2$ target and a high resolution spectrometer, SKS, at the KEK-PS K6 beamline. $\Theta^+$ would be identified in the missing mass spectrum with the resolution better than 2 MeV. In order to detect particles decayed from $\Theta^+$ and improve the $S/N$ ratio, a large acceptance range counter system is installed in front of the SKS. The commissioning and data-taking just started this May. In this talk, analysis status as well as experimental purposes and methods will be presented.

8:15PM DE.00005 Photoproduction of Pentaquark on Deuteron Target , TAKAYUKI NAKAMURA, Tokyo Institute of Technology, MAKOTO OKA, Tokyo Institute of Technology — In 2002, discovery of a five quark state (\$\Theta^+$) was reported by LEPS (Laser Electron Photon at SPring-8) Collaboration in Japan. At present, a lot of detailed researches are being done from both sides of theory and experiment all over the world. We study production of $\gamma$ + D $\rightarrow$ $\Lambda + \Theta^+$ reaction. This production process is the lowest energy reaction among two-body to two-body processes. We calculate the differential cross section and the total cross section of the $\gamma + D$ $\rightarrow$ $\Lambda + \Theta^+$ near the threshold energy. We assume that $\Theta^+$ has the mass $m_{\Theta} = 1540 MeV$ and the width $\Gamma = 21 MeV$. The cases of both negative and positive parities are considered, because the parity has not been determined from experiments. The cross sections are estimated in three cases, (1) for unpolarized photon and deuteron, (2) polarized photon and deuteron and (3) polarized photon and deuteron with the helicity of $\Lambda$ particle specified.

8:30PM DE.00006 Phenomenology of spin 3/2 baryons with pentaquarks , TETSUO HYODO, ATSUSHI HOSAKA, Research Center for Nuclear Physics — We examine several assignments of spin and parity for the pentaquark $\Theta^+$ state ($\Omega^+$ = 3$^\mp$, 3$^+_{2^\mp}$) in connection with known baryon resonances. Assuming that the $\Theta^+$ belongs to an antidecuplet representation which mixes with an octet, we calculate the mass spectra of the flavor partners of the $\Theta^+$ based on the SU(3) symmetry. The decay widths of the $\Theta^+$ and nucleon partners are analyzed for the consistency check of the mixing angle obtained from the mass. It is found that a suitable choice of the mixing angle strongly reprodces the observed masses of $\Omega^+(1450)$ and $\Xi_{1/2}$, when their spin and parity are assigned to be $J^p = 3/2^-$, together with other $J^p = 3/2^-$ resonances. The decay widths of $\Theta^+ \rightarrow KN$, $N(1520) \rightarrow \pi N$, and $N(1700) \rightarrow \pi N$ are also reproduced simultaneously.

8:45PM DE.00007 Suppression of $\Theta^+$ ($J^P = 3/2^-$) photoproduction from the proton , SEUNG-IL NAM, RCNP, Osaka Univ., Japan and Dept.of Physics & NuRI, Pusan Natl. Univ., Korea, ATSUSHI HOSAKA, RCNP, Osaka Univ., Japan, HYUN-CHUL KIM, Dept.of Phys. & NuRI, Pusan Natl. Univ., Korea — We investigate the photoproduction of $\Theta^+$ from the proton and neutron, $\gamma N \rightarrow \Theta^+ N$. Assuming that spin and parity of $\Theta^+$ are $J^p = 3/2^-$, it is shown that the production from the proton is strongly suppressed as compared with that from the neutron. This could provide a possible explanation for the null result of the recent CLAS experiment in finding $\Theta^+$ via the reaction $\gamma p \rightarrow \Theta^+ N$.

9:00PM DE.00008 Anisotropic lattice QCD studies of spin 3/2 penta-quark , NORIYOSHI ISHII, Department of Physics H-27, Tokyo Institute of Technology, TAKUMI DOI, RIKEN BNL Research Center, YUKIO NEMOTO, Department of Physics, Nagoya University, MAKOTO OKA, Department of Physics H-27, Tokyo Institute of Technology, HIDEO SUGANUMA, Department of Physics, Kyoto University — Anisotropic lattice QCD results for the penta-quark(SQ) $\Theta^+$ in $J^P = 3/2^-$ channel are presented for a high-precision mass measurement using a large number of gauge configurations as $N_{\text{conf}} = 1000$. The standard Wilson gauge action at $\beta = 5.75$ with the renormalized anisotropy as $a_s/a_t = 4$, and $(a)$ improved Wilson (clover) action with $\kappa = 0.1210(0.0010)1.2140$ are employed on a $12^3 \times 96$ lattice. Several Rarita-Schwinger interpolating fields with isospin $I = 0$ are examined such as (a) the $NK^-$-type, (b) the (color-flused) $NK^+$-type, (c) a diquark-type. The chiral extrapolation leads to only massive states as $m_{\pi} > 2 GeV$. The analysis with the hybrid BC(1BC) is performed to investigate whether these states are compact $\pi Q$ resonances or not. No localized $\pi Q$ resonance states are found.

9:15PM DE.00009 QCD sum rule for spin-3/2 pentaquarks , JUN SUGIYAMA, Tokyo Institute of Technology, TAKUMI DOI, RIKEN BNL Research Center, MAKOTO OKA, Tokyo Institute of Technology — Most QCD-based-approaches, i.e. sum rules and lattice simulations, for pentaquark baryons have been done under the assumption that the pentaquark have spin-1/2. But, the quark model calculations indicate possibility of spin-3/2. Because the $\Theta^+$ with $J^P = 3/2^-$ decays into $D$-wave $N'K$ states, this scenario may explain the narrow decay width of $\Theta^+$. Thus, we study the spin-3/2 pentaquarks using QCD sum rule technique. The spin-3/2 field is treated as a Rarita-Schwinger field. We consider two kinds of the diquark-type interpolating field operators and analyze which one is preferable. We perform parity projection and explore the existence of the pentaquark with $J^P = 3/2^+$ and $J^P = 3/2^-$. We find that $\Theta^+$ both of $3/2^+$ and $3/2^-$ are possible to exist, the $3/2^-$ state comes lower in energy than $3/2^+$ by about 60MeV and their masses are around 1.5GeV, but they depend on the threshold parameters. We will report the results of the other pentaquark baryon.

9:30PM DE.00010 Can the chiral quark soliton model describe the exotic baryon state? , YOICHI OHNISHI, MASASHI WAKAMATSU, Osaka University — We study the internal quark structure of the exotic baryon state $\Theta^+$ on the basis of an effective quark model, i.e. the SU(3) chiral quark soliton model, which has an intimate connection with the SU(3) Skyrme model. The model contains only one parameter, the dynamical quark mass $M$ which plays the role of the coupling constant between the quark fields and the chiral fields, i.e. the (composite) pions. We evaluate the distribution functions of the $\pi^*$-quark as well as the $\pi^*$-quark in the $\Theta^+$ as a function of $M$. It turned out that the distribution of $\pi^*$-quark has no valence-like structure and it is peaked around $x = 0$. On the other hand, the $\pi^*$-quark distribution is found to violate the positivity bound in an intolerable way for the physically reasonable value of $M$ around 350 MeV. The positivity of the $\pi^*$-quark distribution in the $\Theta^+$ is restored only for unrealistically large values of $M$ around 750 MeV, close to the strong coupling limit. This analysis throws a little doubts on the validity of the chiral soliton pictures of the exotic Pentaquark baryons in contrast to the ordinary nonexotic baryons like the octet and decuplet baryons.
7:15PM DF.00002 Study of excited states in nuclei of astrophysical interest via the \((^{3}\text{He},p)\) reaction\(^1\). K. CHIPPERS, L. ERIKSON, U. GREIFE, F. SARAZIN, Colorado School of Mines, Golden, CO, USA, J. BLACKMON, D. BARDAYAN, M. SMITH, Oak Ridge National Laboratory, Oak Ridge, TN, USA, J. PEARSON, TRIUMF, Vancouver, BC, Canada — The \((^{3}\text{He},p)\) reaction may be used to populate excited states in astrophysical interest due to its high Q value. To this end, a \(^{3}\text{He}\) gas cell target has been designed and constructed for use with radioactive ion beams. Simulations were run using GEANT for several different beams, and experiments using \(^{15}\text{O}\) and \(^{18}\text{F}\) beams are in preparation at the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory.

\(^1\)This work was funded by DOE grant DE-FG02-93ER40789.

7:30PM DF.00003 Extracting ANCs in neutron transfer reactions to determine proton capture reaction rates, TARIQ AL-ALBUDULLAH, X. CHEN, C.A. GAGLIARDI, Y.-W. LIU, G. TABACARU, Y. TOKIMOTO, L. TRACHE, R.E. TRIBBLE, Texas A&M University, F. CARSTOUI, Institute of Physics and Nuclear Engineering, Romania — The high temperatures ( \(>10^8\) K) in novae outbursts enable unstable nuclei to leak out from the hot CNO cycle to the rp-process, where heavier nuclei such as \(^{18}\text{F}\) and \(^{22}\text{Ne}\) are synthesized and might be ejected. Their abundances can be influenced by the \(^{17}\text{F}(p,\gamma)\text{Ne}\) and \(^{23}\text{Mg}(p,\gamma)\text{Al}\) reactions respectively. The first reaction connects the CNO and NeNa cycles, while the second may explain the unobserved \(\gamma\)-ray emission from \(^{22}\text{Ne}\) due to the \(\beta\) decay in \(^{22}\text{Na}\). We have applied an indirect technique to determine the above reaction rates at stellar energies. We have measured the neutron transfer reactions \(^{13}\text{C}(\text{\text{O}},\text{\text{O}})\text{C}\) and \(^{13}\text{C}(\text{\text{O}},\text{\text{N}})\text{O}\) to determine the asymptotic normalization coefficients (ANCS) for the ground and first excited states in \(^{16}\text{O}\) and \(^{23}\text{O}\). These ANCs can be transposed to the corresponding states in the mirror nuclei \(^{16}\text{Ne}\) and \(^{23}\text{Al}\) respectively. As a part of these experiments, we have measured the elastic scattering data to obtain the optical model parameters that are used in DWBA calculations, and hence to extract the ANCs.

7:45PM DF.00004 Development of a high-precision method for alpha resonant scattering measurements for nuclear astrophysics, HISASHI FUJIKAWA, CNS, Univ. of Tokyo, S. KUBONO, A. SAITO, G. AMADIO, J.J. HE, H. YAMAGUCHI, CNS, Univ. of Tokyo, Y. WAKABAYASHI, Kyushu Univ. / CNS, Univ. of Tokyo, S. NISHIMURA, RIKEN, L.H. KHIEM, IOP-VAST, H. OHTA, A. OZAWA, M. YAMAGUCHI, T. YASUNO, Univ. of Tsukuba — An experiment was performed for a development on the experimental method to measure heavy ion + \(\alpha\) resonant scattering. This method should be useful for studies of astrophysical \((\alpha,p)\) reaction and \(\alpha\)-cluster structures. The experiment was performed using \(^{16}\text{O}\) beams at 40 and 60 MeV, supplied by a tandem accelerator at Univ. of Tsukuba. The goal of this development is to obtain with high precision the resonant scattering data with the thick target method that use a gaseous helium of a large volume at room temperature. We used a 300-mm helium target at a pressure of 600 Torr to stop the beam fully in the gas. We set the telescope of position sensitive silicon detectors inside the same gas target and the energy and the energy loss of emitted particles in the gas as well as kinematics. The experimental result and the analysis will be discussed.

8:00PM DF.00005 Coulomb Dissociation of \(^{12}\text{N}\) and \(^{18}\text{O}\), TOSHIIYUKI MINEMURA — T. Minemura\(^4\), T. Motobayashi\(^4\), S. Shimoura\(^4\), H. Murakami\(^4\), Y. Ando\(^4\), Y. Yanagisawa\(^4\), Y. Iwata\(^4\), S. Ozawa\(^4\), S. Takeuchi\(^4\), Y. Higurashi\(^4\), K. Yamada\(^5\), T. Gomi\(^5\), M. Serata\(^6\), H. Kobayashi\(^6\), N. Aoki\(^6\), M. Hira\(^6\), H. Iwasaki\(^6\), K. Yoshida\(^6\), N. Iwasa\(^6\), M. Kurokawa\(^6\), H. Akiyoshi\(^6\), Zs. Fülöp\(^6\), H. Sakurai\(^6\), T. Teranishi\(^6\), Z. Liu\(^4\), M. Ishihara\(^4\), KIKEN\(^7\), Department of Physics, Rikkyo University — The Coulomb dissociation technique was employed to determine the radiative width of excited levels in \(^{12}\text{N}\) and \(^{18}\text{O}\), which dominate the low-energy cross sections of the \(^{13}\text{C}(\gamma,\gamma')\text{N}\) and \(^{12}\text{N}(\gamma,\gamma')\text{O}\) reactions. The \(^{12}\text{N}\) and \(^{18}\text{O}\) radioactive beams were produced through transfer and fragmentation reactions of an impurity 135 \text{MeV}/\text{c}\text{\text{O}}\text{O} beam at RIKEN. For the \(^{12}\text{N}\)-dissociation experiment, the radiative width of the 2\(^\text{nd}\) state at \(E_x=1.19\text{ MeV}\) in \(^{12}\text{N}\) was extracted to be \(\Gamma_x=29.0\pm4.1\text{ MeV}\), the accuracy of which has been much improved compared with earlier studies. For \(^{18}\text{O}\), large E1 strength was found for the first time at around \(E_x=2.5\text{ MeV}\). By the present study, the accuracy of the low-energy photo- capture cross sections for \(^{12}\text{C}\) and \(^{16}\text{O}\) have been improved, and reaction rates are now calculable based on more reliable experimental informations.

8:15PM DF.00006 CRIB enhanced with a Wien Filter for Astrophysical studies, H. YAMAGUCHI, A. SAITO, J.J. HE, Y. WAKABAYASHI, G. AMADIO, H. FUJIKAWA, S. KUBONO, N. YAMAZAKI, Center for Nuclear Study, University of Tokyo, T. TERANISHI, Department of Physics, Kyushu University, N. MIKUURA, Center for Nuclear Study, University of Tokyo, Y. YANAGISAWA, S. MICHIMASA, S. NISHIMURA, M. NISHIMURA, RIKEN, Z. FULOP, Z. ELEKES, ATOMKI — CRIB (CNS Radioactive Ion Beam separator) is a facility at which low-energy and pure radioactive ion (RI) beams can be produced by in-flight separation method. Many astrophysical reactions have been studied at CRIB, mainly by the proton elastic resonance scattering method. In the recent few years, we have developed a Wien filter system for CRIB, in order to have a better separation power for the RI beams. The design and structure of the Wien filter, results of beam separation tests using it, and latest applications for nuclear astrophysics will be presented in this talk.

8:30PM DF.00007 Recent results for capture reactions of interest in nuclear astrophysics\(^1\). GERALD M. HALE, Theoretical Division, Los Alamos National Laboratory — We report recent results for the \(^{1}\text{H}(n,\gamma)\text{H}\) and \(^{12}\text{C}(\alpha,\gamma)\text{O}\) capture reactions that are of interest to nucleosynthesis in the Big Bang, and during the Helium Burning phase of red giant stars, respectively. New data for these reactions are being analyzed in R-matrix analyses of the \(^{2}\text{H}\) and \(^{16}\text{O}\) systems that use a new approach to including photon channels in the theory. Results for the E1 part of the \(^{12}\text{C}(\alpha,\gamma)\) reaction are also constrained by measurements of the \(\beta\)-delayed \(\alpha\) spectrum from the decay of \(^{16}\text{N}\). Comparisons with previous results will be made, and uncertainty estimates will be given for both types of capture cross sections.

\(^1\)Work supported by the US DoE

8:45PM DF.00008 Determination of the \(^{12}\text{N}\rightarrow^{11}\text{C}+p\) asymptotic normalization coefficient from the indirect \(^{11}\text{C}(d,n)^{12}\text{N}\) transfer reaction\(^1\). DONGWON LEE, JAMES POWELL, KARI PERAJAVI, FANQING GUO, DENNIS MOLTZ, JIM O’NEIL, JOSEPH CERNY, LAWRENCE BERKELEY NATIONAL LABORATORY TEAM — The \(^{11}\text{C}(d,n)^{12}\text{N}\) reaction has been known to be an important branch point in supermassive low-metallicity stars because it could produce CNO seed nuclei before the traditional triple-alpha process turns on. In the present work, the \(^{11}\text{C}(d,n)^{12}\text{N}\) transfer reaction was employed with a radioactive ion beam of 150 MeV \(^{11}\text{C}\) with \(6\times10^5\) ions/s on target from the BEARS project at the 88” cyclotron at LBNL. Excellent agreement was obtained between the experimental cross sections (\(\theta_{\text{lab}}=10.9°\) to 71.5°) and DWBA calculations. The asymptotic normalization coefficient (ANC) was deduced to be \((C_{\text{eff}})^2 = (C_{p1/2})^2 + (C_{p3/2})^2 = 1.85 \pm 0.27\text{ fm}^{-1}\), which is in good agreement with the published result from \(^{12}\text{N}(^{11}\text{C},^{12}\text{N})\text{C}\). The astrophysical S-factor at zero-energy, \(S(0) = 0.099 \pm 0.020\) keV \(b\), was also calculated based on the extracted ANC value. These results confirm that the \(^{11}\text{C}(d,n)^{12}\text{N}\) reaction occurs at lower temperatures and densities than previously believed.

\(^2\)Supported in part by the US DOE Contract No. DE-AC03-76SF00098.
9:00PM DF.00009 Cross section measurements of the $^{152}\text{Sm}(\gamma,n)^{151}\text{Sm}$ reaction near threshold, KAORU Y. HARA, JNC, H. HARADA, F. KITATANI, Japan Nuclear Cycle Development Institute (JNC), Japan; H. AKIMUNE, S. GOKO, S. HOHARA, T. KAIHORI, A. MAKINAGA, H. UTSUNOMIYA, T. YAMAGATA, Department of Physics, Konan University, Japan; H. TOYOKAWA, K. YAMADA, National Institute of Advanced Industrial Science and Technology (AIST), Japan — Neutron capture cross sections of the unstable nucleus $^{151}\text{Sm}$ ($t_{1/2}=90\text{ yr}$) are the fundamental data for nuclear transmutation and nuclear astrophysics. The $^{151}\text{Sm}$ is one of radioactive fission products in the nuclear waste. In order to determine the $(n,\gamma)$ transmutation rate of this nucleus, the experimental data are desired to be available in the energy range from thermal to MeV. On the other hand, the branching point nucleus $^{152}\text{Sm}$ is important for characterizing the s-process nucleosynthesis in AGB stars. The inverse $^{152}\text{Sm}(\gamma,n)^{151}\text{Sm}$ reaction was measured near threshold at the AIST facility. Beams of quasi-monochromatic photons from laser Compton scattering (LCS) irradiated an enriched $^{152}\text{Sm}$ sample. We present the experimental method with the LCS $\gamma$ beam and photonuclear cross sections for $^{152}\text{Sm}$. The present data will be used to evaluate the capture cross section of $^{151}\text{Sm}$ with the Hauser-Feshbach statistical model.

9:15PM DF.00010 Proposed Measurement of the $^{242}\text{mAm}(n,g)$ cross section using DANCE/LANCE, R.A. MACRI, U. AGVAANLUVSAN, J.A. BECKER, R.R.C. CLEMENT, D. DASHDORJ, K. MOODY, W. PARKER, P. WILK, C. WU, (LLNL), T.A. BREDEMEIER, M.B. CHADWICK, J. DONNELL, R. REIFARTH, R.S. RUNDBERG, J. SCHWANTES, J. ULLMANN, D.J. VIEIRA, J. WILHELMY, J.M. WOUTERS, (LLNL), M. FOWLER, McFarland Instrumentation Services — Radiochemists at LLNL have produced a 98% enriched sample of $^{242}\text{mAm}$ ($t_{1/2}=141$ yr) via $^{241}\text{Am}(n,g)$ in the Hi-Flux reactor at ORNL and subsequent calutron enrichment. The availability of such a rare sample provides a unique opportunity to study properties of $^{242}\text{mAm}$. A proposal has been submitted to use the DANCE array at the LANCSE to measure the $(n,g)$ cross section on the $^{242}\text{mAm}$ isomer. At DANCE, capture cross sections can be measured for neutron energies ranging from thermal to about 100 keV on milligram-size radioactive targets. LLNL and LANL collaborators are currently working to build and install a fission-tagging detector in DANCE. With this extended capability, fission and capture events can be discriminated, leading to a better signal-to-noise ratio for the $(n,g)$ measurement and enabling a simultaneous measurement of the $(n,f)$ cross section. Progress on the implementation of the fission-tagging detector at DANCE and details of the proposed $^{242}\text{mAm}(n,g)$ experiment will be presented. *Work performed under the auspices of the U.S. DOE by the University of California, LLNL, and LANL under contracts W-7405-ENG-48 and W-7405-ENG-36.

9:30PM DF.00011 The neutron capture cross section of $^{151}\text{Sm}$, RENE REIFARTH, Los Alamos National Laboratory, DANCE COLLABORATION — The Detector for Advanced Neutron Capture Experiments (DANCE) is a 160-element 4π barium fluoride array designed to study neutron capture on small quantities of radioactive material. It is located on a 20 meter neutron flight path, which views an “upper tier” water moderator at the Manuel J. Lujan Jr. Neutron Scattering Center at the Los Alamos Neutron Science Center (LANSCE). The first radioactive isotope under investigation was $^{151}\text{Sm}$ with a half-life of 100 years. $^{151}\text{Sm}$ is an important branch point during the slow neutron capture nucleosynthesis. During the talk the detector will be described, and results for the neutron capture cross section on $^{151}\text{Sm}$ between 10 meV and 100 keV will be presented.

9:45PM DF.00012 Studying close proximity nucleons in nuclei via triple-coincidence measurement of the (e,e'pN) reaction, RAN SHNEOR, Tel-Aviv University — This is a proposal to use the (e,e'pN) reaction to study short range nucleon-nucleon correlations (NN SRC) in nuclei. In the context of this proposal we refer to NN SRC as a pre-existing pair of nucleons which have back-to-back high momenta balancing each other. The two existing magnetic spectrometers in Hall A of Jefferson lab (JLab) were used to measure the (e,e') part of the reaction. The measurement required a third spectrometer (BigBite) and an array of scintillator counters, to simultaneously measure neutrons and protons in coincidence with the outgoing high momenta electron and proton. We chose kinematical conditions that will allow us to determine the fraction of (e,e') events which are associated with NN SRC. This was done as a function of the momentum of the proton in the nucleus in the range 250-600 MeV/c. This experiment expands the existing limits to large $Q^2$, $x > 1$ and “exclusiveness” which were not covered by earlier data or other proposals to JLab. The proposal was approved by the program advisory comity at JLab in Jan 2001 as experiment E01-015. Over 5 years were devoted to the design and the assembly of the two dedicated new detectors (BigBite and the neutron array), various tests and calibrations were conducted which were then followed by final commissioning in the experimental hall, during Dec 2004. The experiment took data from Jan to April 2005.

Tuesday, September 20, 2005 7:00PM - 10:00PM –
Session DG DNP JPS: Deformed Nuclei and the Heaviest Elements
Ritz-Carlton Hotel Plantation 2

7:00PM DG.00001 Strongly deformed structures in $^{172,171}\text{Hf}$, W.C. MA, Y. ZHANG, E. NGUJOI-YOGO, D.G. ROUX, J.A. WINGER, R.B. YADAV, Mississippi State Univ., M.P. CARPENTER, R.V.F. JANSENS, T.L. KHOO, F.G. KONDEV, T. LAURITSEN, E.F. MOORE, S. ZHU, Argonne National Lab, D.J. HARTLEY, US Naval Academy, D. CULLEN, S.V. RIGBY, D.T. SCHOLES, Univ. of Manchester, UK, P. CHOWDHURY, Univ. of Massachusetts (Lowell), S. ODEGARD, Univ. of Oslo, Norway, M.K. DJONGOLOV, Univ. of Tennessee (Knoxville) — Three possible strongly deformed (SD) bands in $^{172}\text{Hf}$ and one in $^{171}\text{Hf}$ were identified from our recent Gammasphere experiment at ANL using the $^{48}\text{Ca}(^{128}\text{Te},x\text{n})$ reactions at 209 MeV. Further, the band in $^{171}\text{Hf}$ has been linked to the known normal deformed structures. The spin/parity of levels in this band as well as other properties, such as the alignment and excitation energy, could be determined, and the intrinsic quasiparticle configuration of the band proposed. The wobbling mode, a characteristic motion of triaxial nuclei originally predicted for even-even nuclei, has been established in $^{172}\text{Hf}$ with the characteristic shape of the triaxial deformation.

7:15PM DG.00002 Re-interpretation of the structure of $^{184}\text{Pt}$, R.B. CAIRILU, Yale, Istanbul, E.A. MCCUTCCHAN, R.F. CASTEN, H. AI, Yale, C.R. FITZPATRICK, Yale, Surrey, G. GURDAL, Yale, Clark, A. HEINZ, J. QIAN, R. WINKLER, Yale — The traditional interpretation of the light Pb, Hg and Pt isotopes invokes the concept of proton intruder states from above the Z=82 shell gap. However, recently, a single configuration IBA-1 Hamiltonian was used to test this interpretation of the light Pt isotopes [1]. Without any need for intruder states, these results showed excellent agreement in both energies and B(E2) values. Among these Pt isotopes, $^{184}\text{Pt}$ lacks sufficient data on relative B(E2) values. Therefore, to obtain further information on this nucleus, we carried out a $\beta$-decay experiment at the Yale Moving Tape Collector at WNSL using the $^{172}\text{Lu}(^{160}\text{O},7n)$ reaction at 132MeV. After producing parent $^{184}\text{Au}$, we observed transitions in $^{184}\text{Pt}$ particularly those from low-spin non-yраст states were observed using clover detectors from YRAST Ball. The results of this work will be discussed. This work was supported by US DOE Grant No.DE-FG02-91ER-40609

cross sections. The experimental setup and results will be presented. This work has been supported by the DOE under grant number DE-FG02-91ER-4069 and for the correlation of alpha and gamma decays. A beam monitor detector provided a measurement of the beam current, allowing the determination of production position and time of implant events and subsequent alpha decays were measured and correlated. An array of gamma detectors surrounding the DSSD was used to proportionate the recoil position with a Proportional Grid Avalanche Counter (PGAC) and subsequently implanted in a Double-sided Silicon Strip Detector (DSSD) located at the focal plane of FMA.

Recoiling beam- and target-like nuclei were identified using the position-sensitive detector CHICO, which allowed event-by-event Doppler correction for the recoiling beam in Hf. The presence of both ground-state and isomeric levels was observed and can be associated with intruder 2\textit{p} orbitals. More recent cranking calculations [2,3] predict that these states exist coextensively in neutron-rich Hf nuclei, with the isomeric states giving rise to higher spins. The first nuclear alignment in 180Hf, predicted at \( \hbar \omega \approx 0.35 \text{ MeV} \), was not observed in recent studies up to the \( \hbar \omega \approx 0.43 \text{ MeV} \) limit of these states. The wobbling model, in the context of the predicted alignments and shape changes, allows for a better understanding of the experimental results. The extended level scheme of 180Hf was presented and its implications for intruder structures will be discussed.

Shape transitions in neutron-rich Ru isotopes: spectroscopy of 110,111,112Ru — The spectroscopy of neutron-rich 110,111,112Ru nuclei was studied by measuring the prompt \( \gamma \)-rays from fusion fragments, produced by the \( ^{238}\text{U}(a,f) \) reaction, in coincidence with the detection of both fragments. For 111,112Ru, both the negative-parity (\( h_{11/2} \) orbitals) and positive-parity (\( g_{7/2} \) and/or \( d_{5/2} \) orbitals) bands were extended to substantially higher spin and excitation energy than known previously. The ground-state and \( \gamma \)-vibrational bands of 110,112Ru also were extended to higher spin. This extension allowed observation of the second band crossing at a rotational frequency of \( \approx 450 \text{ keV} \) in 112Ru, which is \( \approx 50 \text{ keV} \) above the first band crossing. At a similar rotational frequency, the first band crossing for the \( h_{11/2} \) band in 111Ru was observed, which is absent in 109Ru. These band crossings most likely are caused by the alignment of the \( g_{9/2} \) proton pair. This early onset of the band crossing for the aligned \( \pi g_{9/2} \) protons may be evidence of a triaxial shape transition from prolate to oblate occurring in 111Ru. The data, together with the comparison of calculations of the cranked shell model, will be presented. Work supported in part by DOE under contracts no. W-7405-ENG-48 (UC-LNL) and DE-AC03-76SF00098 (UC-LBNL). Work at University of Rochester supported by NSF and AFOSR.
effects are expected to be significant in Coulomb breakup processes. Also, we discuss effects of the nuclear interaction on the breakup processes.

As the internal state of the isomer decays to an excited two-quasiparticle or octupole vibrational band. Supp. by USDOE Grant DE-FG02-94ER40848 and W-31-109-ENG-38.

Shapes and triaxiality in neutron-rich odd-mass Y and Nb isotopes. Y.K. LUO, LGNL/Vanderbilt U., J. RASMUSSEN, LGNL, I. STEFANESCU, Katolic U., A. GELBERG, Inst. Kernphysik, J.H. HAMILTON, A.V. RAMAYYA, J.K. HWANG, Vanderbilt U., S.J. ZHU, Tsinghua U., P.M. GORE, D. FONG, E.F. JONES, Vanderbilt U., S.C. WU, Nat. Tsing Hua U., I.Y. LEE, LGNL, T.N. GINTNER, Michigan State U., M.C. MA, Mississippi State U., G.M. TER-AKOPIAN, A.V. DANIEL, FLNR, JINR, M.A. STOYER, LLNL, R.D. DONANGEOLO, U. Fed. Rio de Janeiro — New level schemes of 99,101Y (Z = 39) and 101,105Nb (Z = 41) are established from prompt \( \gamma - \gamma \) coincidences from the fission of 252Cf at Gammasphere. Bands of \( \pi_5^2 \alpha ^2 \gamma ^2 \) are extended to provide information on nuclear shapes in this odd-Z region. With the Tc (Z = 43), Rh (Z = 45) data and neighboring even-Z data, the Y and Nb isotopes are discussed in terms of shape transition and triaxiality. The difference observed in the signature splittings between Y and Tc, Rh isotopes indicates an axially-symmetric deformed shape in the Y isotopes, and, large and near maximum triaxiality in Tc-Rh isotopes. Triaxial-rotor-plus-particle model calculations strongly support a pure axially-symmetric shape with large quadrupole deformation in Y isotopes. The model calculations yielded \( \gamma \) values from -19° to -13° for the 5/2\(^+\) [422] ground-state bands of 101,103,105Nb and -5° for the negative-parity bands in 101,103Nb.

9:30PM DG.00011 In-beam \( \gamma \)-ray spectroscopy of a neutron-rich nucleus of 240U. T. ISHI, M. ASAII, M. MATSUDA, S. ICHIKAWA, Japan Atomic Energy Research Institute, S. SHIGEMATSU, J. KANEKO, T. KOHNO, M. OGAWA, Tokyo Institute of Technology, A. MAKISHIMA, National Defense Medical College, I. HOSSAIN, Seoul National University — We have measured deexcitation \( \gamma \) rays in a neutron-rich nucleus of 240U for the first time. The 240U nuclei were produced by the two-neutron-transfer reaction of a 200-MeV 18O beam with a 238U target at the JAERI tandem booster facility. Outgoing nuclei and \( \gamma \) rays were measured using 4 Si\( \Delta E\)-\( E \) detectors and 7 Ge detectors, respectively, and \( \Delta E-E-\gamma \) coincidence data were recorded. The outgoing nuclei were clearly separated not only by the atomic number but also by the mass number on the \( E-\Delta E \) plots. The \( \gamma \) rays in 240U were identified by taking coincidence with 18O; the excitation energies of 240U were selected below the neutron separation energy by the kinetic energies of 240U. The multipolarities of \( \gamma \) rays in 240U were determined by the in-plane to out-of-plane anisotropies of \( \gamma \) rays. The ground-state band and the \( K^\pi = 0^+ \) octupole band of 240U were established up to 12\(^+\) and 9\(^+\), respectively. The moment of inertia for the ground-state band of 240U is consistent with the systematics of \( \delta_2 \) and \( \delta_4 \) deformations in actinide nuclei. The octupole-band head of 240U is higher than those of 236,238U by about a hundred keV, suggesting that a secondary maximum of octupole correlations exists at \( N = 144 - 146 \) in U isotopes.

9:45PM DG.00012 Alpha-gamma decay studies of 261Rf and 257No. M. ASAII, K. TSUKADA, T. ISHIY, Y. NAGAME, I. NISHINAKA, K. AKIYAMA, A. TOYOSHIMA, S. ICHIKAWA, T. ICHIKAWA, Japan Atomic Energy Research Institute, M. SAKAMA, Univ. of Tokushima, H. HABA, RIKEN, K. SUEKI, Univ. of Tsukuba, M. SHIBATA, Nagoya Univ., Y. KOJIMA, Hiroshima Univ., Y. OURA, Tokyo Metropolitan Univ. — Alpha-gamma and alpha-electron coincidence measurements were performed for the \( \alpha \) decay of 261Rf and 257No to establish Nilsson single-particle states in odd-mass superheavy nuclei. The neutron single-particle configuration of 3/2\(^+\)[222] has been assigned to the ground state of 257No as well as to the 124.1 keV level in 252Fm. It was found that the ground state configuration of 257No is different from that of lighter states. The g factor of 255Fs and 257Cf. Measured excitation energy in 257No populated by the \( \alpha \) decay of 261Rf (T1/2 = 67 s) revealed that another \( \alpha \)-decaying state in 260Rf with T1/2 = 4.2 s reported in the \( \alpha \)-decay chain of 257Fm is not the ground state but an isomeric state. The ground state configuration of 261Rf is discussed on the basis of the \( \alpha \)-\( \gamma \) coincidence results.

Tuesday, September 20, 2005 7:00PM - 10:00PM – Session DH DNP JPS: Nuclear Reactions: Rare Ion Beams Ritz-Carlton Hotel Plantation 1

7:00PM DH.00001 Structure of exotic isotope \(^9\)C via resonance elastic scattering. G. ROCHEV, Department of Physics, Florida State University, Tallahassee, FL 32306, JAMES KOLATA, LARRY LAMM, Department of Physics, University of Notre Dame, In 46556, FREDERICK BECHTETI, YOU CHEN, DONALD ROBERTS, Department of Physics, University of Michigan, Ann Arbor, MI 48109, PAUL DEYOUNG, Department of Physics and Engineering, Hope College, Holland, MI 49422, JERRY HINNEFELD, Department of Physics, Indiana University—So. Bend, South Bend, IN 46934 — Light exotic nuclei provide important insights into the understanding of nuclear forces at large neutron to proton ratios. The progress in development of modern theoretical approaches such as quantum Monte-Carlo calculations (QMC) and no-core shell model (NCSM) allows for predictions of properties of light nuclei (\( A \leq 12 \)) from the basic principles. Unfortunately, experimental information on the structure of many light exotic isotopes is very incomplete making it difficult to judge the accuracy of the \( ab \) \textit{initio} models in case of large excess of neutrons or protons. The focus of this experimental study is the structure of neutron-deficient carbon isotope \(^9\)C. Only one excited state was known in this nucleus. Excited states in \(^9\)C were populated in resonance elastic scattering of protons on \(^8\)B using method of inverse kinematics and very thick target. The analysis was made using combined R-matrix - Continuum Shell Model approach. The structure of \(^9\)C will be discussed and comparison with the predictions of modern theoretical models will be made.

7:15PM DH.00002 CDCC analysis of breakup reactions of \(^{11}\)Be on \(^{208}\)Pb. TAKUMA MATSUMOTO, RIKEN, KAZUYUKI OGATA, Kyushu University, MASAHIRO YAIYHO, Kyushu University, YASUNORI ISERI, Chiba-Keizai College, TOMOAKI EGAMI, Kyushu University — \(^{11}\)Be is a typical example of one-neutron halo nuclei, where the valence neutron has a large spatial extension with respect to the core nucleus. In the present work, we analyze breakup reactions of \(^{11}\)Be on \(^{208}\)Pb at energies around 70 MeV/nucleon with the method of continuum-discretized coupled-channels (CDCC). As the internal state of \(^{11}\)Be, we take \( s\)-, \( p\)-wave states including the ground \( 1/2^+\) state and the first excited \( 1/2^-\) state and breakup continuum states. In the CDCC calculation, effects of the Coulomb excitation to the first excited \( 1/2^-\) state on the breakup cross section is investigated. The effects are expected to be significant in Coulomb breakup processes. Also, we discuss effects of the nuclear interaction on the breakup processes.
7:30PM DH.00003 ¹⁰C inelastic scattering studied with microscopic coupled-channels method.
Masaaki Takashina, Riken, Yoshiko Kanada-Enyo, YITP, Kyoto University, Yukinori Sakuragi, Osaka City University — In order to test the ¹⁰C internal wave function, we perform microscopic coupled-channels (MCC) calculations of the ¹⁰C(⁰⁺, ²⁺) inelastic scattering by ²⁰⁸Pb target at E/λ=52.7 MeV using the antisymmetrized molecular dynamics (AMD) wave functions of ¹⁰C, and compare the calculated differential cross sections with the measured ones. The MCC calculations with AMD wave functions reproduce the experimental data fairly well, although they slightly underestimate the magnitude of the cross sections. The absolute magnitude of calculated differential cross sections is found to be sensitive to the neutron excitation strength. We prove that the MCC method is a useful tool to connect the inelastic scattering data with the internal wave functions.

7:45PM DH.00004 Isoscalar monopole and dipole responses in ¹⁴O.
Hidetada Baba, RIPS R311N Collaboration — Isoscalar monopole and dipole responses in unstable nucleus ¹⁴O with broad excitation energy range have been studied by inelastic α scattering at 60°A MeV in inverse kinematics. The experiment was performed at the RIKEN Accelerator Research Facility. The ¹⁴O beam was produced by using the projectile fragmentation reaction and selected by the RIKEN Projectile Fragment Separator (RIPS). A radioactive ¹⁴O beam was incident on a liquid-helium target. The excitation energy spectra were obtained from invariant-mass of each decay channel of ¹⁰⁴O→ ¹⁰⁰N+p, ¹⁰⁰C+p+p, ¹⁰⁰C+α, ¹⁰⁰C+ α, ¹⁰⁰C+ α. The isoscalar monopole and dipole strength distributions were deduced by the multipole decomposition analysis with the DWBA calculations. For measured decay channels, the integrated isoscalar monopole and dipole strengths up to Eα = 25 MeV were identified corresponding to about half of the full energy-weighted sum rule. In addition to the fragmented strength distributions as seen in light stable nuclei, substantial continuum strength below 10 MeV for the isoscalar monopole and dipole responses were newly observed.

8:00PM DH.00005 Single Particle Strengths from the (d,p) Reaction on ¹⁸F.
R.L. Kozub, Tenn. Technological U., D.W. Bardayan, J.C. Blackmon, C.J. Gross, C.D. Nesara, J.P. Scott, D. Shapira, M.S. Smith, Oak Ridge National Lab., J.C. Batchelder, UNIRIB, C.R. Brune, Ohio U., A.E. Champagne, UNC-Chapel Hill, L. Sahin, Dulumpur U., J.A. Cizewski, J.S. Thomas, Rutgers, U. Greife, C.C. Jewett, R.J. Livesay, Col. Sch. Mines, Z. Ma, B.H. Moazen, UT-Knoxville — The ¹⁸F nucleus has been studied extensively. However, there have previously been no direct measurements of ¹⁸F+n single-particle components in ¹⁸F, and no measure of neutron vacancies in the ¹⁸F ground state, as such experiments require a (radioactive) ¹⁸F target or beam. We have used the ¹²H(¹⁸F,p)¹⁹F reaction to selectively populate such states in ¹⁹F. The 108.5-MeV radioactive ¹⁸F+p+α beam was provided by the HRIBF at ORNL. Proton-recoil coincidence data were taken for both α-decaying and particle-stable final states. Angular distributions and spectroscopic factors were measured for eight proton groups, corresponding to 12 states in ¹⁹F. The results will be compared to model calculations. Results for states of astrophysical significance were reported earlier.

8:15PM DH.00006 α-Cluster States in ¹⁸O.
Simon Brown, Grigory Rogachev, Bert Green, Kirby Kemper, Alexander Momotyuk, Brian Roeder, Oregon State University, College Station, TX 77843 — α-clustering is a remarkable phenomenon, which plays a very important role in our understanding of physics of unstable ¹⁸O. The α-cluster structures of N=Z nuclei ¹²C, ¹⁶O and ¹⁹Ne has been extensively studied. It was the observation of α-cluster of rotational bands in these nuclei that inspired the development of theoretical models capable of treating clustering phenomena in nuclei. Much less is known, however, about the alpha cluster structure in N≠Z nuclei. It was recently shown in studies [1,2] that α-cluster states can be observed in ¹⁹Ne, with unusual findings such as the doubling of α-cluster rotational bands. The focus of this discussion will be the alpha cluster structure of the ¹⁸O nucleus. The α cluster states in ¹⁸O were populated via elastic scattering of radioactive beam ¹⁴C (from the Florida State Tandem-LINAC facility) on α-particles using the Thick Target Inverse Kinematics technique [3]. Features of ¹⁴C+α molecular rotational bands will be considered.

8:30PM DH.00007 Search for high-spin isomers using radioactive-isotope ¹⁷N beam.
Y. Wakahayashi, T. Teranishi, Kyushu Univ., A. Oadhara, Nishihara Institute of Technology, T. Fukuuchi, S. Kubono, H. Yamauchi, A. Saitoh, H. Fujikawa, G. Amadio, J.I. He, E. Ideguchi, S. Shimoura, H. Baba, CNS, Tokyo Univ., Y. Gono, S. Nishimura, M. Nishimura, S. Michimasa, T. Kishida, Riken, S. Ota, Kyoto Univ., J.Y. Moon, Chung-Ang Univ., T. Ishii, JAERI — High spin isomers are known in ¹⁷N=52 isotones systematically. These isomers are considered to be shape isomers caused by sudden shape changes from near spherical to oblate shapes. In order to search for high-spin isomers in other mass regions, we selected ¹⁷N=51 isotones which have one neutron outside a magic 50 core and proton numbers close to semi-magic 40 core. High spin isomers of ¹⁷N=51 isotones can be expected, which have similar mechanism to those of ¹⁷N=53 isotones. An experiment for isomer search in ¹⁷N=51 isotones was performed using a ¹⁷N secondary beam produced by the low-energy radioisotope beam separator (CRIB) of the Center for Nuclear Study(CNS),University of Tokyo. A ¹⁷Be primary target of 2.3 mg/cm² was bombarded by an ¹⁰⁸O⁺⁺ primary beam of 126 MeV to obtain a ¹⁷N beam of 104 MeV. A ²²Se secondary target of 4.9 mg/cm² was placed at a final focal plane. Two clover Ge detectors were set to measure γ-rays emitted from nuclei produced by the secondary fusion reaction. In this experiment, some γ-rays from nuclei, such as ¹⁰⁶Nb, produced by the ²²Se⁺⁺¹⁷N reaction were observed. In this talk, I will report the result.

8:45PM DH.00008 Search for particle-bound ²⁰O and ²⁸F in p-stripping.
Andreas Schiller, Thomas Baumann, Janet Dietrich, Steffen Kaiser, William Peters, Michael Thoennessen, National Superconducting Cyclotron Laboratory, Michigan State University — We have searched for particle-bound ²⁰O and ²⁸F isotopes in the reaction products of secondary ²⁷F and ²⁹Ne beams, respectively. No events have been observed. Upper limits for the respective production cross sections by one-p-stripping reactions are established under the assumption that ²⁰O and ²⁸F are particle bound. Since the experimental upper limits are much lower than common estimates we conclude that neither ²⁰O nor ²⁸F are likely particle bound.

¹ Perm. addr. TU Dresden, Germany
² Perm. addr. TU Dresden, Germany
9:00PM DH.00009 Measurement of Transfer Reactions on Z=50 Fission Fragments in Inverse Kinematics, S.D. PAIN, Rutgers University, D.W. BARADAYAN, J.C. BLACKMON, ORNL, J.A. CIZEWSKI, Rutgers University, M.S. JOHNSON, ORAU, K.L. JONES, Rutgers University, R.L. KOZUE, Tennessee Tech, R.J. LIVESAY, Colorado School of Mines, B.H. MOAZEN, C.D. NESARAJA, University of Tennessee, M.S. SMITH, ORNL, J.S. THOMAS, Rutgers University — The development of high quality radioactive beams, such as those at the HRIBF at Oak Ridge National Laboratory, has made possible the performance of transfer reactions in inverse kinematics on unstable nuclei. Measurement of (d,p) reactions on neutron-rich nuclei yield data on the development of nuclear structure away from stability, and are of astrophysical interest due to the proximity to suggested r-process paths. Experimentally, (d,p) reactions on heavy (Z=50) fission fragments are complicated by the strongly inverse kinematics, and the relatively low beam intensities. Consequently, projectile detection with high resolution in position and energy, a high dynamic range and a high solid angular coverage is required. A proof of principle experiment has been performed on $^{124}\text{Sn}$ (d,p) in inverse kinematics [1] demonstrating successfully the technique, and the first experiments using radioactive beams ($^{130,132}\text{Sn}(d,p)$) are due to be performed in 2005. The Oak Ridge Rutgers University Barrel Array (ORRUBA), a Si detector array with a high solid angular coverage around 90°, is currently under development to facilitate future measurements. 1. K.L. Jones et al., Phys. Rev. C 70 067602 (2004)

9:15PM DH.00010 Recent Results from Target Development for RIB – Refractory Elements, H.K. CARTER, A. KRONENBERG, E.H. SPEJEWSKI, Oak Ridge Associated Universities, D.W. STRACENER, Oak Ridge National Laboratory — Development of ion beams of short-lived isotopes is crucial for modern nuclear structure and nuclear astrophysics. The Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory uses the ISOL (Isotope Separator Online) technique to provide radioactive ion beams. So far, refractory elements are not accessible with this technique. The code HSC-5 [1], with an extensive thermochemical database predicts possible chemical sidebands which may be transported within the target ion source. We are working on the release of Vanadium, Zirconium, and Molybdenum isotopes in molecular form for example as oxides, fluorides, chlorides, sulfides. A number of new targets have been fabricated and tested for use and recent results from off-line and on-line tests will be presented. This research was sponsored by the NNSA under Stewardship Science Academic Alliance program through DOE Cooperative Agreement # DE-FC03-3NA00143. [1] HSC Chemistry for Windows – Chemical Reaction and Equilibrium Software with extensive Thermochemical Database, Outokumpu Research Oy, Pori, Finland

9:30PM DH.00011 LISE++ development: Abrasion – Fission, OLEG TARASOV, NSCL / MSU — The fission of $^{238}\text{U}$ is induced by both electromagnetic and nuclear processes. At large impact parameters and for high-Z targets, the long-range Coulomb force prevails (Coulomb fission). For smaller impact parameters, peripheral nuclear collisions take place and the fission projectile is left abraded and excited (Abrasion-Fission). After de-excitation by nucleon emission, it can undergo fission with a finite probability. Coulomb Fission and Abrasion-Fission are both included in the production cross section calculations in the latest version of the LIS++ code (www.nscl.msu.edu/lise). Abrasion-Fission is significantly more difficult to model since there are more than 100 fissile nuclei produced after the initial abrasiion stage of the fast heavy projectile (there is only one fissile nucleus in the case of Coulomb fission). To overcome this problem, the Lise code models the Abrasion-Fission fragment production with three excitation energy regions. Post-scission nucleon emission is the final stage. Use of the Lissuf method to define the number of post-scission nucleons is a big advantage of the LIS++ code that allows one to observe shell effects in the TKE distribution, and enables the user to make a rapid mass estimate of the final fission fragment yield. Another advantage of the code is the speed of its calculations. Kinematic models of the fission process are used to perform the fragment transmission calculations and estimate the fragment rates at the end of spectrometer.

9:45PM DH.00012 Production of Neutron-Rich Isotopes from UC Targets for RIB Development, E.H. SPEJEWSKI, H.K. CARTER, A. KRONENBERG, Oak Ridge Associated Universities, D.W. STRACENER, J.-C. BILHEUX, Oak Ridge National Laboratory, A.L. GADDIS, W.H. BRANTLEY, Furman University, J.A. NOLEN, JR., A.C.C. VILLARI, J.P. GREENE, T.A. BURTSEVA, Argonne National Laboratory, W.L. TALBERT, TechSource, Inc. — The Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory (ORNL) provides radioactive beams for research in nuclear physics. An essential function is to produce a variety of radioactive species to meet the intensity, energy, and purity requirements of specific experiments. A primary production method has been proton-induced fission of uranium. The principal targets employed have been $^{235,238}\text{U}$, which is of rock-salt type. The results from such high-temperature actinide compounds may be of interest for research on space reactor (nuclear thermal propulsion) design, as well as spent fuel storage. This research was sponsored by the NNSA under Stewardship Science Academic Alliance program through DOE Cooperative Agreement # DE-FC03-3NA00143.

Tuesday, September 20, 2005 7:00PM - 10:00PM – Session DJ DNP JPS: Instrumentation II Ritz-Carlton Hotel Hawaii

7:00PM DJ.00001 New Actinide Targets for Rare Isotope Beam Generation, ANDREAS KRONENBERG, H.K. CARTER, E.H. SPEJEWSKI, Oak Ridge Associated Universities, Oak Ridge, TN 37831, D.W. STRACENER, Oak Ridge National Laboratory, Oak Ridge, TN, 37831, B. CHAN, P. DORHOUT, Colorado State University, Fort Collins, CO 80523 — Development of high-quality ion beams of short-lived isotopes is crucial for modern nuclear structure and nuclear astrophysics. The talk will focus on the development of targets for the production and release of neutron-rich isotopes, which are produced via fission of actinides. So far, only uranium carbide is widely used as a target, which has been produced and tested in various geometries with densities between 0.6 g/cm$^3$ and 6.0 g/cm$^3$. New compounds, such as thorium oxide, uranium boride ($\text{UB}_2$, $\text{UB}_3$, and $\text{UB}_{12}$) will be discussed and recent results presented. Thorium has a higher fission yield for certain isotopes in the mass region A=90 to 90 and the borides are of interest for a better understanding of the release process after the nuclear reaction. A comparison can be made between the release efficiency of $\text{UB}_2$, which has an alloy-type structure, and $\text{UB}_{12}$, which is of rock-salt type. The results from such high-temperature actinide compounds may be of interest for research on space reactor (nuclear thermal propulsion) design, as well as spent fuel storage. This research was sponsored by the NNSA under Stewardship Science Academic Alliance program through DOE Cooperative Agreement # DE-FC03-3NA00143.

7:15PM DJ.00002 Secondary Beam Lines in the Hadron Hall at J-PARC, HIROYUKI NOUMI, KEIZO AGARI, ERINA HIROSE, MASAHARU IEIRI, JUN IMAZATO, YOHI KATOH, MICHIHUMI MINAKAWA, YOSHINORI SHINTO, SHINWA MASAUDA, YOSHIHIRO SUZUKI, HITOSHI TAKAHASHI, TOSHIYUKI TAKASAKI, MINORU TAKASAKI, KAZUHIRO TANAKA, AKIHIRO TOYODA, YOSHIKAZU YAMADA, YUTAKA YAMANOI, HIROAKI WATANABE, High Energy Accelerator Research Organization (KEK), HADRON BEAM LINE GROUP TEAM — A beam-line facility for nuclear and particle physics experiments, Hadron Hall, is being constructed at J-PARC in Tokai, Japan. A high-power proton beam of 750 kW from the 50-GeV Proton Synchrotron will be extracted to the Hadron Hall. High-intensity secondary kaons, pions, anti-protons, etc will be produced by irradiating a target with the primary proton beam. Huge amount of power deposit at the target will arise very high radiation and heated environment. Thus, beam-line equipments around the target must be resistant against high radiation dose and heat deposit. Since only a target, T1, will be placed in the Hadron Hall at the beginning, some secondary beam lines are designed to share T1 in order that various experiments can be carried out efficiently. Unique layout and performances of the secondary beam lines and relevant R&D works will be presented.
7:30PM DJ.00003 Precision Photon Flux Determination for the Jefferson Lab PrimEx Experiment  
ARAM TEBYURAYAN, University of Kentucky, PRIMEX COLLABORATION — The Hall B Jefferson Lab PrimEx Collaboration is using tagged photons to perform a 1.5% level measurement of the absolute cross section for the photoproduction of neutral pions in the Coulomb field of a nucleus. Such a high precision pushes the limits of the photon tagging technique in regards to the determination of the absolute photon flux. The Collaboration has taken a multifaceted approach to this problem which has included measuring the absolute tagging ratios with a total absorption counter as well and relative tagging ratios with a pair spectrometer. In addition the PrimEx experimental setup, with its new state of the art hybrid calorimeter (HyCal), provides a unique opportunity to cross check the flux normalization procedure by measuring cross sections for well known electromagnetic processes. Data were collected during the Fall 2004 PrimEx run, and analysis is currently underway. Results of these investigations will be presented.

7:45PM DJ.00004 High resolution Lambda hypernuclear spectroscopy by electron beam at Jlab  
AKIHKO MATSUMURA, Tohoku University, E01-011 COLLABORATION — Hypernuclear spectroscopy has been extensively studied with meson beam. The high quality primary electron beam at Jefferson Lab. makes it possible to perform hypernuclear spectroscopy with much better mass resolution than with meson beam. The improved mass resolution will provide detailed information about hypernuclear structure. Lambda-N interaction and so on. However, the hypernuclear study through (e,e'K+) reaction was thought difficult due to huge background electrons from bremsstrahlung and small cross section. In E01-011, the scattered electron spectrometer was vertically tilted by about 8 degrees to avoid electrons from Bremsstrahlung Miller scattering. They have very forward angular distribution and improve signal to noise ratio. Since total singles rate at detection plane decreases by a factor of 10^4, we can use 50 times higher intensity beam(30 uA) and 5 times thicker targets(100mg/cm^2) than the previous (e,e'K+) experiment. Furthermore, a large acceptance and high resolution kaon spectrometer is used. The angular distribution and improve signal to noise ratio. Since total singles rate at detection plane decreases by a factor of 10^4, we can use 50 times higher intensity beam(30 uA) and 5 times thicker targets(100mg/cm^2) than the previous (e,e'K+) experiment. Furthermore, a large acceptance and high resolution kaon spectrometer is used. The energy resolution will be improved to be 400 keV (FWHM). Data taking starts from June to August 2005 with C, B and Si targets. I report the overall design of the experiment and preliminary analysis status.

8:00PM DJ.00005 Acceleration of polarized proton in the AGS with multiple partial Siberian snakes  
JUNPEI TAKANO, RIKEN / BNL / Titech, LEIF AHRENS, MEI BAI, KEVIN BROWN, ERNEST COURANT, CHRISTOPHER GARDNER, JOSEPH GLENN, C-A Dept., BNL, TOSHIYUKI HATTORI, Titech, HAIXIN HUANG, FANGLEI LIN, ALFREDO LUCCIO, WILLIAM MACKAY, C-A Dept., BNL, MASAHIRO OKAMURA, RIKEN, VADIM PITYANS, THOMAS ROGER, STEVEN TEPKIAN, NICHOLAOS TSOUPAS, C-A Dept., BNL, RIKEN TEAM, C-A Dept., BNL TEAM, TITECH TEAM — The polarized proton has been accelerated in Alternating Gradient Synchrotron (AGS) and Relative Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL) for studying the spin physics of proton. The normal conducting helical dipole partial Siberian snake (Warm Snake) and the super conducting helical dipole partial Siberian snake (Cold Snake) have been installed in the AGS for overcoming the imperfection and intrinsic depolarizing resonances. The cold snake had been under commissioning in RUN5, but the polarization of the polarized proton in the AGS was improved with the warm snake only. The AGS also has a previously used solenoid partial snake. We will show a new idea of using three snakes for perfectly canceling the spin mismatch and some calculated results of spin tune with these three snakes.

8:15PM DJ.00006 Preparation of Self-supporting targets of 11B and 13C  
YOSHIKO SASAMOTO, TAKAHIRO KAWABATA, Center for Nuclear Study, University of Tokyo, ISAO SUGAI, YASUHIRO TAKEDA, High Energy Accelerator Research Organization — Alpha inelastic scattering measurements are planned in order to examine cluster structures in ^11B and ^13C. For precise measurements, self-supporting and high-quality targets with a thickness of ~500 µg/cm^2 must be prepared. The vapor deposition is widely used to make thin carbon and boron films, but it is difficult to prepare self-supporting films thick enough by this method. Pressing method is also effective for preparation of high-purity films, but the films prepared by this method are too thick for ^13C. We have developed a vapor deposition method for preparing the polarized proton solid target specialized for RI beam experiments. The target makes use of spontaneous electron alignment in photo-excited aromatic molecule, while ordinary polarized targets are based on Boltzmann polarization in high magnetic field. Reducing the magnetic field needed for polarization, our technique makes it possible to detect low energy recoiled protons in the scattering experiments under inverse kinematics condition. In this talk, recent progress and present situation of the target are reported. A radioactive beam experiment using this target is planned on J-PARC in June 2005. In this experiment, we measure the vector analyzing power of the elastic scattering of ^12C and polarized proton. Results obtained in this experiment will be reported as well.

8:30PM DJ.00007 Polarized proton solid target for ^2+^4He elastic scattering experiment  
SATOSHI SAKAGUCHI, TAKASHI WAKUI, TOMOHIRO UESAKA, CN University of Tokyo, HIDEYUKI SAKAI, CN University of Tokyo; University of Tokyo, R388 COLLABORATION — Recently, structures of unstable nuclei have been actively studied with radioactive nuclear beams. However, measurement of spin polarization observables has not been possible in the research of unstable nuclei, because of the lack of polarized probe which is applicable for RI beam experiments. To overcome the situation, our group have fabricated polarized proton solid target specialized for RI beam experiments. The target makes use of spontaneous electron alignment in photo-excited aromatic molecule, while ordinary polarized targets are based on Boltzmann polarization in high magnetic field. Reducing the magnetic field needed for polarization, our technique makes it possible to detect low energy recoiled protons in the scattering experiments under inverse kinematics condition. In this talk, recent progress and present situation of the target are reported. A radioactive beam experiment using this target is planned on J-PARC in June 2005. In this experiment, we measure the vector analyzing power of the elastic scattering of ^12C and polarized proton. Results obtained in this experiment will be reported as well.

8:45PM DJ.00008 Study of an electron beam deflection with channeling in silicon crystals  
SHINYA SAWADA, High Energy Accelerator Research Organization (KEK), ICTHITA ENDO, MASATARKA INUMA, Graduate School of Advanced Sciences of Matter, Hiroshima University, HIROTOSHI KUROIWA, TAKEHIRO OHNISHI, Venture Business Laboratory, Hiroshima University, SERGEY STROKEV, TOHRU TAKASHI, KIETAROU UEDA, Graduate School of Advanced Sciences of Matter, Hiroshima University — Crystal channeling is a promising way to defocus high energy particles. As the basis for future applications of crystal channeling for a beam-handling system, such as a beam-splitting system at J-PARC and a collimator at a thermal beam line, a Si crystal was irradiated using a high energy electron beam at Hiroshima University. The deflection of the electron beam at Hiroshima University was incident on a silicon crystal (16 µm). The profile of the beam after passing through the crystal was measured by an image intensifier at 2.34-m downstream of the crystal. If channeling occurs, the profile will change along the width of the crystal changes. In this talk, results of the experiments are presented, as well as a companion with a simulation and future prospects.

9:00PM DJ.00009 Higher-order calculations on a fragment separator layout for RIA  
M. HAUSMANN, A.M. AMTHOR, B.M. SHERRILL, A. ZELLER, NSCL, Michigan State University, East Lansing, MI 48824 — The planned Rare Isotope Accelerator (RIA) will provide unprecedented quantities of rare isotopes for basic science and potential applications. A key part of the RIA concept is a large acceptance fragment separator that is intended to efficiently collect and separate the exotic nuclides of interest. A preliminary baseline design of the pre-separator stage has been developed using the ion optical codes GRAPHIC TRANSPORT (by U. Rohrer based on a CERN-SLAC-FERMILAB version by K. L. Brown et al.) and GICO (H. Wollnik et al., AIP Conf. Proc. 177(1988)74), where the latter is used also to optimize higher order corrections. In the present layout all relevant aberrations up to 3rd order are corrected at the pre-separator image plane and most of them also at the central intermediate image. Provisions are included for a beam dump system located slightly downstream of the first dipole magnet at an image location where the beam can be separated from the fragments of interest. Investigations of the preliminary layout with the Monte Carlo code MOCADI (N. Iwasa et al. NIM B126(1997)284) indicate a transmission of about 60% for ^134Sn generated by induced fission of ^238U. We will compare different ion optical solutions and present the status of our work. In the future we intend to further optimize the layout to extend the calculations beyond 3rd order, and to verify the results using alternative codes, e.g. COSY INFINITY (K. Makino, M. Berz, NIM A427(1999)338).
9:15PM DJ.00010 Design and operation of a DANCE/LANSCE fission-tagging detector. R.R.C. CLEMENT, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, M. FOWLER, Sunner Associates, Santa Fe, New Mexico 87501, USA, J.A. BECKER, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, T.A. BREDEWEG, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA, R.A. MACRI, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, D.J. VIEIRA, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA, C.Y. WU, A. AGVAANLUVSAN, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, M. CHADWICK, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA, K. MOODY, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, J. O’DONNELL, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA, W. PARKER, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, R. REIFARTH, R.S. RUNDBERG, J. SCHWANTES, J. ULLMANN, J. WILHELMY, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA, P. WILK, Lawrence Livermore National Laboratory, Livermore, California 94550, USA, J.M. WOUTERS, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA, J. YURKON, National Superconducting Cyclotron Laboratory, East Lansing, Michigan 48824, USA, LAWRENCE LIVERMORE NATIONAL LABORATORY, LIVERMORE, CALIFORNIA 94550, USA TEAM, SUMNER ASSOCIATES, SANTA FE, NEW MEXICO 87501, USA TEAM, LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO 87545, USA TEAM, NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY, EAST LANSING, MICHIGAN 48824, USA TEAM — The 4π BaF2 Detector for Advanced Neutron Capture Experiments (DANCE) at Los Alamos Neutron Science Center (LANSE) was designed and built to measure neutron capture cross sections, X(n,γ), for small, sub-milligram, radioactive samples. The DANCE beam-line at the Lujan Center provides neutrons from thermal to about one hundred keV permitting X(n,γ) measurements over a large energy range. One difficulty in the neutron capture measurement on actinides is the contribution of the fission component X(n,f) to the measured gamma-ray spectrum. The solution to this dilemma is the addition of a fission-tag to the event. The fission-tagging detector is a cylindrical ppc (parallel plate avalanche counter) collocated with the fissionable sample. The response of the detector to fission fragment pairs would provide the necessary event information to separate the (n,γ) and (n,f) reactions. A detailed description of the design and operation of the gas-handling system will be presented, together with details of the design and operation of the fission-tagging detector. Work performed under the auspices of the U.S. DoE by the University of California, LosAlamos National Laboratory (W-7405-ENG-36), Lawrence Livermore National Laboratory (W-7405-ENg-48) and the U.S. NSF by the National Superconducting Cyclotron Laboratory (PHY-0110253). Work benefited from use of Los Alamos Neutron Science Center (W-7405-ENG-36).

9:30PM DJ.00011 Performance of the PbWO₄ Hybrid Electromagnetic Calorimeter at Jefferson Laboratory. MARVIN PAYEN, North Carolina A&T State University, PRIMEX COLLABORATION — The goal of the PrimEx experiment at Jefferson Lab is to perform a high precision measurement of the π⁺ lifetime via the Primakoff effect. The initial data-taking phase has recently been completed. A new electromagnetic hybrid calorimeter (HYCAL) consisting of 1152 lead tungstate (PbWO₄) crystals and 576 lead (Pb) glass Cherenkov modules was designed and constructed by the collaboration to conduct the lifetime measurement with a precision of 1.5%. This novel electromagnetic calorimeter has high resolution, acceptance, and efficiency; characteristics that are required for the detection of the π⁺ decay photons. The HYCAL has been tested with photon beams in the few GeV energy range. Results for the energy and position resolutions for both PbWO₄ and Pb-glass, including the transitions region, will be presented. This project is supported under NSF MRI grant PHY-0679640.

9:45PM DJ.00012 Liquid Hydrogen Target Cooled by Liquid Helium for Pentaquark Experiment. SHIGERUISHIMOTO, KEK-IPNS, KENICHIIMA, Kyoto Univ., KIMIORIMOMOTO, KEK-IPNS, DAISUKE NAKAJIMA, Tokyo Univ., SHOJISUZUKI, KEK-IPNS, NOBUJATANAKA, KEK-IPNS, KEK-PS-E559 COLLABORATION — A liquid hydrogen target for the pentaquark experiment (KEK-PS, E559) has been successfully developed at KEK 12 GeV PS (proton synchrotron). The target sizes are 67.8 mm diameter and 110 mm length. The hydrogen vessel was made from PET (Polyethylene Terephthalate) for the cylinder and Mylar for end caps. The inner material PET t=0.3 mm was obtained from a commercial PET bottle for drinking water. The hydrogen target was cooled by a heat exchanger and continuous flow of cold helium gas from liquid helium container. The cooling time from room temperature to full of liquid hydrogen at 20 K was about 3 hrs. The consumption of liquid helium was 1.3−2.0 l/hr during stable operation. In the preparation stage, the hydrogen pressure was stabilized at 110.9 ± 0.07 kPa for more than 10 hrs. The measured target temperature was 21.06 ± 0.015 K., then the fluctuation of hydrogen density was obtained as ± 2.3 × 10⁻⁴.

Tuesday, September 20, 2005 7:00PM - 10:00PM — Theme: Electroweak Interactions Ritz-Carlton Hotel Maui

7:00PM DK.00001 A Polarized ³He Neutron Spin Filter for n + p → d + γ¹. TIM CHUPP, University of Michigan FOCUS CENTER, NDGAMMA COLLABORATION — The n + p → d + γ¹ experiment uses a puls cold neutron beam to measure λ⁺, the parity-violating correlation of neutron spin and the direction of gamma-ray emission upon capture of polarized neutrons by protons. A large area polarized ³He neutron spin filter has been constructed and used for measurements on the FP12 beam line at the Los Alamos Neutron Scattering Center. The spin filter consists of rotating cylindrical targets, 9.5 cm (out) × 12.5 cm inside diameter, which covers most of the available neuton beam area. The cells, made at NIST, use boron free, alumina-silicate glass (GE-180) and are filled with about 1 atmosphere (at room temp.) of ³He, natural rubidium and N₂. Two broadband, 30 W laser diode arrays coupled to optical fibers irradiate the cell and polarize rubidium vapor. Polarization is transferred to ³He nuclei though spin-exchange collisions. The transmission of neutrons through the spin filter is used to measure the neutron polarization, and the ³He polarization is extracted from the wavelength dependence. Continuous ³He polarization greater than 50% (± 2%) has been maintained over the course of several weeks. A ³He analyzer cell, polarized off-line can be positioned down stream from the experiment to monitor neutron polarization and spin flipping. Cell construction, polarizer design, performance, and polarimetry will be described in this talk.

7:15PM DK.00002 Dressed Helium Comagnetometry for the Neutron EDM Experiment. A. ESLER, J.C. PENG, University of Illinois at Urbana-Champaign, S.K. LAMOREAUX, C.Y. LIU, J. TORGERSON, Los Alamos National Laboratory, NEUTRON EDM COLLABORATION — The electric dipole moment (EDM) of the neutron provides a unique window into CP-violating processes in the light-quark baryon sector. A new experiment with ultracold neutrons aims to measure the neutron EDM with a sensitivity of 10⁻²⁷ e·cm. The experiment will use a novel direct comagnetometry technique with polarized ³He “dressed” by a RF magnetic field, to match its effective magnetic moment to that of the neutron. This method allows a sensitive measurement of the neutron precession rate relative to the ³He. We have studied the dressed ³He spin system experimentally using a polarized ³He source at Los Alamos. Results of this first measurement of spin dressing effects on the ³He magnetic moment will be presented.

7:30PM DK.00003 A New Ultracold Neutron Source for Fundamental Physics. YASUHIRO MASUDA, IPNS, KEK — Ultracold neutrons (UCN) can be used for various kinds of fundamental physics, for example neutron EDM, neutron beta decay, gravity, neutron capture of RI beams and n-bar oscillation. In these experiments, UCN density is the most important parameter. New generation UCN sources are being developed in many institutes in the world. We are developing a spallation UCN production in superfluid helium (He-II) [1]. In the mini-symposium, we will discuss the present status and future possibilities of the He-II spallation UCN source.

7:45PM DK.00004 Analysis of Ultracold Neutron Depolarization Studies, Y.-P. XU, H.O. BACK, A.T. HOLLEY, R.W. PATTIE, A.R. YOUNG, NCSU, J.-H. YUAN, Caltech, P. GELTENBORT, ILL, M. MAKELA, A. SAUNDERS, LANL, A. PICHLMAIER, PSI, R.R. MAMMEI, M. PITT, R. VOGELAAR, Virginia Tech, UCNA COLLABORATION — Studies of ultracold neutron (UCN) transport and depolarization provide important support data for experiments such as the UCNA experiment at LANSCE. The UCNA experiment’s goal is to make an absolute measurement of the beta-asymmetry for neutron decay using UCN, a measurement which requires essentially 100% polarized UCN. We present progress on the analysis of several experiments conducted at ILL which have measured the depolarization rate for UCN on guides with diamond-like carbon (DLC) coatings. These experiments provide a consistent picture of depolarization rates expected for these coatings on non-magnetic substrates, and indicate that DLC coatings will be more than adequate for the UCNA project’s first planned measurements.

8:00PM DK.00005 Solid State Ultra-Cold Neutron Detectors, SETH HOEYL, University of Washington, ADAM HOLLEY, North Carolina State University, ALEJANDRO GARCIA, University of Washington, PETER GELTENBORT, Institut Laue-Langevin, DAN MEL-CION, University of Washington, ANNE SALLASKA, University of Washington, SKY SJUE, University of Washington, ALBERT YOUNG, North Carolina State University, UCNA COLLABORATION — The reflective properties of Ultra-Cold Neutrons (UCN) enable easy transport and bottling, but, make neutron detection a technical challenge. Typically, UCN are allowed to accelerate in the Earth’s gravitational field to sufficient velocity to penetrate an aluminum entrance window of a 3He proportional counter. Here we describe the construction and characterization of the ILL at two kinds of prototype solid-state detectors which can be used to monitor the UCN density inside the UCNA spectrometer without gravitational acceleration, and perhaps more critically, without the danger of 3He leaks. The first type consists of 300 μg/cm² of LIF (natural isotopic abundance) evaporated on ~1 μm thick nickel foils. The second type consists of ~10¹⁸ ¹⁰B ions implanted in a 2000A thick vanadium layer, also evaporated onto nickel foils. We find that both types have a lower critical velocity than aluminum, and, therefore, aluminum window proportional counters for in-situ density measurements.

8:15PM DK.00006 The UCN Source at LANSC, M. MAKELA, T. BOWLES, R. HILL, G. HOGAN, S. LAMOREAUX, C. MORRIS, A. SAUNDERS, LANL, T. KAWAI, U of Kyoto, B. FILIPPONE, B. PLASTER, J. YUAN, Caltech, P. GELTENBORT, ILL, K. SOYAMA, Japan Atomic Energy Agency, A. Nakayama, Los Alamos, ANNE SALLASKA, University of Washington, SKY SJUE, University of Washington, AMO HU, A. GARCIA, L. SUEZ, A. SEREBROV, PNP, T. KITAGAKI, Tohoku U, A. GARCIA, S. HOEDEL, A. SALLASKA, S. SJUE, U. of Washington, T.M. ITO, UTK, R.B. VOGELAAR, R.R. MAMMEI, M. PITT, Virginia Tech — A new source of ultra-cold neutrons (UCN), using a solid deuterium moderator has been built at the Los Alamos Neutron Science Center (LANSCE). Closely based on a prototype that was tested at Los Alamos, the new source supplies two UCN beam lines: one for the UCNA experiment and the other for development of the Los Alamos UCN EDM experiment and a neutron lifetime experiment. The LANSCE 800 MeV proton beam creates spallation neutrons from a tungsten target. The spallation neutrons are cooled with a cold polyethylene moderator. These cold neutrons then interact with solid deuterium and become UCN. This talk will present a summary of the current source design, UCN production capabilities, and some aspects of UCN delivery to planned experiments.

8:30PM DK.00007 Performance Characteristics of A Low-Background Front-End Electronics Package for Germanium Spectrometers, TODD HOSSBACH, CRAIG AALSETH, Pacific Northwest National Laboratory, MAJORANA COLLABORATION — The Majorana project is a next-generation ⁷⁶Ge neutrinoless double-beta decay search, using 57 isotopically enriched segmented germanium crystals mounted in each of 8 modular cryostats. This configuration provides physical granularity which should reject most expected backgrounds. To achieve greater effective granularity, a method of radial pulse-shape analysis is planned. Maximum PSD efficiency is achieved with low-noise electronics and a minimal signal bandwidth of ~25 MHz. Pacific Northwest National Laboratory has developed a fourth generation Low-Background Front-End Electronics Package (LFEP-4) using carefully selected and screened low-background components. The performance characteristics of the LFEP-4, namely bandwidth, noise, and energy resolution, have been quantified and compared with conventional HPGe front-end electronics. To meet the requirements of the Majorana experiment, a fifth-generation LFEP has been designed with lower power dissipation and increased signal bandwidth, while maintaining a minimal footprint. Details of the LFEP-5 design and anticipated performance are presented.

8:45PM DK.00008 Search for WIMPs Dark Matter by means of segmented NaI(Tl) scintillator, KEN-ICHI FUSHIMI, HIDEYUKI KAWASUSO, MASAKO TOI, ERIKO AIHARA, RENA HAYAMI, KENSUKE YASUDA, ERIKA MATSUMOTO, SHINTARO NAKAYAMA, NORIHIKO KOORI, Facul. of Integrated Arts and Sciences, The University of Tokushima, KAYOKO ICHIHARA, SAORI UMEHARA, FYUTA HAZAMA, SEI YOSHIDA, MASAHARU NOMACHI, Dept. of Physics, Osaka University — Searching for WIMPs dark matter with highly segmented NaI(Tl) scintillator array is proposed. The sensitivity was estimated by means of Monte Carlo simulation and it was found that the detector array had high sensitivity for not only spin-dependent interaction (EX) but also spin-independent (SI) interaction. The performance of the prototype thin NaI(Tl) plate scintillator with the thickness of 0.05cm and wide area of 5cmX5cm will be presented in this meeting. It has shown the excellent energy resolution of 21%(FWHM) at 60keV gamma ray and the low energy threshold of a few keV.

9:00PM DK.00009 Pulse Shape Discrimination for HPGe Detectors in Search for Dark Matter, DONGMING MEI, ANDREW HIME, STEVE ELLIOTT, Los Alamos National Laboratory — In the detection of WIMP-induced nuclear recoil with a high-purity germanium detector, the main recoil signal is electron recoil produced by natural and cosmogenic radioactivity. The capability of discriminating a nuclear recoil from an electron recoil is crucial to reduce the background and to reach good sensitivity for the detection of WIMPs. Digital pulse shape analysis is an encouraging approach to the discrimination of nuclear recoils from electron recoils. The sensitivity of pulse shape is essentially governed by two effects: (1) the drift time of the charge carriers that move along the electric field lines towards the corresponding electrode; (2) the density of electron-hole pairs along the track. The high density of charge carriers along the ionization track forms a plasma-like cloud of charge that shields the interior from the influence of the electric field and eventually results in a longer drift time. Both effects govern the pulse rise time associated with charge collection. Nuclear recoils induced by neutrons in a segmented Ge detector lead to a study of pulse rise time differences between these two classes of events and we provide a preliminary result on the potential of this technique.

9:15PM DK.00010 Polarized ³He ion source, SEPIIS based on the spin-exchange collisions, MASAYOSHI TANAKA, Kobe Tokio College, YUTAKA TAKAHASHI, KEIJI TAKAHASHI, MASARU YOSOY, SHIGEHIRO YASUDA, RCPN, Osaka-u.ac.jp, YASUHUMI KOMENO, CHIKA INABA, TADASHI SHIMODA, HIDEAKI IZUMI, TAKESHI FURUKAWA, Dept. of Physics, Osaka University — Over the decade we have developed the polarized ³He ion source for spin physics research at intermediate energy regions. Though we started constructing an OPPIS polarized ³He ion source at first, we failed in obtaining a highly polarized ³He beam contrary to the great success in the proton OPPIS. Next, we proposed and checked the validity of an “electron pumping” polarized ³He ion source, EPPIS. Though the EPPIS decisively demonstrated its usefulness, the further development is currently suspended because of practical difficulty associated with a budget. To overcome this we proposed a SEPIIS polarized ion source based on the enhanced spin-exchange cross sections between alkali atoms and an incident ³He ion at extremely low energies less than 1 keV, which is expected by the theoretical calculation allowing the quasi-molecule formation. An advantage of SEPIIS relative to EPPIS is that no pumping laser with a high intensity, and a high magnetic field to keep the polarization are required. The construction of bench-test device for the SEPIIS will soon be in completion. We hope to present not only the present status of the construction of SEPIIS but also the first preliminary result on the SEPIIS performance in this joint meeting.
9:30PM DK.00011 Development of a Polarized $^{6}$Li$^{3+}$ Ion Source at RCNP, A. TAMII, K. HATANAKA, K. FUJITA, H. MATSUBARA, S. MORINOBU, S. NINOMIYA, Y. SAKEMI, Y. SHIMIZU, Y. TAMESHIGE, RCNP Osaka Univ., T. UESAKA, T. WAKUI, CNS Univ. of Tokyo, H. OKAMURA, CYRIC Tohoku Univ., T. WAKASA, Dep. of Phys. Kyushu Univ., T. NAKAGAWA, RIKEN — Nuclear spin-isospin excitations show rich features in various nuclei. One of key points to study such excitations is to use a selective probe for the reactions relevant to the physics of interest.

Our plan is to develop a new polarized $^{6}$Li$^{3+}$ ion source for producing $^{6}$Li$^{3+}$ beams at 100 MeV/U at the Research Center for Nuclear Physics (RCNP). Polarized $^{6}$Li atoms are produced by the optical pumping method. The atoms are injected into an 18GHz ECR ionizer for producing $^{3+}$ ions, directory or after being stripped of an electron by using a surface ionizer. Several depolarization processes should be cared, such as the ones due to inhomogeneous magnetic field, ECR effect in the RF field, excitation and de-excitation processes of ions, etc. We will report on the design of the ion source and recent results of feasibility tests.

9:45PM DK.00012 Development of a high efficiency neutron detector array at HRIBF, S.N. LIDDICK, UNIRIB, K. RYKACZEWSKI, R. LILLIE, M.J. SALTMARSH, ORNL, J. BATCHELDER, UNIRIB, S. ILYUSHKHIN, J.A. WINGER, Mississippi State — A new high-efficiency neutron detector array will be introduced at the HRIBF to complement existing experimental equipment for the beta decay studies of neutron-rich fragment nuclei. The neutron detector array will consist of 2 foot long $^{3}$He tubes at 10 atmosphere surrounding by a polyethylene moderator. With an expected efficiency of $\sim$70% the array will greatly aid in the determination of absolute beta-delayed neutron branching ratios when combined with the “ranging-out” of postaccelerated radioactive ion beams [1]. Geant4 [2] and MCNP calculations have been performed to simulate the efficiency of the array in a variety of geometries and results were compared to efficiencies of existing neutron detectors. Simulation results will be presented. Work supported by DOE grants DE-AC05-00OR22725, DE-AC05-76OR00033 and DE-FG02-96ER41006.

References

Wednesday, September 21, 2005 9:00AM - 12:00PM —
Session EA DNP JPS: Applications of Nuclear Science Ritz-Carlton Hotel Salon 4

9:00AM EA.00001 Recent Progress in Muon Science; Fusion Energy and Industrial Homeland -Security Application, KANETADA NAGAMINE — (1) Recently, unexpected phenomenon were discovered in muon catalyzed fusion experiment on D-T mixture: i) Anomalous $\mu$ regeneration from the stuck ($\mu^{+}$) after the $\mu$CF in condensed D-T mixture suggesting an enhanced regeneration and reduced muon sticking in high-T condensed D-T; ii) Sensitive dependence of (d$\mu$F) molecular formation on the ortho/para state controlled D$_{2}$ suggesting an enhanced (d$\mu$F) formation in D-T mixture. Now, a clear future is seen for a realization of break-even. (2) By using the detection system of the near-horizontal cosmic-ray muon radiography originally developed for probing volcanic mountains, measurements were conducted to probe the inner structure of a blast furnace. The thickness of the brickwork was measured, yielding a crucial information for predicting the lifetime of the furnace. By extending muon radiography method using a compact accelerator system, a quick and element-selective detection of hidden special nuclear materials will be possible.

9:45AM EA.00002 Failures in Semiconductor Devices from Cosmic-Rays Induced Neutrons, S.A. WENDER, Los Alamos National Laboratory — Neutron-induced failures in semiconductor devices are an increasing concern in the semiconductor industry. Understanding these failures involve several areas of nuclear science. Neutrons are produced in the upper atmosphere by cosmic-ray bombardment of nuclei in the air. Because the neutrons are uncharged, they have long mean-free paths and can reach aircraft altitudes and below. Neutron interactions in semiconductor devices produce ionized recoils or reaction products that deposit charge in the vicinity of nodes and cause the devices to fail. The types of failures include bit flips, latchups and burnout. Predicting the failure rate depends on knowing the neutron flux in the environment of the semiconductor device and the response of the device to neutrons. Many companies have measured the system response at an accelerated rate by using the high-energy Los Alamos Neutron Science Center (LANSCE) spallation neutron source. The LANSCE source produces a neutron spectrum that is very similar in shape to the neutron spectrum produced by cosmic-rays in the earth’s atmosphere but is approximately $10^{4}$ times more intense than the sea-level neutron flux. This acceleration factor allows testing of semiconductor devices to measure their response and development and testing of failure models and approaches to mitigation.

10:30AM EA.00003 Particle Therapy with use of Accelerators, FUMINORI SOGA, National Institute of Radiological Sciences — In many countries, cancer is the largest fraction of mortality and outcome of this disease is one of the most important subjects in health of mankind. Nowadays, medical application of nuclear physics has been developed in many branches. Among these, the cancer treatment with use of particle accelerator is the most prominent development. There are two streams in charged particle therapy, either proton or heavy ion therapies. In many institutions, medical treatments on charged particle therapy are ongoing, and in addition new facilities for medically dedicated accelerator are under construction. In my presentation, starting from principles of methodology in this science and technology for medical application, the overview on present status of their activities and research works for advancement toward future will be described.

11:15AM EA.00004 Detection of well-shielded special nuclear material in cargo containers via active neutron interrogation, JENNIFER CHURCH, Lawrence Livermore National Laboratory — Approximately 6 million cargo containers arrive at U.S. seaports annually, carrying up to 30 tons of non-homogenous cargo each. Highly enriched uranium (HEU) and other special nuclear material concealed inside these containers is difficult to detect with existing portal monitors. This is due in part to the attenuation of low energy $\gamma$-rays in the cargo. A new system is currently being developed to reduce the likelihood of false-negative and false-positive detections of fissile material in the cargo, without slowing the flow of commerce through the port. The technique utilizes a neutron beam to induce fission, and a wall of plastic scintillators to detect subsequent delayed high-energy $\gamma$-rays after $\beta$-decay of the fission products [1]. The delayed $\gamma$-rays above 3 MeV are highly penetrating and have energies above natural background radiation. Because half-lives of most of the fission products are less than 160 seconds, decay curves over 100 second intervals become an efficient diagnostic. Previously, experiments using 14 MeV neutrons with HEU hidden in wood and steel have shown the $^{16}$O(n,$p$)$^{16}$N reaction to be a significant interference due to 6 MeV $\gamma$-rays produced from the decay of $^{16}$N. New experimental work using a 3-7 MeV broad spectrum neutron beam will be presented and compared to simulations and past experimental results. This work is performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory contract No. W-7405-Eng-4.

Wednesday, September 21, 2005 9:00AM - 11:45AM —
Session EB DNP JPS: Mini-symposium on Relativistic Heavy Ions, Recombination Ritz-Carlton Hotel Salon 3
9:00AM EB.00001 Quark Recombination at RHIC . CHIHO NONAKA, Duke University — Recently the recombination of thermalized valence quarks has proposed as the dominant mechanism for the production of hadrons at intermediate transverse momentum (2-4 GeV/c) in relativistic heavy ion collisions. A lot of evidence that suggests the quark recombination has been found in the RHIC data, such as hadron spectra, ratios of hadron production, nuclear modification factors and elliptic flow as a function of transverse momentum. Especially the quark number scaling in elliptic flow strongly shows the validity of dominance of the recombination mechanism in hadronization. Furthermore the more detailed argument about physical observables at RHIC (correlated emission of hadrons, event-by-event fluctuations, hadronization time, entropy problem) has been done from the point of view of the quark recombination. I will discuss the recent progress of the quark recombination at RHIC.

9:30AM EB.00002 Fluctuations and Correlations in Parton Recombination . STEFFEN BASS, CHIHO NONAKA, Duke University, RAINER FRIES, University of Minnesota, MASAYUKI ASAKAWA, Osaka University, BERNDT MUELLER, Duke University — Parton recombination models have been very successful in explaining data taken at RHIC on hadron spectra, nuclear modification factors and elliptic flow emission patterns in Au+Au collisions at transverse momenta above 2 GeV/c, which have exhibited features which could not be understood in the framework of basic perturbative QCD. Recently, however, more sophisticated dynamical correlation observables, such as jet-like two particle correlations have become available. I will show how these observables can be addressed by the recombination approach through incorporating two-particle correlations into the quark distributions which are used as initial condition for the calculation. In addition, I will discuss entropy-conservation and charge fluctuations in the recombination approach. Finally, I will investigate the possible effect realistic light-cone wave-functions including higher Fock-states may have on the well-known elliptic flow valence-quark number scaling law.

9:45AM EB.00003 Results of Identified pions, kaons, (anti-)protons in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV from STAR . HAIDONG LIU, STAR COLLABORATION — Ultra-relativistic Au+Au collisions at RHIC create a hot and dense medium that exhibits novel properties. Study of these properties and hadronization mechanisms of the medium requires identified particle results over wide transverse momentum ($p_T$) range. In this talk, we will present the results of pions, kaons and (anti-)protons $p_T$ spectra in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV using the STAR detector at RHIC. The particle identification is achieved by a combination of the Time-Of-Flight (TOF) and the Time Projection Chamber (TPC) detectors. The $p_T$ range is measured up to 12 GeV/c for pions, 3 GeV/c for kaons and 6 GeV for (anti-)protons. The particle ratios and the nuclear modification factors ($R_{AA}$ and $R_{CP}$) will be presented. The physics indications of these measurements will be discussed.

10:00AM EB.00004 Baryon/meson Effects in Hot and Cold Nuclear Matter . JULIA VELKOVSKA, Vanderbilt, PHENIX COLLABORATION — A number of exciting phenomena have been observed at intermediate-$p_T$ (2 - 5 GeV/c) in heavy ion collisions at RHIC: enhanced proton/pion ratios, particle species dependent yield suppression factors, and quark-number scaling of elliptic flow. Quark-recombination models have been invoked to explain the data, but alternate mechanisms such as baryon junctions and strong radial flow have also been proposed. Particle species dependencies are also seen in the Cronin enhancement measured at RHIC and at lower energies. Measurements involving heavy mesons are necessary to distinguish mass effects from baryon/meson effects. We study the nuclear modification factors for $\phi$-mesons in d+Au and Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV as a function centrality and compare to the results for protons and pions. The high-statistics Au+Au data sample obtained in Run-4 of RHIC allows for a $v_2$ measurement of $\phi$ that can be used to further test the empirical quark-scaling rule. We also investigate the effect of baryon transport using $\pi/K/p$ spectra from 62 GeV Au+Au collisions.

10:15AM EB.00005 Open Heavy Flavor and $J/\Psi$ Production at Large Rapidities in dAu Collisions at RHIC , MING XIONG LIU, Los Alamos National Lab, PHENIX COLLABORATION — We study heavy flavor production through prompt muon measurements in the forward and backward rapidities 1.2 < $|\eta|$ < 2.4 in dAu collisions with the PHENIX muon detectors. The rapidity dependence of prompt muon yields is studied as a function of the transverse momentum of the muon. Open charm is predominantly produced through gluon-gluon interactions at RHIC energy, thus such measurements will shed new light on gluon (anti)shadowing in small (large) Bjorken $x$'s in the Au nucleus. We also compare open charm to $J/\Psi$ yields in the forward and backward rapidities in dAu collisions and study the origin of the large forward and backward asymmetry observed by the PHENIX experiment in $J/\Psi$ production in the dAu collisions. This will help us to understand various normal nuclear effects - such as parton shadowing, initial state energy loss and nuclear absorption - on open charm and $J/\Psi$ production at RHIC. The current status of this analysis will be presented.

10:30AM EB.00006 Heavy flavor production from single muons in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV . ANUJ PURWAR, Los Alamos National Lab, PHENIX COLLABORATION — Heavy flavor production in the dense partonic matter created at RHIC can be modified either by energy loss for heavy quarks or by charm enhancement. Measurement of open charm as a function of centrality will also be critical to interpreting the measured production of $J/\Psi$ in Au+Au collisions, as $J/\Psi$ production is predicted to be modified by both initial state and final state effects in Au+Au collisions. One way of measuring open charm is to look at single muons from semi-leptonic decays. The PHENIX experiment at RHIC is uniquely positioned to make this measurement using its two muon arms. Single muons from Au+Au collisions have to be extracted from a background of hadron punch throughs and muon decays from light mesons. We present the latest results of open charm from Au+Au collisions using the PHENIX muon arms (pseudorapidity range: 1.2 < $|\eta|$ < 2.4).

10:45AM EB.00007 Measurements of $J/\Psi \rightarrow e^+e^-$ in Au-Au collisions at $\sqrt{s_{NN}}$ = 200 GeV by PHENIX at RHIC , TAKU GUNJI1, Center for Nuclear Study, University of Tokyo — Measurements of the $J/\Psi$ yield in heavy ion collisions are expected to be one of the most promising probes of deconfined matter, since theoretical models predict that the $J/\Psi$ yield could be strongly suppressed due to the color Debye screening effect in Quark Gluon Plasma. Recently, many theoretical efforts have been made to investigate the behavior of $J/\Psi$ production at RHIC energy. One of the interesting predictions that has emerged, is that the $J/\Psi$ yield could be enhanced due to the recombination of uncorrelated $c\bar{c}$ pairs. The PHENIX experiment measured the $J/\Psi$ yield in Au-Au collisions at $\sqrt{s_{NN}}$ = 200 GeV by using $e^+e^-$ decay mode at mid-rapidity ($|\eta| < 0.35$) and $\mu^+\mu^-$ decay mode at forward-rapidities (1.2 < $|\eta|$ < 2.2). The latest results of $J/\Psi$ invariant yield and $J/\Psi$ pT distribution obtained by using its $e^+e^-$ decay mode from $\sqrt{s_{NN}}$ = 200 GeV Au+Au collisions will be shown.

11:00AM EB.00008 $J/\Psi$ production at forward rapidity in $\sqrt{s_{NN}}$=200 GeV Au-Au collisions in PHENIX experiment . MINJUNG KWEO, Korea University, PHENIX COLLABORATION — The modification of heavy quarkonium yields and spectra is considered one of the most promising signatures of the predicted nuclear phase transition into the deconfined quark-gluon plasma. During RHIC run 4, the PHENIX muon spectrometers, covering 1.2 < $|\eta|$ < 2.4 and -1.2 < $|\eta|$ < -2.2, yielded several thousands of $J/\Psi$ particles in Au-Au collisions at $\sqrt{s_{NN}}$=200 GeV. The $R_{AA}$ dependence over centrality, $p_T$ and rapidity will be presented using the $J/\Psi$ production via $\mu^+\mu^-$ channel.
11:15AM EB.00009 Measurement of J/ψ Polarization via Dielectron Decay Channel in √s_{NN} = 200 GeV d+Au and Au+Au Collisions by the PHENIX Experiment\(^3\), ALEXANDRE LEBEDEV, Iowa State University, PHENIX COLLABORATION — Charmonium, and, in particular, J/ψ, is considered as a leading probe of the hot and dense matter created in relativistic heavy ion collisions. A good understanding of the J/ψ production mechanism is necessary for studying the properties of this hot and dense matter. One important diagnostic tool for studying J/ψ production mechanisms is the measurement of J/ψ polarization. Such measurement helps to differentiate between various production models, and understand production and subsequent hadronization of charm quark pairs. We present the results of the J/ψ polarization measurement in d+Au and Au+Au collisions at √s_{NN} = 200 GeV by the PHENIX experiment at RHIC. J/ψ polarization is measured as a function of transverse momentum.

\(^3\)A.Lebedev for The PHENIX Collaboraton

11:30AM EB.00010 Production of Λ and ¯Λ particles in Au+Au collisions at √s_{NN} = 200 GeV, DEBSANKAR MUKHOPADHYAY, Vanderbilt University, PHENIX COLLABORATION — The measurements of Λ and ¯Λ particles are crucial to study the net baryon density and strangeness production in relativistic heavy ion collisions. The PHENIX experiment at RHIC has recorded 1.5 × 10\(^8\) Au+Au events during 2003-4 run period at RHIC. The data sample will allow us to make a detailed study of the centrality dependence of Λ and ¯Λ yields. We shall present the analysis status of the Λ and ¯Λ's.

Wednesday, September 21, 2005 9:00AM - 12:30PM — Session EC DNP JPS: Mini-symposium on Structure Changes of Asymmetric Nuclear Systems —
Ritz-Carlton Hotel Salon 2

9:00AM EC.00001 Regularities in Nuclear Spectra and Simple Signatures, RICHARD CASTEN, Yale University — Nuclei are complex quantum many-body systems, composed of two kinds of interacting fermions. Yet they display astonishing simplicities and regularities. Key challenges of nuclear physics are to identify such regularities, to use them as phenomenological signatures of structure and to understand their microscopic origins. This talk will focus on the first two of these challenges. The first involves the development of dynamical and structural symmetries and the discovery of approximate manifestations of them in real nuclei. These simple paradigms often lead to new signatures of structure. A number of examples of regularities in nuclear properties and their applications to nuclei far from stability will be discussed. These include empirical extractions of valence proton-neutron interactions, and their relation to shell structure; new signatures for phase transitional behavior in the equilibrium structure; evidence for ordered and chaotic behavior in nuclei; with a very simple signature for ordered spectra; and the evolution of collectivity in particle-particle compared to particle-hole regions. Work supported by the US DOE under Grant No. DE-FG02-91ER-40069.

9:30AM EC.00002 Collective states in silicon and sulfur isotopes from N=20 to 28, C.M. CAMPBELL, D. BAZIN, M.D. BOWEN, B.A. BROWN, J.M. DINCA, D.-C. DINCA, A. GADE, T. GLASMACHER, W.F. MUELLER, H. OLLIVER, K. STAROSTA, J.R. TERRY, Department of Physics and Astronomy, and the National Superconducting Cyclotron Laboratory, Michigan State University, N. AOKI, T. MOTOBAYASHI, H. SAKURAI, S. TAKEUCHI, K. YONEDA, RIKEN (Institute of Physical and Chemical Research), S. KANNO, Department of Physics, Rikkyo University, H. SUZUKI, Department of Physics, University of Tokyo, S.P. WEPPNER, Collegium of Natural Sciences, Eckerd College — The evolution of low-lying collective states in neutron-rich silicon and sulfur isotopes has been studied by inelastic proton scattering in inverse kinematics at the Coupled Cyclotron Facility of the NSCL. Gamma-ray detection was used to select inelastic events exciting specific bound states. New gamma-ray transitions were observed and placed into level schemes. Angle-integrated excitation-cross sections to the first 2+ state in each even-even silicon and sulfur isotope were used to determine quadrupole deformation parameters. The evolution of collectivity was examined by looking at trends of deformation parameters and level energies as functions of neutron number. Results will be compared with shell-model predictions. This work was supported by NSF grants PHY-0110253, PHY-9875122, PHY-0244453, INT-0889581 and by the Japan Society for the Promotion of Science.

9:45AM EC.00003 Mirror symmetry of Gamow-Teller transitions by the comparison of \(^{37}\text{Cl}(^{4}\text{He},t)^{37}\text{Ar}\) and \(^{37}\text{Ca}(\beta^+)^{37}\text{K}\), Y. SHIMBARA, B.A. BROWN, NSCL, Michigan State University, Y. FUJITA, T. ADACHI, M. YOSHIFUKU, Osaka University, G.P.A. BERG, KVI, H. FUJIMURA, Kyoto University, H. FUJITA, ITemba Labs, K. FUJITA, K. HATANAKA, K. KAWASE, Y. KITAMURA, N. NAKANISHI, N. SAKAMOTO, Y. SAKEMI, Y. SHIMIZU, Y. TAMESHIGE, M. YOSOJI, RCNP, Osaka University, K. HARADA, J. HARA, Konan University, J. KAMIYA, K. KATARO, RIKEN, T. KAWABATA, CNS, University of Tokyo, M. UCHIDA, Tokyo Institute of Technology, T. WAKASA, Kyusyu University — Under the assumption of isospin symmetry, the distributions of Gamow-Teller (GT) transition strengths \(I(GT)\) are identical between \(^{37}\text{Cl} \rightarrow ^{37}\text{Ar}\) and \(^{37}\text{Ca} \rightarrow ^{37}\text{K}\). The differences between the empirical \(I(GT)\) distributions from \(^{37}\text{Cl}(p,n)^{37}\text{Al}\) and \(^{37}\text{Ca} \beta^-\text{decay}\) caused a great deal of controversy. One of problems in the \((p,n)\) experiments was the rather poor resolution. In order to study the individual transitions for \(^{37}\text{Cl} \rightarrow ^{37}\text{Ar}\), we performed a high-resolution, 30 keV (FWHM), \(^{37}\text{Cl}(^{4}\text{He},t)^{37}\text{Ar}\) experiment at 140 MeV/u \(^{4}\text{He}\) beam. The \(I(GT)\) distribution was extracted from the differential cross sections and compared with the \(^{37}\text{Ca} \beta^-\text{decay}\) data. Overall, they had similar distributions. However, the fine structures were not necessary consistent.

10:00AM EC.00004 Study of High-Spin States in neutron-rich Ti Isotopes, M. NIUKURA, E. IDEGUCHI, H. IWASAKI, S. SHIMOURA, M. TAMAKI, CNS, Univ. of Tokyo, T. FUKUCHI, Rikkyo Univ., H. BABA, T. KUBO, M. KUROKAWA, S. MICHIMASA, K. MORIMOTO, T. OHNISHI, T. SUDA, Y. KOSHDAA, RIKEN, S. OTA, Kyoto Univ., N. HOKOIOWA, Y. WAKABAYASHI, Kyushu Univ., C. ISHIDA, Royal Inst. of Tech., T. KOIKE, Tohoku Univ., T. KOMATSUZUKA, K. MIYAKAWA, A. OZAWA, Univ. of Tsukuba, I. TANIHATA, ANL — We have studied high-spin states of neutron-rich Ti isotopes \(^{49-52}\text{Ti}\) by using a fusion reaction of a secondary beam. The experiment was performed at RIPS facility in RIKEN. The secondary \(^{48}\text{Ar}\) beam was produced by a projectile fragmentation reaction of a \(^{56}\text{Ca}\) primary beam with 63 MeV/nucleon. By using aluminium degraders placed at the first and second focal planes, an energy of the secondary beam was reduced to 4.0\pm 0.9 MeV/nucleon. The \(^{46}\text{Ar}\) beam was transported to the final focal plane and bombarded to a \(^{9}\text{Be}\) target in order to induce the secondary fusion reaction, \(^{9}\text{Be}(^{46}\text{Ar},xn)^{55-57}\text{Ti}\). Gamma rays from the high-spin states of the reaction products \(^{49-51}\text{Ti}\) were detected by the GRAPE (Gamma-Ray detector Array with Position and Energy sensitivity) system. Based on excitation functions and \(^{7}\text{Be}(^{48}\text{Ar},xn)^{55-57}\text{Ti}\) -coincidence measurements, we have identified new high-spin states in \(^{49}\text{Ti}\) and \(^{51}\text{Ti}\). In the present talk, we will report on the experimental results and discuss the newly observed high-spin states.
10:15AM EC.00005 Intermediate-energy Coulomb excitation of \(^{46}\)V, \(^{50}\)Mn, and \(^{54}\)Co\(^1\) — L.A. RILEY, M.J. BOJAZI, J.W. KREMENAK, D.C. MCLINCHY, Ursinus College, D. BAZIN, A.D. BECERRIL, J.M. COOK, A. GADE, T. GLASMACHER, W.F. MUELLER, C. VAMAN, National Superconducting Cyclotron Laboratory, Michigan State University, P.D. COTTLE, K.W. KEMPER, R.R. REYNOLDS, B.T. ROEDER, Florida State University — The reduced transition strengths \(B(E2; 2^+ \rightarrow 0^+)\) for the \(N = Z\) nuclei \(^{46}\)V, \(^{50}\)Mn, and \(^{54}\)Co have been measured via intermediate-energy Coulomb excitation at 60 MeV/nucleon. The \(0^+\) and \(2^+\) states of these \(T_z = 0\) nuclei are the \(T = 1\) analog states of the ground states and \(2^+\) states of the corresponding \(T_z = \pm 1\) nuclei. The present result for \(^{54}\)Co is combined with the existing \(B(E2; 1^- \rightarrow 0^+)\) results \cite{1} for the corresponding \(T = 1\) states in \(^{54}\)Fe and \(^{54}\)Ni to test isospin purity in the mass 54 \(T = 1\) multiplet. \cite{1} S. Raman et al., Atomic Data Nucl. Data Tables 78, 1 (2001). \cite{2} K. L. Yurkevitz et al., Phys. Rev. C70, 054319 (2004).

\(^1\)This work was supported by the U.S. National Science Foundation under grants PHY-0110253 and PHY-0355129.

10:30AM EC.00006 Inelastic proton scattering on the neutron rich Cr isotopes — ERI TAKESHITA, Department of Physics, Rikkyo University, RIKEN COLLABORATION, UNIVERSITY OF TOKYO COLLABORATION, TOKYO INSTITUTE OF TECHNOLOGY COLLABORATION, CENTER FOR NUCLEAR STUDY COLLABORATION, KFK COLLABORATION — Inelastic proton scattering on the neutron rich Cr isotopes at around \(N = 40\) has been investigated. Spectroscopy of these nuclei is of great importance because of the strong deformation suggested by the low excitation energies of the first \(2^+\) states in \(^{60,62}\)Cr \cite{1}. In the present work, the structures of the neutron rich Cr isotopes were studied by measuring the excitation energies and the (p,p') cross sections to these states. The experiment was performed at RIPS in RIKEN. The Cr isotopes were produced by the fragmentation of 63MeV/nucleon \(^{70}\)Zn and were excited by bombarding a liquid hydrogen target. De-excitation \(\gamma\) rays were detected by the NaI(Tl) array DALIZ in coincidence with the scattered particles. A time of flight spectrometer is newly developed to greatly improve the particle identification resolution for the scattered particles. With the cross sections to the first excited states derived from the \(\gamma\)-ray spectra, the structure of the neutron rich Cr isotopes will be discussed.


10:45AM EC.00007 Proton Inelastic Scattering on \(^{74}\)Ni — S. KANNO, Rikkyo University, N. AOKI, H. SAKURAI, T. MOTOBAYASHI, T. KUBO, S. TAKEUCHI, K. YONEDA, RIKEN, H. IWASAKI, H. SUZUKI, Department of Physics, University of Tokyo, T. NAKAMURA, Tokyo Institute of Technology, D. BAZIN, M.D. BOWEN, C.M. CAMPBELL, J.M. COOK, D.-C. DINCA, A. GADE, T. GLASMACHER, W.F. MUELLER, H. OLLIVER, J.R. TERRY, Department of Physics and Astronomy and National Superconducting Cyclotron Laboratory, Michigan State University — The proton inelastic scattering on the neutron-rich nucleus \(^{74}\)Ni has been investigated aiming at exploring the evolution of the magicity at \(Z=28\) in a very neutron-rich region. In the Ni isotopes lighter than \(^{72}\)Ni, the first \(2^+\) states are located higher than those of the neighboring isotones, reflecting the magicity at \(Z=28\). In the present experiment, the excitation energy of the first \(2^+\) state \((E_x(2^+))\) and the deformation parameter of a more neutron-rich Ni isotopes \(^{74}\)Ni were measured by proton inelastic scattering. \(^{74}\)Ni was produced at NSCL by the projectile fragmentation of a 140 MeV/nucleon \(^{90}\)Kr beam on a \(^{18}\)Be target. The \(^{74}\)Ni beam impinged on a liquid hydrogen (LH2) target and the NaI(Tl) scintillator array (APEX) placed around the LH2 target detected the de-excitation \(\gamma\) rays. \(E_x(2^+)\) was determined from the \(\gamma\)-ray spectrum measured in coincidence with the scattered \(^{74}\)Ni ions. The deformation parameter was extracted from the angle-integrated cross section.

11:00AM EC.00008 Quadrupole deformation of the self-conjugate nucleus \(^{72}\)Kr\(^1\) — A. GADE, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824, D. BAZIN, A. BECERRIL, C.M. CAMPBELL, J.M. COOK, D.-C. DINCA, T. GLASMACHER, G.W. HITT, W.F. MUELLER, H. OLLIVER, J.R. TERRY, K. YONEDA, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824, D.J. DEAN, Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, M.E. HOWARD, Department of Physics, Ohio State University, Columbus, Ohio 43210 — We report on the first determination of the absolute \(B(E2; 0^+ \rightarrow 2^+)\) excitation strength in the \(N = Z\) nucleus \(^{72}\)Kr via intermediate-energy Coulomb excitation performed at the National Superconducting Cyclotron Laboratory at Michigan State University. \(^{72}\)Kr is the heaviest self-conjugate system for which this quantity has been measured. The deduced quadrupole deformation strength is compared to predictions of a variety of self-consistent models predicting shape coexistence. Large-scale shell-model Monte Carlo calculations reproduce the experimental \(B(E2)\) value and link the result to the gap between the \(fp\) and \(gd\) major shells and the occupation of the deformation-driving \(g_{9/2}\) orbit.

\(^1\)This work was supported by the National Science Foundation under Grants No. PHY-0110253, PHY-9875122, PHY-0244453 and PHY-0342281, and the U.S. DOE under Contract No. DE-AC05-00OR22725.

11:15AM EC.00009 Microscopic description of single-particle levels with modern NN interactions — SHINICHIRO FUJII, CNS, University of Tokyo, RYOJI OKAMOTO, Kyushu Inst. of Tech., KENJI SUZUKI, Kyushu Inst. of Tech. — Recently, \(ab\) initio nuclear structure calculations starting with realistic NN interactions have been possible beyond few-nucleon systems. The coupled-cluster method (CCM) will be one of the promising ones for this kind of study, and actually the application of the CCM to nuclear structure calculations has been increasing. We have developed a many-body theory, the unitary-model-operator approach (UMOA), to perform \(ab\) initio structure calculations for a wide range of the mass numbers of nuclei. The UMOA can be regarded as one of the CCM, and leads to an energy independent and Hermitian effective interaction through a unitary transformation of the original Hamiltonian. The unitary transformation employed in the UMOA has also been used to derive the effective interaction in the \(ab\) initio no-core shell model (NCSM). In the UMOA, the energies of ground states and single-particle (hole) levels can be calculated taking into account a sufficiently large model space. I will show some recent results for nuclei around \(^{14}\)C, \(^{16}\)O, \(^{24}\)O, and \(^{40}\)Ca using modern NN interactions.

11:30AM EC.00010 Hartree-Fock-Bogoliubov calculations with Gaussian expansion method — HUNISOH NAKADA, Chiba University — An algorithm of the Hartree-Fock-Bogoliubov (HFB) calculations using the Gaussian expansion method is newly developed. By this method we can handle various effective interactions on the same footing, and the wave-function asymptotics, either exponential or oscillatory ones, are efficiently handled even for finite-range interactions. In the previous study we have shown by the spherical Hartree-Fock calculations that the shell structure around \(N=16\) and 32 depends on the effective interactions (e.g. the Skyrme, the Gogny interaction and M3Y-type interactions) and their parameters, to an appreciable extent. Applying the HFB calculations, influence of the pair correlations on the magicity of \(N=16\) and 32 will be discussed.
11:45AM EC.00011 Ground and single-particle properties in Gogny+Tensor mean-field calculations. 

Daisuke Abe, Takaharu Otsuka, Department of Physics, University of Tokyo — In the study of the nuclear structure with the mean-field method, the DIr interaction as the standard Gogny-type effective interaction has been used. The results obtained from DIr are generally in good agreement with the experimental data. But some behaviors of DIr results are not so close to experiments. We have therefore proposed a new Gogny-type interaction ‘GT2’. GT2 is similar to DIr in many respects, but the tensor term is introduced and the parameters are modified to remedy certain shortcomings. The tensor force plays an important role in the structure of nuclei. So it is essential for us to take into account the tensor force. We showed the data calculated with DIr and GT2. The difference between proton and neutron single-particle energies h1/2 and g1/2 of 5b isotope was investigated. We found the tensor force and the effect of neutron skin resulted in the interesting interplay. In this study, we shall present some results calculated from GT2. The isotopic shifts of Ca and Pb will be included. The isotop shifts mean the changes of the nuclear charge radii with increasing neutron number. In the case of Ca and Pb, the experimental data show unusual behaviors. We study such isotopic shifts by using GT2. We further discuss some properties of exotic nuclei, focusing on the competition between tensor-force effect and neutron-skin effect.

12:00PM EC.00012 Looking at nuclei in the black sphere picture. 

Akihisa Kohama, Riken, Kei Iida, Riken BNL Research Center, Kazuhiro Oyamatsu, Riken & Aichi Shukutoku University — We review our method for systematically analyzing proton elastic scattering data for stable nuclei, by assuming that the target nucleus is a “black” sphere. This method gives a length scale, a, the values of which are determined so as to reproduce the angle of the first diffraction maximum in the scattering data. We find that the absorption cross section, πa2, agrees with the empirical total reaction cross section for C, Sn, and Pb to within error bars for proton incident energies, Tp, higher than ∼ 800 MeV. Our preliminary results suggest that this agreement is retained for Tp down to a few hundreds MeV. For Tp >> 800 MeV, we also find that γ/3/2a almost completely agrees with the empirically deduced values of the r.m.s. matter radius for nuclei having mass larger than about 50, while it systematically deviates from the deduced values for A <∼ 50. This tendency suggests a significant change of the nuclear matter distribution from a rectangular one for A <∼ 50. Possible application of our method to neutron-rich unstable nuclei is finally discussed.

12:15PM EC.00013 Equation of state of nuclear matter and nuclei in laboratories and neutron-star crusts. 

Kazuhiro Oyamatsu, Aichi Shukutoku University, Kei Iida, Riken BNL Research Center — We systematically examine how sensitive macroscopic properties of nuclei in laboratories and neutron-star crusts are to the density dependence of the symmetry energy. Using macroscopic nuclear models constructed in such a way that they reproduce empirical data for masses and radii of stable nuclei equally well, while depending on the still uncertain parameters such as the symmetry energy density derivative coefficient L and the nuclear matter incompressibility K, we calculate radii and masses of heavy unstable nuclei, the charge number of nuclei in neutron star crusts, and the deepest end of the crust at which nuclei melt into uniform matter. We find that the results for all these quantities show almost no K dependence but appreciable L dependence. Future possible determination of L from radioactive matter beam experiments and its significance for the presence of “pasta” nuclei in neutron star crusts are finally discussed.
10:15AM ED.00005 Dilepton production near partonic threshold in transversely polarized $pp$ scatterings

HIROSHI YOKOYA, Niigata University, HIROTAKA SHIMIZU, Hiroshima University & KEK, GEORGE STERMAN, SUNY, WERNER Vogelsang, BNL & RIKEN BNL Research Center — Recently, it has been suggested that collisions of transversely polarized protons and antiprotons at the GSI could be used to determine the nucleon’s transversity densities from measurements of the double-spin asymmetry for the Drell-Yan process. We investigate the QCD higher-order corrections, in this kinematic regime, in terms of available fixed-order contributions as well as all-order soft-gluon resummations. We find these corrections are large, especially at large invariant mass regions. We examine the resummation formula with physically motivated cut-off which keep it away from the region where non-perturbative dynamics take place. We find that this reduce the large enhancements, moderately at lower scale collision, but rather at higher scale collisions. The unpolarized dilepton cross section for the GSI kinematics may therefore provide information on the relation of perturbative and nonperturbative dynamics in hadronic scattering. The spin asymmetry turns out to be rather robust, relatively insensitive to higher orders, resummation, and the cut-offs.

10:30AM ED.00006 Twist-3 Mechanm for Single Spin Asymmetry Reexamined

YUJI KOIKE, Niigata University, KAZUHIRO TANAKA, Juntendo University — In the framework of the collinear factorization, single transverse spin asymmetry (SSA) is a twist-3 observable which represents quark-gluon correlations in a hadron. In this talk, we present a lightcone-gauge calculation of SSA for the direct-photon production in the $pp$ collision which is relevant for the RHIC-SPIN program. Some time ago, Qiu and Sterman presented a Feynman-gauge calculation for the quantity. The derivation of the cross section for SSA involves identification of the pole contribution in the Feynmann diagram, and expressing SSA in terms of gauge invariant correlation functions is quite involved. So it is interesting to reexamine the result in a different gauge. After identifying the relation between different representations of the twist-3 distribution functions for the transversely polarized nucleon, we show how each pole contribution can be identified and expressed in terms of the gauge invariant functions in the lightcone gauge.

10:45AM ED.00007 Transverse Spin Results from STAR

WILLIAM CHRISTIE, Brookhaven National Laboratory, STAR COLLABORATION — One of the main objectives of the Spin physics program at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory is to study transverse spin effects. Measurements of large Feynman $x (xF)$ neutral pion production in polarized proton collisions at $p = 200$ GeV has been reported by STAR. Cross section measurements at $\eta = 3.3, 3.8$, and $4.0$ were found to be consistent with next-to-leading order perturbative QCD calculations. The analyzing power was found to be large and positive at $xF>0.3$, and consistent with phenomenological calculations based on the Collins effect, the Sivers effect, and initial-state higher twist contributions. This contribution will summarize these measurements, as well as give an outlook of future STAR semi-inclusive measurements to determine the Transversity and Sivers distribution functions.

11:00AM ED.00008 Double Longitudinal Asymmetry in Jet $k_t$ Measured in Di-hadron Correlations in Polarized $p+p$ Collisions at $\sqrt{s} = 200$ GeV in the PHENIX Experiment at RHIC

ROBERT HOBB, University of New Mexico, PHENIX COLLABORATION — By measuring the azimuthal correlations between two high $p_t$ hadrons, one can extract jet properties such as the fragmentation transverse momentum $p_t$ and the “intrinsic” transverse momentum $k_t$. In longitudinally polarized $p+p$ collisions, differences in the extracted average $k_t$ for like and un-like helicity combinations (double asymmetry) may give information on the relationship between the polarization and the partonic transverse momentum, and thus the orbital angular momentum of the hard-scattered partons. This method is similar to a technique previously suggested by Meng Ta-chung et al. in the Drell-Yan channel. In this talk we present the physics technique, the analysis method and the current status of the analysis for $\pi^0$ - hadron azimuthal correlations in PHENIX with data from RHIC in 2003, 2004 and 2005.

11:15AM ED.00009 Measurement of Transverse Single-Spin Asymmetries in Neutral Pion and Charged hadron Production at PHENIX

WALED EMAM, University of California at Riverside, PHENIX COLLABORATION — A number of experiments studied polarized proton collisions at center of mass energies $\sqrt{s} \leq 20$ GeV and observed large transverse single-spin asymmetries for pion production at high $x_F$ and moderate transverse momentum ($0.5 < p_T < 2.0$ GeV/$c$). At high center of mass energy of 200 GeV the $p^0$ asymmetry at high $x_F$ was found to persist. On the other hand, a 20-GeV measurement of the asymmetry in $\pi^0$ production at $-0.15 < x_F < -0.15$ and $1 < p_T < 4$ GeV/$c$ was found to be consistent with zero. These asymmetries can be generated by spin-dependent effects such as the Collins fragmentation function and the Sivers function. The PHENIX experiment, one of the large experiments being conducted at the Relativistic Heavy Ion Collider (RHIC), has measured the transverse spin asymmetries for mid-rapidity production of neutral pions and non-identified charged hadrons in polarized proton-proton collisions. From data collected during the 2001-2 run at $\sqrt{s} = 200$ GeV, $0.5 < p_T < 5.0$ GeV/$c$, and $x_F$ close to zero, the asymmetries seen are consistent with zero within statistical errors of a few percent.

11:30AM ED.00010 New Prospects for Transverse Physics with the PHENIX detector

MICKEY CHIU, University of Illinois at Urbana-Champaign, PHENIX COLLABORATION — PHENIX has made measurements of the transverse single spin asymmetry $A_N^{p}$ for pion-production at $x_F$ and non-identified charged hadrons near $x_F \sim 0$ at collider energies, and measurements of $p^0$ asymmetry have been made at the same $\sqrt{s}$ but at $x_F \sim 0$ by the STAR and Brahms collaborations. Asymmetries as large as ~ 30% have been found. Currently, these large asymmetries are thought to come either from higher-twist contributions, modifications to the parton distribution functions (Sivers), modifications to the fragmentation functions (Collins), or even perhaps some combination of the three. Future progress will require separating these effects. We discuss future prospects with the PHENIX detector for reducing these ambiguities in inclusive single spin asymmetries by looking at correlations between hadrons from the same and from back to back jets.

11:45AM ED.00011 Measurement of the single transverse-spin asymmetry of forward neutrons in $p+p$ collisions at RHIC-PHENIX

MANABU TOGAWA, Kyoto University, PHENIX COLLABORATION — The Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory (BNL) has been operated with polarized proton beams colliding at the center of mass energy $\sqrt{s}=200$ GeV. In the RUN2 (2001-2002), a large single transverse spin asymmetry $A_N^{\pi}$ (-10%) of the forward neutrons measured at the 12 o’clock interaction point experiment. In the ISR experiment, it is $\sqrt{s}=30.6$ to 62.7 GeV in $p+p$ collisions, the cross-section of forward neutron production was measured to be larger than at mid-rapidity. Our understanding of this effect is based on pion exchange. The forward neutron asymmetry can shed new light to understand such forward physics. Through the 2003-2005, PHENIX experiment has measured the forward neutrons by ZDC (Zero Degree Calorimeter) with SMD (Shower Max Detector) which is position sensitive detector. The energy resolution of ZDC is twice better than that of the hadron calorimeter which was used in the 12 o’clock experiment. In this talk, we will report the measurement of the single transverse-spin asymmetry of forward neutrons by the PHENIX experiment and discuss the physics implication of the neutron asymmetry.
Borel analysis of the correlation function for Θ obtained by subtracting the two-hadron-reducible contribution from the naive correlation function. Instead, we propose to use the two-hadron-irreducible correlation function, which is of three existing works on the pentaquark. Therefore, it is dangerous to draw a conclusion from the sum rules using naive pentaquark correlation functions nothing to do with pentaquark. We show that the two-hadron-reducible contributions are large in the operator product expansion of the correlation functions pentaquark correlations function include two-hadron-reducible contributions, which are given by convolution of baryon and meson correlation functions and have ud in a constituent quark model. First one is the Jaffe-Wilczek model (Θ parity are not yet determined. Several models have been proposed to predict the spin and parity of KN experimental groups. Though the mass and width for Θ+ (1540) MeV energy region; one is a broad 1/2+ resonance with width of Γ ≈ 110 MeV located at ≈ 535 MeV above the NK threshold, and the other is a sharp 1/2+ resonance with Γ = 0.21 MeV at 539 MeV. We also will report the structure of X(3872) which has been reported by the Belle group.

9:45AM EE.00004 Analysis of the pentaquark mass and decay width in a constituent quark model. HIDEKI MATSUMURA, Graduate School of Science and Technology, Niigata University, YASUYUKI SUZUKI, Department of Physics, Niigata University — After the discovery of the pentaquark Θ+ by the LEPS collaboration at Spring-8 in Japan, its existence was further investigated by other experimental groups. Though the mass and width for Θ+ decay reported by several experimental groups are consistent each other to some extent, its spin and parity are not yet determined. Several models have been proposed to predict the spin and parity of Θ+. There are two representative studies on the pentaquark in a constituent quark model. First one is the Jaffe-Wilczek model (ud − ud − s), the other one is the Karlkin-Lipkin model (ud − ud). As these models are restricted to a special degree of freedom of spin, isospin, and color, they may be insufficient to describe the pentaquark more accurately. For the purpose, we use explicitly correlated basis functions as the orbital wave function, and take into account all possible spin, isospin, and color channels, then present a precise 5-body calculation for Θ+. By using a real stabilization method, we identify a Θ+ resonance in the continuum. In this way, we analyze the pentaquark mass and NK decay width for spin and parity states.

10:00AM EE.00005 Non-interacting KN contribution in the QCD sum rule for the pentaquark Θ+ (1540). YOUNGSHIN KWON, ATSUSHI HOSAKA, Research Center for Nuclear Physics, Osaka Univ., Japan, SU HOUNG LEE, IPAP, Yonsei Univ., Korea — We perform a QCD sum rule analysis for the pentaquark baryon Θ+ with the non-interacting KN contribution treated carefully. The coupling of the Θ+ current to the KN state is evaluated by applying the soft kaon theorem and vacuum saturation. When using a five-quark current including scalar and pseudo-scalar diquarks, the KN contribution turns out not to be very important and the previous result of the negative parity Θ− is reproduced again. The Borel analysis of the correlation function for Θ+ with the KN continuum states subtracted yields the mass of the JPG = 1/2− Θ+ around 1.5 GeV.

10:15AM EE.00006 Two-Hadron-Irreducible Qcd Sum Rule for Pentaquark Baryon. OSAMU MORIMATSU, KEK, YOSHIHIKO KONDO, Kokugakuin University, TETSUO NISHIKAWA, Tokyo Institute of Technology — We point out that naive pentaquark correlations function include two-hadron-reducible contributions, which are given by convolution of baryon and meson correlation functions and have nothing to do with pentaquark. We show that the two-hadron-reducible contributions are large in the operator product expansion of the correlation functions of three existing works on the pentaquark. Therefore, it is dangerous to draw a conclusion from the sum rules using naive pentaquark correlation functions with naive ansatz for the spectral function under the dispersion integral. Instead, we propose to use the two-hadron-irreducible correlation function, which is obtained by subtracting the two-hadron-reducible contribution from the naive correlation function.
10:30 AM EE.00007 Λ(1405) as a pentaquark. SACHIKO TAKEUCHI, Japan College of Social Work, KIYOTAKA SHIMIZU, Sophia University — Recent findings of the strangeness +1 particle gives new light to q̅q̅π systems. Here we apply this method to investigate the features of the old but not-fully-understood baryon: Λ(1405). From the quark model view points, Λ(1405) has been considered as the flavor-singlet q̅q̅ state with the orbital excitation. On the other hand, it has been reported that the state can also be understood as N̅K and Σπ states [1]. Recent works of hyperon also suggest that Λ(1405) may have a more complicated structure than a simple baryon [2]. It is known that the N̅K (TJ̅P̅)=(0,1/2−) state does not have a repulsion from the color-magnetic interaction, CMI. By introducing the mixing among the q̅q̅π flavor multiplets, we have found that there are two states where CMI are strongly attractive and may form a resonance below the N̅K threshold. It is also interesting what kind of states they become when the system is bound in nuclei.

In the present talk, we will discuss the features of the q̅q̅π systems with the strangeness −1 (TJ̅P̅)=(0,1/2−), and argue that this component may be important and should be mixed to the q̅ state.


10:45 AM EE.00008 Magnetic moment of Λ(1405) as a S-shell pentaquark. TAKASHI INOUE, Dept. Phys. Sophia University — Many theoretical interpretations have been given for exotic baryons, Θ+ and Ξ− in various scenarios: chiral quark soliton, hadron bound state, valence quark pentaquark and so on. The simplest pentaquark model is the S-shell pentaquarks where all quarks and an anti-quark are in the ground S-wave state. There is an experimental indication of the Θ+ being iso-scalar. If we take this indication into S-shell pentaquarks, the Θ+ becomes a member of flavor SU(3) anti-decuplet with J̅P = 1/2− and 3/2−. In this model, there are also accompanying flavor SU(3) octets with J̅P = 1/2− and 3/2−. These octets include one Λ hyperon as the ground state of the octet. The structure of observed Λ(1405) with J̅P = 1/2− has been given the scenario of p-wave excited 3-quark, meson-baryon quasi-bound state and so on. Now, we have one another scenario: a S-shell pentaquark. In this paper, we study Λ(1405) in this scenario, especially its magnetic moment. Magnetic moment of the Λ pentaquark is given by μΛ = \sum_q \langle \lambda | \mu_q | S_q | \lambda \rangle \bar{S}_{q\bar{q}}. Using the fit to ground state baryons, we obtain μ_Λ(1405) = 0.42 μ_N. This prediction is in contrast with that of p-wave excited 3-quark model: μ_Λ(1405) ≈ −0.13 μ_N.

It is interesting that the present result agree with the prediction μ_Λ(1405) = +0.25 ± 0.45 μ_N in the meson-baryon resonance approach. It seems natural because both approaches share five-valence contents for the hyperon. Further discussions will be given at the conference.

11:00 AM EE.00009 Measurement of charged Σ Baryons at RHIC-PHENIX. CHRISTOPHER PINKENBURG, Brookhaven National Laboratory, PHENIX COLLABORATION — The PHENIX experiment at RHIC has the ability to detect the annihilation signal of anti neutrons with its highly segmented large acceptance electromagnetic calorimeter. Utilizing this capability, a measurement of Σ is possible. Charged pions are measured in the central arm spectrometer of the PHENIX detector which provides excellent particle identification up to high transverse momentum. The major challege of this analysis is therefore to understand the response of the PHENIX electromagnetic calorimeter for anti neutrons which is currently derived from the observed response for identified anti protons. Over the last years PHENIX took high statistics datasets for a variety of systems (p-p, d-Au, Cu-Cu, Au-Au) at various energies. This provides an ideal basis for the development of such an analysis.

Due to the similarity of the measurement this analysis can serve to set an upper limit on a possible anti–Pentaquark production (Θ− πK−). We will present the method and the current status of the analysis.

11:15 AM EE.00010 Nucleon structure from lattice QCD with domain wall fermions quarks. SHIGEMI OHTA, IPNS/KEK and RBRC/BNL, RBC COLLABORATION — We review RBC lattice numerical calculations of nucleon structure with domain wall fermions (DWF) quarks. DWFs allow arbitrarily accurate and continuum-like chiral and flavor symmetries at finite lattice spacing. This allows fully non-perturbative renormalization of relevant currents. Helped also by rectangular improved DBW2 gauge action that facilitates the use of DWF at relatively coarser lattice spacings, the RBC Collaboration has successfully reproduced such quantities as the ratio of isovector vector and axial charges, ⟨g_A/g_V⟩, and the ratio of the first moments of structure functions ((x)_{u-d}/(x)_{d-u-d}). First moments of some other structure functions are calculated as well. And 2-flavor dynamical domain wall results exist for many of these quantities, though some of them are yet to be renormalized.

Wednesday, September 21, 2005 9:00AM - 11:30AM — Session EF DNP JPS: Neutrino Physics Ritz-Carlton Hotel Plantation 3

9:00 AM EF.00001 Atmospheric neutrinos in SNO. CHARLES CURRAT, Lawrence Berkeley National Lab, SUDBURY NEUTRINO OBSERVATORY COLLABORATION — High energy muons and neutrinos are produced by the interaction of primary cosmic rays in the Earth’s upper atmosphere. SNO is in a unique position amongst world experiments located underground. At the depth of over 6 km water equivalent, it is the deepest underground laboratory currently in operation. SNO can make a number of novel measurements using muons. First, SNO’s great depth and uniform overburden makes possible an accurate determination of the muon range spectrum. Second, SNO’s depth allows for a measurement of atmospheric neutrinos above the threshold. It is also interesting what kind of states they become when the system is bound in nuclei. We will review SNO’s capabilities for measurements of muons and neutrinos of atmospheric origin. Progress on the ongoing analysis, including the projected sensitivity to the atmospheric neutrino oscillation parameters, will be shown.

9:15 AM EF.00002 FINeSSE, Δ as measurement through neutrino scattering. TEPPPEI KATORI, Indiana University Cyclotron Facility, FINESSE COLLABORATION — FINESSE, Fine-grained Intense Neutrino Scintillator Scattering Experiment, is an experiment to measure ΔS (nucleon spin component carried by strange quarks). ΔS is measured through neutrino-nucleon Neutral Current Elastic (NCE) scattering. A novel non-segmented liquid scintillator tracking detector can track low energy and large angled protons which is necessary for the extraction of ΔS. A ΔS measurement using neutrino beam is not only clean and robust theoretically, but also yields the smallest experimental error. An overview of the experiment will be discussed.

9:30 AM EF.00003 MiniBooNE Status: Cross Section Results. HEATHER RAY, Los Alamos National Laboratory — MiniBooNE, located at Fermi National Laboratory, is an experiment designed to confirm or refute the LSND neutrino oscillation result. MiniBooNE will look for oscillations of νμ → νe in a closed-box appearance analysis. The event sample at MiniBooNE is dominated by the four following processes: CCQE (charge current quasi-elastic, 40%), CCπ+ (charge current π+, 25%), NCE (neutral current elastic, 16%), NCEπ0 (neutral current π0, 7%). This talk will focus on the current status of cross section measurements for these four processes.

1On behalf of the SNO collaboration

2H. Ray, for the MiniBooNE Collaboration
9:45 AM EF.00004 Neutrino Flavor Changing Neutral Currents in Gravitational Collapse and the Early Universe, PHILIP AMANIK, GEORGE FULLER, BEN GRINSTEIN, University of California, San Diego — Flavor changing neutrino interactions are a predicted feature of some extensions of the Standard Model. We assess the impact of these processes in stellar collapse and in the very early universe. We find the stellar collapse environment to be sensitive to neutrino flavor changing scattering on heavy nuclei. In general we find that astrophysical environments may offer a probe of these processes at levels below current experiment bounds.

10:00AM EF.00005 Mini Z' Burst from Relic Supernova Neutrinos and Late Neutrino Masses, INA SARCEVIC, University of Arizona — In models in which neutrino mass is generated by the symmetry breaking at low scales, additional light bosons are generically present. We show that the interaction between diffuse relic supernova neutrinos (RSN) and the cosmic background neutrinos, via exchange of these light scalars, can result in a dramatic change of the SN neutrino flux. Measurement of this effect with current or future experiments can provide a spectacular direct evidence for the low scale models. We demonstrate how the observation of neutrinos from SN1987A constrains the symmetry breaking scale of the above models. We also discuss how current and future experiments may confirm or further constrain the above models, either by detecting the "accumulative resonance" that diffuse RSN go through or via a large suppression of the flux of neutrinos from nearby SNbursts.

10:15AM EF.00006 Probing the quantum nature of the neutrino with two-particle interferometry, THOMAS D. GUTIERREZ, NU XU, Lawrence Berkeley National Laboratory — One of the primary contemporary problems in neutrino physics is determining if the neutrino is its own antiparticle. That is, is the neutrino a Majorana (\(\nu = \bar{\nu}\)) or Dirac (\(\nu \neq \bar{\nu}\)) fermion. Currently, the only experimental approach being used to determine the quantum nature of the neutrino is through neutrinoless double beta decay. In this work, two-particle intensity interferometry, a second-order interference effect, is explored as another possible tool to distinguish between massive Dirac and Majorana neutrinos. A simple theoretical framework is discussed as well as some experimental considerations.

10:30AM EF.00007 Sterile Neutrinos and Stellar Collapse, JUN HIDAKA, GEORGE FULLER, University of California, San Diego — We investigate the effects of medium-enhanced active-sterile neutrino flavor conversion in the infalling core of a presupernova star. We consider frameworks is discussed as well as some experimental considerations.

10:45AM EF.00008 Double Gamow Teller Resonance by means of Heavy Ion Reaction, KELLI TAKAHISA, Y. KOREEDA, RCNP, Osaka University, H. AKIMINE, Konan University, H. EIJI, RCNP, Osaka University, H. FUJIMURA, Seoul National University, M. FUJWARA, RCNP, Osaka University, M. GREENFIELD, International Christian University, K. HARA, H. HASIMOTO, K. HATANAKA, T. ITAHASI, T. KAWABATA, K. KAWASE, N. MAEHARA, RCNP, Osaka University, S. MORDECHAI, University of the Negev, Y. NAGAI, K. NAKANISHI, S. NIHOMIYA, T. SHIMA, RCNP, Osaka University, M. TANAKA, Kobe Tokiwa Jr. College, A. TOMYO, RCNP, Osaka University, S. UMEHARA, Department of Physics, Osaka University, H. YOSHIDA, RCNP, Osaka University, S. YOSHIDA, Department of Physics, Osaka University, S. YOSOI, Department of Physics, Kyoto University — To study double spin-isospin responses in view of the \(\beta \beta\) decays, double charge-exchange nuclear reactions have been measured at RCNP. We have succeeded to measure the double charge exchange reaction by means of heavy ion reaction. From these experiments, we conclude that the \((^{11}\text{B},^{11}\text{Li})\) reaction at 70 MeV/nucleon is a good spectroscopic tool. We believe that the reaction can be well applied to the study of pure spin-flip nuclear responses including DGT excitations.

11:00AM EF.00009 Electron Capture Branch of \(^{100}\text{Tc}\) and the Efficiency of a Proposed Mo Neutrino Detector, SKY SYKE, ALEJANDRO GARCIA, SETH HOEDEL, SMARAJIT TRIAMBAK, ERIK SWANSON, University of Washington, FABIAN NAAB, University of North Texas, IRSHAD AHMAD, Argonne National Lab, HEIKKI PENTTILA, JUSSI HUKJARI, University of Jyväskylä, ALEJANDRO ALGÓR, Institute of Nuclear Research of the Hungarian Academy of Sciences — We present results from a measurement of the Electron-Capture branch of \(^{100}\text{Tc}\) performed at the IGISOL facility in Jyväskylä, Finland. The value of the \(^{100}\text{Tc}\) EC BR determines the \(^{100}\text{Mo}\) neutrino absorption cross section to the ground state of \(^{100}\text{Tc}\), which determines the efficiency of a proposed real-time pp neutrino detector.

11:15AM EF.00010 Test of Nuclear Wavefunctions for Neutrinoless Double Beta Decay, J.P. SCHIFFER, ANL, S.J. FREEMAN, Manchester, K.E. REHM, ANL, A.C.C. VILLARI, ANL and GANIL — The possibility of observing neutrinoless double beta decay (\(0\text{v}\text{bb}\)) is of great current interest. If this process is observed, the major uncertainty will come from the nuclear matrix elements. For the case of \(^{76}\text{Ge}\), theoretical predictions vary by over an order of magnitude. We propose the study of nuclear reactions to quantitatively test the relevant wave functions, which may help narrow the range of reasonable predictions. Since the \(0\text{v}\text{bb}\) process involves two correlated neutrons changing into two correlated protons with no intermediate state, it has some relationship to the well-known BCS pairing correlations in nuclear ground states. The latter are best probed by two-nucleon transfer reactions: e.g. \(^{72}\text{Ge}(p,t)^{72}\text{Ge}\) and \(^{74}\text{Ge}(He,n)^{75}\text{Se}\). In addition, the occupancy and the changes in occupancy of the valence orbits can be probed using careful measurements of one-nucleon transfer cross sections and sum rules. This work was supported in part by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. W-31-109-ENG-38.

Wednesday, September 21, 2005 9:00AM - 12:15PM – Session EG DNP JPS: Electromagnetic Interactions II Ritz-Carlton Hotel Plantation 2

9:00AM EG.00001 Double-Polarization Experiments Using Polarized HD at LEGS, C. STEVEN WHISNANT, James Madison University. LEGS COLLABORATION — A novel, solid, frozen-spin \(^{2}H^{2}D\) target has been developed for measurements of double-polarization observables in the \(\Delta\) resonance region. Our focus is the determination of the pion photo-production amplitudes for the neutron and proton. Cross sections, beam asymmetries and the \(E\) and \(C\) double-polarization observables are measured simultaneously. \(E\) provides information on the GDH and Spin-Polarizability spin sum rule integrals. We report here a preliminary analysis of one month of data collected on a \(^{2}H^{2}D\) target with polarizations of \(<P_{\mu}> = 30.0\%\) and \(<P_{\pi} > = 31.5\%\) and in-beam spin relaxation times of about one year. The photon beam energies ranged from 190 - 422 MeV with circular polarizations between 59\% and 100\%. Data collected during this run period focused on \(^{11}\text{B}\) production from the neutron using a detector system optimized to detect the recoil neutron in coincidence with the \(^{11}\text{B}\). This work is supported by the U.S. Department of Energy under contract DE-AC02-98CH10886, by the U.S. National Science Foundation, and by the the Instituto Nazionale de Fisica Nucleare, Italy.

\(^{3}\)C. Steven Whisnant for the LEGS-Spin Collaboration.
9:15AM EG.00002 A Measurement of the Deuteron Magnetic Dipole Form Factor from Vector Polarization Observables. PETE KARPIUS, JOHN CALARCO. University of New Hampshire Nuclear Physics Group, BLAST COLLABORATION — A measurement of the vector analyzing powers $T_\epsilon^E$ and $T_\epsilon^M$, and the magnetic dipole form factor $G_M^p$, in elastic electron-deuteron scattering has been conducted at the MIT-Bates Linear Accelerator Facility using a polarized electron beam, an internal polarized atomic deuterium target, and the symmetric BLAST (Bates Large Acceptance Spectrometer Toroid) detector in the Bates South Hall Ring. The beam helicity dependent target vector asymmetries, simultaneously measured in both sectors of BLAST, allow the extraction of $T_\epsilon^E$ and $T_\epsilon^M$. To our knowledge this is the first such use of a polarized target in measuring these observables. At low $Q^2$, the statistically more significant observable $T_\epsilon^E$ is dominated by the interference of $G_M^p$ and the charge monopole form factor $G_E^p$. The high accuracy to which $G_E^p$ is known in this region allows for the extraction of $G_M^p$, yielding the first such measurement of this kind from spin observables. Preliminary results for $T_\epsilon^E$, $T_\epsilon^M$, and $G_M^p$ will be presented. This work supported by DOE grants 181021 (UNH) and DEFC02-94ER40818 (MIT-Bates).

9:30AM EG.00003 Recoil Polarization in Deuteron Photodisintegration. XIAODONG JIANG, Rutgers University, THE JEFFERSON LAB HALL A COLLABORATION — High energy deuteron photodisintegration exhibits simple behaviors, including constant-angle cross sections that follow the constituent counting rules, for $p_T > 1.3$ GeV/c, and angular distributions that exhibit a slight asymmetry about $\theta_{\text{min}} = 90^\circ$. Measured recoil polarizations are small above 1 GeV, much smaller than hadronic model predictions, but not vanishing as predicted by helicity conservation. The limited $90^\circ$ polarization data are insufficient to come to firm conclusions concerning the validity of several quark model predictions that are generally in agreement with the cross section data. We have taken new recoil polarization data, a five-point angular distribution at $E_e \approx 2$ GeV. We will show the calibration $e^p$ elastic scattering data agree with earlier results, the polarimeter performance agrees with expectation, and the $\gamma d \rightarrow p^0 n^0$ data compared with model predictions. This work has been supported by the National Science Foundation, through grant PHY 03-54871 to Rutgers University.

9:45AM EG.00004 $G_E^p/G_M^p$ with BLAST. ADRIAN SINDILE, JOHN CALARCO. University of New Hampshire, BLAST COLLABORATION — One of the experiments that recently finished running at the MIT Bates Lab is the measurement of the $G_E^p/G_M^p$ ratio, using a polarized electron beam, an internal polarized atomic hydrogen gas target and the symmetric BLAST (Bates Large Acceptance Spectrometer Toroid) detector in the South Hall Ring of the Bates Linear Accelerator Facility. We have used the super-ratio technique to extract the proton electric to magnetic form factor ratio for a $Q^2$ between 0.1 and 0.9 (GeV/c)$^2$ from two-spin-dependent asymmetries we have measured simultaneously in the left and right sector of the BLAST detector respectively. This is the first time $G_E^p/G_M^p$ was measured using a polarized target. Preliminary results will be presented. DOE Grant Numbers: 181021 (UNH); DEFC02-94ER40818 (MIT-Bates).

10:00AM EG.00005 Medium modifications of nucleon structure functions. WOLFGANG BENTZ, Dept. of Physics, School of Science, Tokai University, Japan, IAN CLOET, ANTHONY THOMAS, Thomas Jefferson National Laboratories (JLab), U.S.A. — Using a chiral effective quark-diquark model for the single nucleon, we calculate the equation of state of nuclear matter in the mean field approximation, and the properties of a bound nucleon. In particular, we focus on the spin-independent and spin-dependent structure functions. For both cases, we first describe the free nucleon structure functions, and then consider the medium modifications. For the spin-independent case, we show the important role played by the mean vector field in the medium to explain the EMC effect. Concerning the spin-dependent case, we give predictions for the polarized EMC effect in the nuclear matter picture as well as for finite nuclei.

10:15AM EG.00006 Nucleon electromagnetic form factors in nuclear matter. TAH HORIKAWA, WOLFGANG BENTZ. Tokai University — We use the quark-diquark picture to construct the nucleon, and calculate its electromagnetic form factors. Furthermore, we estimate the medium effects for electromagnetic form factors by using the equation of state of nuclear matter in the mean field approximation. In this contribution, I explain the effect of the diquark intrinsic form factor, and the renormalization from the vector meson and pion cloud around the constituent quarks.

10:30AM EG.00007 Comparison of the ($e, e'p$) cross sections at low momentum transfer on light nuclei with relativistic calculations. TADASKI TAMAE, Tohoku University. THE (E,EP) COLLABORATION — The ($e, e'p$) cross sections have been measured on $^{12}\text{C}$, $^{16}\text{O}$ and $^{40}\text{Ca}$ at an energy transfer of 60 MeV and low momentum-transfer around 105 MeV/c. The cross sections at missing momenta between 180 and 300 MeV/c obtained from the experiment are compared with theoretical calculations based on the relativistic distorted-wave impulse approximation (RDWIA) with and without meson exchange currents (MEC) made by Pavia group in Italy. The contribution of MEC due to the seagull currents is large in the high missing momentum region for $^{12}\text{C}$ in particular for the longitudinal component, while it is small on $^{16}\text{O}$ and $^{40}\text{Ca}$. Current-conserving operators ($cc_1, cc_2, cc_3$) are used in the theoretical calculation. It is known that they give large difference for the $(\gamma, p)$ reaction, while the difference is small for the quasi-elastic ($e, e'p$) reaction. Influence to the choice of the current operator is medium in the ($e, e'p$) reaction at low momentum transfer, but still large. The calculations overestimate the experimental cross sections by a factor of two in the low missing momentum region for all three nuclei. It indicates that some important ingredients are missing in the theoretical calculation.

10:45AM EG.00008 Inclusive Scattering from Nuclei at $x>1$ and High $Q^2$ with a 6 GeV beam. NADIA FOMIN, University of Virginia — Inclusive electron scattering from nuclei at large $x$ and $Q^2$ is the result of a reaction mechanism that includes both quasi-elastic scattering from nucleons and deep inelastic scattering from the quark constituents of the nucleons. Consequently, it provides an opportunity to investigate the transition from a regime where nucleon degrees of freedom dominate to one where the more fundamental QCD interactions are exposed. Data in this regime can be used to study a wide variety of topics, including the extraction of nuclear momentum distributions, the influence of final state interactions and the approach to $y$-scaling, the strength of nucleon-nucleon correlations, and the approach to $z$-scaling, to name a few. We recently performed an experiment in Jefferson Lab’s Hall C using a 6 GeV beam and a range of both light and heavy nuclei which was designed to significantly extend the kinematic region at high momentum transfer and large (negative) $y$, previously explored in SLAC experiment NE3 and Jefferson Lab experiment E89-008. After a brief statement of the physics goals of this experiment, we will present preliminary results.

11:00AM EG.00009 New sum rules for the spin dependent structure functions $g_1$. KORETUNE SUSUMU, Shimane University — Sum rules for the spin dependent structure function $g_1$ derived from the canonical quantization on the null plane have been regularized and transformed to the ones which are mainly concerned with the low energy quantities. These sum rules are related to the cross section of the photonproduction. Through these sum rules, it is discussed that there is a deep connection between the elastic and the resonance contributions, and that it is this relation which explains why the sign change discussed by the Drell Hern Gerasimov sum rule and Ellis Jaffe sum rule occurs in the very small $Q^2$ region. Thus the sum of these contributions can be related to the high energy behavior.
11:15 AM EG.00010 Resonant Spin Structure (RSS) of the Proton  KARL SLIFER, University of Virginia, JLAB RSS COLLABORATION — Spin-dependent structure functions have been extracted from an inclusive doubly polarized asymmetry measurement at low momentum transfer \(Q^2 \approx 1.3 \text{GeV}^2\) in the resonance region. Longitudinally polarized electrons of incident energy 5.755 GeV were scattered from a polarized solid ammonia target in Jefferson Lab’s experimental Hall C. Both NH3 and ND3 were used as target material giving access to the proton and deuteron spin structure respectively. For the first time at low \(Q^2\) and in the resonance region, proton asymmetries were measured with both perpendicular and parallel target field orientation, allowing a precision determination of the spin structure functions \(g_1(x,Q^2)\) and \(g_2(x,Q^2)\). The \(W\)-dependence of the nucleon spin asymmetries \(A_1(W,Q^2)\) and \(A_2(W,Q^2)\) has been measured with high resolution, allowing for clear identification of individual resonance regions. Preliminary proton data will be presented which enable a test of local duality in the polarized spin structure functions. The moments of the spin structure functions, including the extended GDH sum and the \(d_2\) matrix element, are also evaluated and compared with theoretical expectations.

11:30 AM EG.00011 Spin Structure Functions of the Deuteron in the Region of the Nucleon Resonances  SHIGEYUKI TAJIMA, University of Virginia, JEFFERSON LAB E01-006 COLLABORATION — The Jefferson Lab (JLab) E01-006 collaboration performed precise measurement of the spin structure functions of the proton and deuteron in the region of nucleon resonances (final state invariant mass \(W < 2\)) at the four-momentum transfer squared of \(Q^2 = 1.3(\text{GeV}/c)^2\). The \(W\) dependence of \(A_1\) and \(A_2\) has been measured with high resolution, allowing for clear identification of individual resonance regions. The spin structure measurements in the resonance region allow us to study the local duality for the polarized spin structure functions. In this experiment, the longitudinally-polarized electron beam of 5.755 GeV energy was scattered from a polarized solid ammonia target in Hall C at JLab. The scattered electrons were then detected in High Momentum Spectrometer (HMS), which allows us to measure inclusive scattering asymmetries. Ordinary (NH3) and deuterated (ND3) ammonia were used as polarized proton and deuteron targets. High precision measurements of the beam-target asymmetries (\(A_1\) and \(A_2\)) with polarization of the target material being parallel or perpendicular to the beam direction allow us to determine the spin asymmetries (\(A_1(W,Q^2)\) and \(A_2(W,Q^2)\)) and the spin structure functions \(g_1(x,Q^2)\) and \(g_2(x,Q^2)\) in a model independent way. In this talk, preliminary results for the deuteron spin structure functions as well as very preliminary results for the neutron will be presented.

11:45 AM EG.00012 Coherent vector meson electroproduction off the deuteron  ATILLA GONENC, BRIAN RAUE, LAIRD KRAMER, Florida International University, CLAS COLLABORATION — QCD predicts Color Transparency (CT), which refers to nuclear medium transparency to small color neutral object produced in high momentum transfer reactions, due to reduced strong interaction. Despite several studies at BNL, SLAC, FNAL, DESY and Jefferson Lab, a definitive signal for CT still remains elusive. In this paper, we present the results of a new study at Jefferson Lab motivated by theoretical calculations that suggest fully exclusive measurement of coherent vector meson electroproduction off the deuteron is a favorable channel for studying CT. Vector meson production has a large cross section at high energies, and the deuteron is the best understood and simplest nuclear system. Exclusivity allows the production and propagation to be controlled separately by controlling \(Q^2\), \(l_f\) (formation length), \(l_c\) (coherence length) and \(t\). This control is important as the rapid expansion of small objects increases their interaction probability and masks CT. The CT signal appears in a ratio of cross sections at high \(-t\) (where rescattering is significant) to low \(-t\) (where single nucleon reactions dominate).

12:00 PM EG.00013 Precise Measurement of the Nuclear Dependence of Structure Functions in Light Nuclei  JASON SEELY, Laboratory for Nuclear Science, Massachusetts Institute of Technology, E03-103 COLLABORATION — The EMC effect has been with us for over 20 years. During this time, the nuclear dependence of the structure functions, and thus quark distributions, has been studied with much success. However, the bulk of the experimental effort has been to measure the effect in heavy nuclei where it has the same \(x\) dependence and differs only in magnitude. Calculations predict large differences in both the magnitude and \(x\) dependence of the EMC effect on \(^3\)He and \(^4\)He and precise measurements of the EMC effect in these nuclei could be used to distinguish between existing models. To that end, E03-103 has measured the inclusive electron scattering cross-section on \(^1\)H, \(^2\)H, \(^3\)He, and \(^4\)He, as well as the heavier targets Be, C, Cu, and Au. These data will provide the first measurement of the EMC effect on \(^3\)He above \(x > 0.5\), and improve upon the existing measurement of the effect on \(^4\)He. Preliminary results for the EMC ratios on \(^3\)He and \(^4\)He will be presented.

Wednesday, September 21, 2005 9:00 AM - 12:00 PM –
Session EH DNP JPS: Mini-symposium on Nuclear Physics in Extreme Astrophysical Conditions

| Ritz-Carlton Hotel Plantation 1 |

9:00 AM EH.00001 Measurement of the astrophysical \(^8\)Li(\(\alpha, n\)) reaction cross section  HIROARI MIYATAKE, IPNS, KEK — It has been discussed that \(\alpha, n\) reactions of light neutron-rich radioactive nuclei play important roles in the \(r\)-process at a ‘hot bubble’ formed in a supernova explosion\[1\]. A systematic study of these astrophysical reaction rates has been started at the Tandem facility in Japan Atomic Energy Research Institute (JAERI). Direct measurements of \(^9\)Li(\(\alpha, n\))\(^1\)B, \(^12\)B(\(\alpha, n\))\(^1\)N, \(^16\)N(\(\alpha, n\))\(^1\)F reaction cross sections have been performed, so far. In particular, the \(^8\)Li(\(\alpha, n\)) is one of critical reactions in going to heavier elements across the stability gap of \(A = 8\) not only in the \(r\)-process but also in the possible nucleosynthesis at the Big Bang. We will report a result of the exclusive measurement in the energy region of \(E_{\text{cm}} = 0.7 - 2.6\) MeV together with a preliminary one in the lower energy region of \(E_{\text{cm}} = 0.14 - 1.7\) MeV covering the Gamow window at \(T = 1\). The \(^8\)Li-RNB was produced via the \(^7\)Be(\(^7\)Li,\(^8\)Li)\(^8\)Be transfer reaction and was separated using the recoil mass separator. The typical intensity and purity were 5.0 kpps and 99%, respectively. Then, \(^8\)Be enters directly to a fast counter named as Multi-Sampling and Tracking Proportional Chamber (MSTPC) filled with He (90\%) + CO2(10\%). The He-gas works not only as a counter gas but also as a target material. Three-dimensional trajectories and energy losses of all the charged particles were measured to identify the reaction point and its energy. Neutrons emitted simultaneously were also measured by a plastic-scintillator array. The excitation function of the reaction cross section was thus measured in the broad energy range. The obtained result has ten times better statistics compared to the previous exclusive measurement\[2\]. An improved astrophysical S-factor will be discussed together with some information of excited states in the compound nucleus, \(^1\)B. \(^1\)B will also be mentioned about relevant experimental plan, which will be performed using light neutron-rich RNBs supplied from JAERI-RMS or Tokai Radioactive Ion Accelerator Complex (TRIAC)\[3\].


9:30 AM EH.00002 Measurements with \(^7\)Be beams at the HRIBF\(^1\), D.W. BARDAWAY, J.C. BLACKMON, J.J. DAS, C.D. NESARAJA, M.S. SMITH, D.W. STRACENER, ORNL, K.Y. CHAE, Z. MA, U. TENN, A.E. CHAMPAGNE, R. FITZGERALD, D.W. VISSLER, UNC, U. GREIF, R.J. LIVESAY, Colorado School of Mines, V. GUIMARAES, U. SÃO PAULO, J. HOWARD, R.L. KOZUB, Tenn. Tech. U., M.S. JOHNSON, ORAU, K.L. JONES, S.D. PAIN, J.S. THOMAS, Rutgers, P.D. PARKER, Yale — \(^7\)Be beam has been used at the HRIBF to study important reactions in stellar burning. Precise knowledge of the \(\beta\)-delayed\(^\beta\) rate is important for interpreting solar neutrino flux observations. A direct measurement of the \(\beta\)-delayed\(^\beta\) rate is being made by bombarding a \(^7\)Be target with a \(^7\)Be beam and counting \(^8\)B recoils at the focal plane of the DRS mass spectrometer. The \(^7\)He(\(^7\)He,\(^8\)He)\(^8\)He reaction also occurs in stellar burning, but interpretation of low energy measurements have been hindered by a surprisingly strong low-energy rise in the cross section. This rise could, in part, be due to broad \(^7\)Be resonances. We have studied \(^2\)H(\(^7\)Be,\(^7\)Be)\(^8\)Be to search for any such broad \(^7\)Be levels. Initial results from these measurements will be presented.

\(^1\)ORNL is managed by UT-Battelle, LLC for the U.S. DOE under Contract No. DE-AC05-00OR22725.
reaction rate for excited states in physics: and rates for radiative proton capture reactions can be precisely determined. In particular, the breakup of a radioactive ion beam at ISAC (TRIUMF), using the DRAGON separator. We also used the DRAGON's BGO array to measure the from a search for excited states in CD. For the GSI kinematics, where in fact one may observe slope different than for CD (at least for the GSI1 data), they find a fortuitous cancellation that leads to a vanishingly small slope correction. Hence the validity of these correction based on the observed slopes can not be substantiated.


10:00AM EH.00009 New Measurement of the E1 Component of the 12C(α,γ)16O Reaction, X.D. TANG, M. NOTANI, K.E. REHM, I. AHMAD, J. GREENE, A.A. HECHT, D. HENDERSON, R.V.F. JANSENS, C.L. JIANG, E.F. MOORE, R.C. PARDO, G. SAVARD, J.P. SCHIFFER, S. SINHA, Argonne National Laboratory, M. PAUL, Hebrew University, L. JISONNA, R.E. SEGEL, Northwestern University, C. BRUNE, Ohio University, A. CHAMPION, U. of North Carolina, A. WUOSMAA, Western Michigan University — The radiative capture reaction 12C(α,γ)16O is an important process in nuclear astrophysics. Since the cross sections at red-giant temperatures are extremely small (∼10^{-17} b) indirect techniques have to be used to determine its astrophysical rate coefficient. The 12C component of this rate is best determined through a measurement of the beta-delayed alpha decay of 14N. For a measurement of this decay we have built a system of high-acceptance gas-ionization detectors, which are insensitive to beta particles that limited earlier measurements. Beam impurities that affected one of the earlier experiments were eliminated through the choice of the 14N production technique. New results from this experiment and comparisons with earlier data will be presented. This work was supported by the US Department of Energy, Nuclear Physics Division, under contract No. W-31-109-ENG and by the NSF Grant No. PHY-02-16783 (Joint Institute for Nuclear Astrophysics).

10:15AM EH.00005 New Measurement of the 16O Component of the 12C(α,γ)16O Reaction, X.D. TANG, M. NOTANI, K.E. REHM, I. AHMAD, J. GREENE, A.A. HECHT, D. HENDERSON, R.V.F. JANSENS, C.L. JIANG, E.F. MOORE, R.C. PARDO, G. SAVARD, J.P. SCHIFFER, S. SINHA, Argonne National Laboratory, M. PAUL, Hebrew University, L. JISONNA, R.E. SEGEL, Northwestern University, C. BRUNE, Ohio University, A. CHAMPION, U. of North Carolina, A. WUOSMAA, Western Michigan University — The radiative capture reaction 12C(α,γ)16O is an important process in nuclear astrophysics. Since the cross sections at red-giant temperatures are extremely small (∼10^{-17} b) indirect techniques have to be used to determine its astrophysical rate coefficient. The 12C component of this rate is best determined through a measurement of the beta-delayed alpha decay of 14N. For a measurement of this decay we have built a system of high-acceptance gas-ionization detectors, which are insensitive to beta particles that limited earlier measurements. Beam impurities that affected one of the earlier experiments were eliminated through the choice of the 14N production technique. New results from this experiment and comparisons with earlier data will be presented. This work was supported by the US Department of Energy, Nuclear Physics Division, under contract No. W-31-109-ENG and by the NSF Grant No. PHY-02-16783 (Joint Institute for Nuclear Astrophysics).

10:30AM EH.00008 Investigation of proton resonant states in 23Al and 22Mg using radioactive beams at CNS, JIJUNJUN HE, SHIGERU KUBONO, TAKASHI TERANISHI, MASAHIRO NOTANI, HIDETADA BABA, SHIN'ICHIRO MICHIMASA, Center for Nuclear Study, University of Tokyo (CNS), Japan, SHUNJI NISHIMURA, MIZUKI NISHIMURA, YOSHIYUKI YANAGISAWA, RIKEN (The Institute of Physical and Chemical Research), Japan, HIRONORI IWASAKI, Department of Physics, University of Tokyo, Japan, NAHO HOKOIWA, MIBIYA KIBE, YASUYUKI GON, Department of Physics, Kyushu University, Japan, JUN-YUNG MOON, JU-HAHN LEE, CHUN-SIK LEE, Department of Physics, Chung-Ang University, South Korea, SEIGO KATO, Department of Physics, Yamagata University, Japan — We have studied the proton resonances in of Physical and Chemical Research), Japan, HIRONORI IWASAKI, Department of Physics, University of Tokyo, Japan, NAHO HOKOIWA, MIBIYA KIBE, YASUYUKI GON, Department of Physics, Kyushu University, Japan, JUN-YUNG MOON, JU-HAHN LEE, CHUN-SIK LEE, Department of Physics, Chung-Ang University, South Korea, SEIGO KATO, Department of Physics, Yamagata University, Japan — We have studied the proton resonances in 23Al and 22Mg via the resonant scattering of radioactive particles on a thick CH2 target. The 22Mg and 21Na beams were separated by the CNS Radioactive Ion Beam separator (CRIB) with energies of 4.4 AMeV and 4.0 AMeV, respectively. At scattering angles of θlab = 4°, 17° and 23°, the recoiled particles were measured by three sets of ΔE-E Si telescopes. As for nucleus 23Al (via 22Mg+p), several new resonant states were observed. As for nucleus 22Mg (via 21Na+p), the previously observed resonant states were confirmed. The states above the alpha threshold were observed, which are related to the 12Ne(α,p)21Na reaction. The resonant parameters were deduced from an R-matrix code. The nuclear structures and the astrophysical implications are discussed.

10:45AM EH.00007 Excited states in 22Mg and the 21Na(p,γ)22Mg reaction, CYBELE JEWETT, UWE GRIFFIE, KELLY CHIPP, FRED SARAZIN, Colorado School of Mines, SHAW BISHOP, JOHN D'ARIAU, MICHAEL LAMEY, MICHAEL TRINCZEK, Simon Fraser University, DAVE HUTCHISON, DAVE OTTEWELL, ART OLIN, LOTHAR BUCHMANN, JONATHAN PEARSON, SABINE ENGEL, DARIO GIGLIOTTI, CHRIS RUIZ, GOTZ RUPRECHT, CHRISTOP VOVKENHEUERM, TRIUMF, CARL GROSS, DAVID RADFORD, CHANG-HONG YU, JEFF BLACKMON, DANIEL BARDAYAN, MICHAEL SMITH, Oak Ridge National Laboratory, RAY KOZUB, Tennessee Technical University, DRAGON - TRIUMF COLLABORATION, CLARIO/RMS - ORNL COLLABORATION — In explosive astrophysical scenarios like novae or x-ray bursts, the 21Na(p,γ)22Mg reaction is believed to play an important role. The proton capture proceeds predominantly via isolated states in the 22Mg nucleus. This talk will present results from a search for excited states in 22Mg via the 12C-12C reaction measured at HRIFB (ORNL). A direct measurement of 21Na(p,γ)22Mg was performed with a radioactive ion beam at ISAC (TRIUMF), using the DRAGON separator. We also used the DRAGON’s BGO array to measure the γ-branching ratios of the excited states in 22Mg, and compared their J+ assignments with previously published values.

11:00AM EH.00008 Breakup of loosely bound nuclei as indirect method in nuclear astrophysics: 9B, 9C, 15C, 23Al, L. TRACHE, C.A. GAGLIARDI, R.E. TRIBBLE, Texas A&M University, College Station, TX, F. CARSTOUN, NIPNE Bucharest, Romania — We discuss the use of one-nucleon breakup reactions of loosely bound nuclei at intermediate energies as an indirect method in nuclear astrophysics. These are peripheral processes, therefore we can extract asymmetric normalizing coefficients (ANC) from which astrophysical S-factors and rates for radiative proton capture reactions can be precisely determined. In particular, the breakup of 9B and 9C is described in terms of an extended Glauber model. Existing experimental data for the breakup of 9B and 9C on light through heavy targets are analyzed. We show that there exists a favorable kinematical window in which breakup reactions are highly peripheral. In this regime the ANC is the better spectroscopic information to be extracted. Glauber model calculations in the eikonal approximation and the optical limit using different effective interactions give consistent, though slightly different results. This shows the possibilities and the limits of the precision of the method. Breakup reactions can be measured with radioactive beams as weak as a few particle per second, and can be used for cases where no direct measurements or other indirect methods for nuclear astrophysics can be applied. We discuss also the use of one-neutron-removal to assess (n,γ) rates using 15C as example, and the proposed use of the breakup of proton drip line nucleus 23Al to obtain the stellar reaction rate for 22Mg(p,γ)23Al.
11:15 AM EH.00009 Coulomb Dissociation of $^{27}\text{P}$ for Study of $^{26}\text{Si}(\text{p,}\gamma)^{27}\text{P}$ Reaction, YASUHIRO TOGANO, Department of Physics, Rikkyo University, RIKKYO UNIV.-RIKEN-ATOMKI-TIT-UNIV. OF TOKYO-TOHOKU UNIV.-CNS-KYOTO UNIV. COLLABORATION — The $^{26}\text{Si}(\text{p,}\gamma)^{27}\text{P}$ reaction was investigated by the Coulomb dissociation of $^{27}\text{P}$. This reaction is suggested to be relevant to the synthesis of $^{26}\text{Al}$ whose 1.8 MeV $\gamma$-line distribution in the Galaxy is observed by satellite telescopes. In order to estimate the reaction flow around $^{26}\text{Al}$, we determined the gamma decay widths of excited states in $^{27}\text{P}$, which mainly determine the resonant capture reaction rate. The experiment was performed at RIPS beam line in RIKEN. A beam of the unstable $^{27}\text{P}$ nucleus at 57 MeV/nucleon was produced by the fragmentation of a 115-MeV/nucleon $^{38}\text{Ar}$ beam. The $^{27}\text{P}$ beam bombarded a Pb target. The excitation energy of $^{27}\text{P}$ was extracted by combining the momentum vectors of $^{26}\text{Si}$ and proton. The three known excited states in $^{27}\text{P}$ [1] as well as a new excited state at around 2.0 MeV were observed. The gamma decay width of the first excited state was deduced to be $(1.3 \pm 0.8) \times 10^{-3}$ eV. Details of experiment and astrophysical implications of the measured gamma decay widths will be presented.


11:30 AM EH.00010 Lifetime of the 4.033 MeV state in $^{18}\text{Ne}$, BARRY DAVIDS, GORDON BALL, RITUPARNA KANUNGO, TRIUMF, MYTHILI SUBRAMANIAN, University of British Columbia — In astrophysical environments the $^{19}\text{O}(\alpha,\gamma)^{20}\text{Ne}$ reaction proceeds predominantly through resonances lying just above the $^{15}\text{O} + \alpha$ threshold at 3.529 MeV in $^{19}\text{Ne}$. The reaction rate in novae is determined by the resonance strength of the 4.033 MeV 3/2$^+$ state. This state may also make the largest contribution to the reaction rate at the higher peak temperatures reached in x-ray bursts. By populating these states and observing the subsequent $\alpha$- and $\gamma$-decays, one can deduce the branching ratio $\Gamma_{\alpha}/\Gamma_{\gamma}$. If $\Gamma_{\gamma}$ is also known, one can then calculate the resonance strength and thereby the contribution of each state to the astrophysical rate of the $^{19}\text{O}(\alpha,\gamma)^{20}\text{Ne}$ reaction. Experimental data on the radiative widths of these states are sparse. An effort to measure the lifetime of the 4.033 MeV state by the Doppler shift attenuation method (DSAM) resulted in an upper limit. A complementary measurement of the Coulomb excitation to this state at intermediate beam energies resulted in an upper limit on the radiative width, corresponding to a lower limit on the lifetime. The 95% confidence level allowed region for the lifetime, and therefore the reaction rate, spans two orders of magnitude. We are planning to measure the lifetime of this state using the DSAM, populating it via the $^4\text{He}(^{20}\text{Ne},\alpha)^{16}\text{Ne}$ reaction at a $^{20}\text{Ne}$ beam energy of 34 MeV.

3Work supported by NSERC, Canada

11:45 AM EH.00011 Computational Infrastructure and Nuclear Data Activities for Nuclear Astrophysics at Oak Ridge National Laboratory, C.D. NESARAJA, M.S. SMITH, D.W. BARDAYAN, J.C. BLACKMON, E.J. LINGERFELT, J.P. SCOTT, Oak Ridge National Laboratory, K. CHAE, Univ. of Tenn., R.L. KOZUB, Tenn. Tech. Univ., J.S. THOMAS, Rutgers Univ., R.A. MEYER, RAME — A Computational Infrastructure for Nuclear Astrophysics has been developed to enable rapid incorporation of the latest nuclear physics data in astrophysics models. The infrastructure is a platform-independent suite of computer codes and is available online at nucastodata.org. The user-friendly interface enables users to easily upload their data, create reaction rates, easily access and manage libraries of cross sections and rates, perform simple data evaluation tasks, run element synthesis calculations, and visualize them with animations. The suite's new features and its utilization for nova and X-ray burst modeling will be discussed. Other nuclear data activities at ORNL include evaluating properties and reactions of unstable nuclei being measured at ORNL's HRIBF. Reactions with radioactive beams of $^{18}\text{F}$, $^{82}\text{Ge}$, and $^{84}\text{Se}$ are among those being studied. A survey of evaluation results and plans for additional work will be presented.

1Supported by DOE (DE-AC05-000R22725)

Wednesday, September 21, 2005 9:00AM - 12:00PM — Session EJ DNP JPS: Instrumentation III  Ritz-Carlton Hotel Hawaii

9:00AM EJ.00001 The $8\pi$ Spectrometer: A Detector Array for Decay Spectroscopy, W.D. KULP, Georgia Tech, 8\pi  COLLABORATION — The $8\pi$ spectrometer, an array of 20 Compton-suppressed HPGe detectors arranged in a regular icosahedral geometry, was originally designed for $\gamma$-ray coincidence spectroscopy following heavy-ion reactions. At TRIUMF/ISAC-I, the $8\pi$ has been recommissioned for studies of rare radioactive decays. The symmetry of the array virtually eliminates the effects of $\gamma - \gamma$ angular correlations when the integrated array is used in coincidence spectroscopy. When $\gamma - \gamma$ coincidences are analyzed by the five possible angles between detector pairs, however, rich angular correlation information may be extracted. Results from angular correlation decay studies with the $8\pi$ will be presented and implications for high-granularity detector arrays will be discussed.

1Work supported in part by the USDOE under contract DE-FG02-96ER40958.

9:15AM EJ.00002 Reduction of $\gamma$-ray background using Compton camera, Y. GONO, RIKEN, Japan, A. ODARARA, Nishinippon Inst. of Tech., Japan, S. MOTOMURA, RIKEN, Japan, Y. ISOZUMI, Kyoto Univ., Japan, T. KIKEGAWA, KEX-PF, Japan, Y. MOTIZUKI, RIKEN, Japan, T. FUKUCHI, Rikkyo Univ., Japan, Y. WAKABAYASHI, Kyushu Univ., CNS Univ. of Tokyo, Japan — Development of the method to reduce the background $\gamma$-rays was carried out by using the Compton camera. Compton camera can make the image of the distribution of the $\gamma$-ray source. A change of a decay constant of $^{40}\text{K}$ under high pressure is of interest in studies of the fields in nuclear physics, nuclear astrophysics and earth science. As much amount of $^{40}\text{K}$ chemical compound is included in the earth, the $\gamma$-ray of 1461 keV is easily observed as a natural background. It is crucial to reduce the natural background $\gamma$-rays in this experiment. RIKEN group developed the Compton camera which is called to be GREI (Gamma-Ray Emission Imaging). GREI consists of two double sided strip Ge detectors. By selecting events that the only $\gamma$-rays are emitted from the source position, it was found that the background $\gamma$-rays could be reduced about 94%. This effect corresponds to that by a shield of the 4.7 cm thick lead bricks.

9:30AM EJ.00003 Freons in Parallel Plate Avalanche Counters (PPACs), E. NORBECK, J.E. OLSON, Y. ONEL, University of Iowa — Freons that contain only C, H, and F are still allowed at National Laboratories because they do not harm the ozone layer. The perfluorokanes, no H or double bonds, have the additional advantage of being nontoxic and can be recirculated through a purifier cartridge that removes all impurities except noble gasses. At atmospheric pressure small molecules are preferred because they require less voltage. As a PPAC gas, CF$_4$ and R134A (CF$_2$H$_2$CF$_3$), the working fluid in automobile air conditioners, give similar results. With a plate spacing of 0.6 mm at 3050 V and 700 torr, R134A gave signals of amplitude 350 mV and width 1.5 ns with the detector directly coupled into 50 $\Omega$ cable. The radiation source was Compton scattered electrons from a 7 mCi $^{55}\text{Co}$ gamma-ray source. Methane, CH$_4$, gave similar results, but with much less primary ionization because of the small molecular weight. The mixture, 95% Ar + 5% CO$_2$, required only 1000 V, but the signals were smaller and slower. If low pressures are required, heavy gasses are preferred because of the larger amount of primary ionization. Perfluoropropane, C$_3$F$_8$, and perfluorocyclobutane, C$_4$F$_8$, are gasses at room temperature that work well in the 20 to 100 torr range with a 0.6 mm plate spacing, but are less useful with a 2.5 mm spacing. For all of the PPAC gasses, small amounts of impurities reduce the threshold voltage for sparking.
235 of neutron capture on complicated by low-energy neutron-induced fission, which competes with neutron capture to varying degrees depending on the nuclide of interest. Measurements of neutron capture and (n, fission) cross sections with the DANCE array will also provide a means to study several important issues associated with neutron-induced fission, including (n, fission) cross sections as a function of energy. Measurements of neutron capture on 235 have established that a new state of matter has been formed in collisions of heavy ions at √sNN = 5.5 TeV. ALICE Transition Radiation Detector (TRD) is now in the production stage. A first beam test of full size six-chamber detector stack of TRD was performed at CERN PS beam line in October 2004. In this talk, electron identification capability using neural network method will be reported.

Electron identification capability of real size Transition Radiation Detector for ALICE using neural network method. YUHEI MORINO, CNS, University of Tokyo, SHOTA SAITO, TAKU GUNJI, HIDEKI HAMAGAKI, KYOCHOI OZAWA, ALICE TRD COLLABORATION — It is predicted from QCD theory that the phase transition would be occurred from ordinary hadronic matter to a plasma of de-confined quarks and gluons, called quark-gluon-plasma (QGP) at high energy density and high temperature. ALICE experiment is one of the experiments which will be held at Large Hadron Collider at CERN in near future (2007). The physics goal of the ALICE experiment is to study such QCD phase transition at CMS energy of √sNN = 200 GeV. ALICE Transition Radiation Detector (TRD) will be installed to provide electron identification and particle tracking. For measurements of quarkonia, it is required for the ALICE TRD to satisfy pion rejection factor of larger than 100 at 90% electron efficiency. The TRD for ALICE is now in the production stage. A first beam test of full size six-chamber detector stack of TRD was performed at CERN PS beam line in October 2004. In this talk, electron identification capability using neural network method will be reported.

Electron identification capability of real size Transition Radiation Detector for ALICE using neural network method. YUHEI MORINO, CNS, University of Tokyo, SHOTA SAITO, TAKU GUNJI, HIDEKI HAMAGAKI, KYOCHOI OZAWA, ALICE TRD COLLABORATION — It is predicted from QCD theory that the phase transition would be occurred from ordinary hadronic matter to a plasma of de-confined quarks and gluons, called quark-gluon-plasma (QGP) at high energy density and high temperature. ALICE experiment is one of the experiments which will be held at Large Hadron Collider at CERN in near future (2007). The physics goal of the ALICE experiment is to study such QCD phase transition at CMS energy of √sNN = 200 GeV. ALICE Transition Radiation Detector (TRD) will be installed to provide electron identification and particle tracking. For measurements of quarkonia, it is required for the ALICE TRD to satisfy pion rejection factor of larger than 100 at 90% electron efficiency. The TRD for ALICE is now in the production stage. A first beam test of full size six-chamber detector stack of TRD was performed at CERN PS beam line in October 2004. In this talk, electron identification capability using neural network method will be reported.

Recent development of the Optical Transition Radiation detector at the J-PARC slow-extraction beam line. AKIHISA TOYODA, KEIZO AGARI, ERINA HIROSE, MASAHARU IRIE, YOHJI KATOH, MICHI-FUMI MINAKAWA, HIROYUKI NAOI, YOSHINORI SATO, YOSHIO SUZUKI, HITOSHI TAKEUCHI, MINORU TAKASAKI, KAZUHIRO TANAKA, YOSHIKAZU YAMADA, YUTAKA YAMANOI, HIROAKI WATANABE, KEK — The J-PARC slow-extraction beam line under construction will provide a high intensity proton beam with a beam power of 750 kW. To handle such high intensity beam line safely, it is necessary to monitor the beam profile precisely without fault. Moreover, beam loss at the beam monitor should be minimized to reduce the residual dose rate and the heat deposition at the beam monitor. As such beam profile monitor, we have developed the OTR (Optical Transition Radiation) detector. This monitor is composed of the OTR screen as a radiator and a camera system with an image intensifier to measure the OTR light. Because the OTR light intensity only depends on the reflectivity of the OTR screen, we can minimize a thickness of the OTR screen so that the problem of the residual dose and the heat deposition is expected to be resolved. In this talk, we will report the result of the beam test of a prototype OTR detector performed at KEK-PS beam line. The beam response, a background condition, and a readout system will be presented.

Recent development of the Optical Transition Radiation detector at the J-PARC slow-extraction beam line. AKIHISA TOYODA, KEIZO AGARI, ERINA HIROSE, MASAHARU IRIE, YOHJI KATOH, MICHI-FUMI MINAKAWA, HIROYUKI NAOI, YOSHINORI SATO, YOSHIO SUZUKI, HITOSHI TAKEUCHI, MINORU TAKASAKI, KAZUHIRO TANAKA, YOSHIKAZU YAMADA, YUTAKA YAMANOI, HIROAKI WATANABE, KEK — The J-PARC slow-extraction beam line under construction will provide a high intensity proton beam with a beam power of 750 kW. To handle such high intensity beam line safely, it is necessary to monitor the beam profile precisely without fault. Moreover, beam loss at the beam monitor should be minimized to reduce the residual dose rate and the heat deposition at the beam monitor. As such beam profile monitor, we have developed the OTR (Optical Transition Radiation) detector. This monitor is composed of the OTR screen as a radiator and a camera system with an image intensifier to measure the OTR light. Because the OTR light intensity only depends on the reflectivity of the OTR screen, we can minimize a thickness of the OTR screen so that the problem of the residual dose and the heat deposition is expected to be resolved. In this talk, we will report the result of the beam test of a prototype OTR detector performed at KEK-PS beam line. The beam response, a background condition, and a readout system will be presented.

Simultaneous measurement of (n,γ) and (n,fission) cross sections with the DANCE 4π BaF2 array. T.A. BREDEWEG, M.M. FOWLER, E.M. BOND, M.B. CHADWICK, E.-I. ESCH, L.F. HUNT, J.M. O’DONNELL, R.S. RUNDBERG, J.M. SCHWANTES, J.L. SONG, C.S. YOON, S.H. KIM, Gyeongsang Natl. University — Hybrid emulsion experiment, KEK-E373, has been carried out to study baryon-baryon interaction in S = −2 sector via Ξ− capture in the emulsion which produced (K−, Ξ−) process. In the present, 3 hypernuclear events and 2 twin hypernuclear events are found. Furthermore a candidate of Ξ− emission events from Ξ− capture is also found. These events give important information on B−B interaction. In the future, new experiments (BNL-E964 and one at J-PARC) are planned in order to study B−B interaction systematically. In the experiment, position of produced Ξ− s in the emulsion was predicted from (K−, Ξ−) reaction kinematics by analyzing counter data. Therefore, searching area of the emulsion could be limited and effective analysis could be performed. However, in the future experiments number of produced Ξ− become 10 or more times than that of KEK-E373. And if the analyzing speed is enough to search all area of the emulsion, non-triggered Ξ− s produced by K− n → Ξ− can be detected. In order to analyze these data, new auto scanning system have been developed. In the system CCD camera which shoot the emulsion image don’t stop in the analysis. Thus, dead time caused by go-process in changing search area become to 0.

A Comprehensive New Detector (R2D) at RHIC II. JOHN W. HARRIS, Yale University, FOR THE RHIC II DETECTOR (R2D) EXPLORATORY WORKING GROUP* COLLABORATION — Results from the Relativistic Heavy Ion Collider (RHIC) have established that a new state of matter has been formed in collisions of heavy ions at √sNN = 200 GeV. However, fundamental questions remain to be addressed regarding whether the system is deconfined, chiral symmetry is restored, a color glass condensate exists, and how the system evolves through eventual hadronization. Jets, heavy flavors and electromagnetic probes are sensitive to the initial high density stage, and should provide the requisite new insight. Such a thorough investigation necessitates jet measurements with particle identification at large momenta, measurement of all quarkonium states up to the Y(3s) state including feed-down in pp, pA and AA, and measurements at forward rapidities including forward-midrapidity correlations. For this purpose, we propose a comprehensive new detector for upgraded luminosity RHIC II operation with large acceptance (-3 < y < 3, Δφ = 2π) tracking and calorimetry in a 1.5 T solenoidal magnetic field for hadron, muon and photon identification and momentum measurements up to 20-30 GeV/c. We describe the detector, summarize its performance and discuss its potential physics impact in an era with heavy ions in the Large Hadron Collider.

* P. Steinberg et al., nucl-ex/0503002.
11:15AM EJ.00010 Measurements of Stability of Gas Electron Multiplier (GEM), YORITO YAMAGUCHI, HIDEKI HAMAGAKI, KYOICHIRO OZAWA, SUSUMU ODA, CNS, University of Tokyo, MASAHIDE INUZUKA, National Research Institute for Cultural Properties, Tokyo. — Recently, we produce a new type of Gas Electron Multiplier (GEM) foils by a plasma etching method. We investigate the gain stability of the GEM made at CNS, University of Tokyo. The GEM, which has been originally developed at CERN using micro-pattern technology, is expected to have the possibility of high rate operation together with good spatial resolution. The GEM made at CERN (CERN-GEM) is produced by the chemical etching method and has holes with a double-conical shape. It has been reported that the gas gain of CERN-GEM increases (or decreases) as a function of illumination time. One possible reason of the illumination-time dependence is that the Kapton insulator in the GEM charges up. The charging-up is thought to be due to a double-conical shape of holes of the CERN-GEM. We succeeded in producing the GEM (CNS-GEM) which has holes with a cylindrical shape by the plasma etching method. The CNS-GEM is expected to have better gain stability than CERN-GEM since the CNS-GEM has better electron transmission and less probability of charging-up. In this talk, the result of measurements for gain stability of the CNS-GEM compared with that of the CERN-GEM and the current status of development of the CNS-GEM will be reported.

11:30AM EJ.00011 Development of Residual Gas Ionization Profile Monitor for slowly extracted proton beams, YOSHINORI SATO, High Energy Accelerator Research Organization (KEK), KEizo AGARI, MASAHARU IEIRI, YOHJIKO KATO, ERIKA HIROSE, YOICHI IGARASHI, SUSUMU INABA, MICHIFUMI MINAKAWA, HIROYUKI NOUMI, MASATOSHI SAITO, YOUSHIHIRO SUZUKI, HITOSHI TAKAHASHI, MINORU TAKASAKI, KAZUHITO TANAKA, AKIHISA TOYODA, YUTAKA YAMANO, HIROKI WATANABE, High Energy Accelerator Research Organization (KEK). — We have developed Residual Gas Ionization Profile Monitor (RGIPM) for slowly extracted proton beams at Japan Proton Accelerator Research Complex (J-PARC). Beam monitors must be non-destructive to keep beam losses as low as possible for maintenance reasons. The profiles of beams are measured by collecting knock-on electrons produced by ionization of residual gas in 1 Pa vacuum. Applying the magnetic field parallel to the collection electric field is essential to reduce diffusion by collisions of electrons with residual gas molecules. A prototype RGIPM has been installed in the slow-extraction beam line at KEK 12 GeV Proton Synchrotron. The results of the test experiments of the prototype monitor are presented.

11:45AM EJ.00012 Progress in the Development of a Lead Slowing-Down Spectrometer at LANSE, R.C. HAIGHT, S.A. WENDER, J.M. O’DONNELL, A. MICHAUDON, D.J. VIEIRA, J.M. SCHWANTES, T.A. BREDEWEG, E.M. BOND, J.B. WILHELMY, Los Alamos National Laboratory, D. ROCHMAN, Brookhaven National Laboratory, T. ETHVIGNOT, T. GRANIER, CEA-Bruyeres-le-Chatel, Y. DANOY, C. ROMANO, Rensselaer Polytechnic Institute — Lead Slowing-Down Spectrometers (LSDS) have been used for many years to measure neutron-induced fission cross sections of very small samples of actinides. We are extending the range to ultra-small samples by driving a 20-ton LSDS with short, intense pulses of 800-MeV protons from the Proton Storage Ring at the Los Alamos Neutron Science Center. Neutrons are produced by the pulsed proton beam from the LANSE Proton Storage Ring striking a tungsten target in the center of the lead. Fission reactions are detected as a function of time, and therefore neutron energy, after the beam pulse. Initial experiments have confirmed the calculated performance of the LSDS and have demonstrated the capability of measuring the neutron-induced fission cross section of Pu-239 with a sample mass of less than 10 nanograms. Progress in the development of this new capability and plans for a program of measurements will be described.

Wednesday, September 21, 2005 9:00AM - 12:15PM
Session EK DNP JPS: Strange Baryon and Meson Production  Ritz-Carlton Hotel Maui

9:00AM EK.00001 Ξ spectroscopy in photoproduction on a proton target at Jefferson Lab, LEI GUO, Jefferson Lab, CLAS COLLABORATION. — The CLAS Collaboration at Jefferson Lab conducted a photo-production experiment on a proton target using a tagged photon beam with an energy range of 1.6-3.8 GeV during May-July 2004. With an integrated luminosity of about 70 pb⁻¹, this experiment provides the largest data set for photon-proton reactions ever collected. The reaction γp → K⁺K⁻Ξ⁻(1320) has been investigated with the two K⁺'s detected by CLAS and Ξ⁻(1320) constructed from missing four momentum. The preliminary results of the cross section measurement of Ξ⁻(1320) for the photon energy range of 2.7-3.8 GeV will be presented. In search for excited cascade states, the reaction of γp → K⁺K⁺K⁻π⁻(Ξ⁻(1320))) has been explored. Preliminary results of excited cascade states decaying into Ξ⁻π⁻ will be shown. The feasibility of searching for pentaquark cascade states in photoproduction on a proton target will also be discussed.

9:15AM EK.00002 Diffractive φ photo-production off the Deuteron Near Threshold in LEPS/SPRING-8, MANABU MIYABE, Department of Physics, Kyoto University, KEITO HIRIE, Research Center for Nuclear Physics, SUGURU SHIMIZU, Department of Physics, Graduate School of Science Osaka University, WEN CHEN CHANG, Institute of Physics Academia Sinica, DEPARTMENT OF PHYSICS, KYOTO UNIVERSITY TEAM, RESEARCH CENTER FOR NUCLEAR PHYSICS TEAM, DEPARTMENT OF PHYSICS, GRADUATE SCHOOL OF SCIENCE OSACA UNIVERSITY TEAM, INSTITUTE OF PHYSICS ACADEMIA SINICA TEAM, SPRING-8/LEPS COLLABORATION. — Measurement of φ photo-production off the deuteron at forward angles investigates a unique way of studying the reaction mechanisms. Close to production threshold, meson-exchange processes can either be exchanged, in a way of π or η shows up, or than the dominating channel of Pomeron exchange in the high energy region. The isoscalar φ-meson exchange can be eliminated in coherent photo-production from the deuteron as an isoscalar target. In the SPRING-8/LEPS experiment, we have measured photo-production of φ from liquid deuterium target with a photon energy from production threshold to 2.4 GeV. Linearly polarized photon beam was generated by backward Compton scattering. In this talk, we will report preliminary results of differential cross section and decay asymmetry for both coherent and incoherent production.

9:30AM EK.00003 Λ(1405) and Σ(1385) Photoproduction at LEPS/SPRING-8, DEUK SOON AHN, Osaka University & Pusan National University, TAKASHI NAKANO, Osaka University, JUNG KEUN AHN, Pusan National University, LEPS COLLABORATION. — We have the measured p/pd for γ+p→K⁺+Λ(1405) and γ+p→K⁺+Σ(1385) reactions on the Liquid Hydrogen target at Eγ = 1.5 - 2.4 GeV by using a linearly polarized photon beam. From the t distributions we have estimated the contribution of t-channel kaon exchange in the Σ⁺→π⁺K⁻ channels due to interference of f=0 and f=1 amplitudes. The same model predicts the modification of mass spectrum of Λ(1405) in nuclear medium. The hyperon photo-production experiment were performed at SPring8/LEPS with polyethylene, carbon and copper targets. The energy range of the backward Compton scattering photon was 1.5 - 2.4 GeV. In this talk, I will report the experimental details and status of the analysis of Λ(1405) lineshape from proton and carbon.

9:45AM EK.00004 Λ(1405) photoproduction at SPring8/LEPS, HISAKO FUJIMURA, MASAYUKI NIYAMA, Department of Physics, Kyoto University, THE LEPS GROUP COLLABORATION. — The structure of Λ(1405) is a long standing question in hadron physics whether Λ(1405) is the spin-triplet partner of JF = 3/2, Λ(1520) or a Meson-Baryon resonance. Recent theoretical works based on chiral dynamics predict its lineshape to be different in the Σ⁺π⁻ and Σ⁻π⁺ channels due to interference of f=0 and f=1 amplitudes. The same model predicts the modification of mass spectrum of Λ(1405) in nuclear medium. The hyperon photo-production experiment were performed at SPring8/LEPS with polyethylene, carbon and copper targets. The energy range of the backward Compton scattering photon was 1.5 - 2.4 GeV. In this talk, I will report the experimental details and status of the analysis of Λ(1405) lineshape from proton and carbon.
10:00AM EK.00005 Nucleon Motion Effects for Hyperon Production Reactions, SHINTARO HASHIMOTO, Department of Physics, Kyushu University, MICHIO KOHNO, Physics Division, Kyushu Dental College, KAZUYUKI OGATA, Department of Physics, Kyushu University, YUKINOBU WATANABE, Department of Advanced Energy Engineering Science, Kyushu University, MITSUJI KAWAI, Department of Physics, Kyushu University — The huge mass of the density in NJL model suggests the possible character changes of η meson, not only in vacuum, but also at finite temperature and finite density, which suggest the breaking of the isospin conservation does not match the isospin in nuclear medium. In this presentation, we propose the formation reaction of the η meson, in particular the η′(958) state also called the η′ state. This is in contrast to previous analysis, where a rather simple reaction-model was adopted. In the present paper we discuss effects of the Fermi motion of a struck target-nucleon on the energy spectrum of the outgoing particle in detail and aim to clarify the reaction mechanisms of the inclusive (π±, K±) and (K±, K±) reactions. We will also discuss the role of multistep processes, which can easily be included in the SCDW model analysis, in the study of the hyperon single-particle potential.

10:15AM EK.00006 Electron population during the cascade of kaonic nitrogen atoms, TAKAHISA KOIKE, Advanced Meson Science Laboratory, RIKEN — The huge mass of the η′(958) meson is believed to have close connection with the breaking of the axial U(1) symmetry at the quantum level referred as the U(1) anomaly. There are many theoretical studies for the effects of the U(1) anomaly on the η′ meson, not only in vacuum, but also at finite temperature and finite density, which suggest the possible character changes of η′ at finite temperature and/or finite density. At the present time, however, there exists no experimental information on the property and behavior of the U(1) anomaly at finite density. In this presentation, we propose the formation reaction of the η′-mesic nuclei in order to investigate the η′ properties, especially its mass shift, at finite density. We apply the NJL model to describe η′ properties in nuclear medium, and show the clear relations between NJL parameters and expected reaction spectra, which should be the first step to get deeper insights on U(1) anomaly at finite density from experimental data. The η′ mass in the medium should provide us important information on the properties of the U(1) anomaly in the nuclear medium.

10:20AM EK.00007 Formation reaction of η′(958)-mesic nuclei and U(1) anomaly at finite density in NJL model, HIDEKOSHI NAGAIHO, Research Center for Nuclear Physics, Osaka Univ., MAKOTO TAKIZAWA, Showa Pharmaceutical Univ., SATOUMI HIRENZAKI, Nara Women’s Univ. — The huge mass of the η′(958) meson is believed to have close connection with the breaking of the axial U(1) symmetry at the quantum level referred as the U(1) anomaly. There are many theoretical studies for the effects of the U(1) anomaly on the η′ meson, not only in vacuum, but also at finite temperature and finite density, which suggest the possible character changes of η′ at finite temperature and/or finite density. At the present time, however, there exists no experimental information on the property and behavior of the U(1) anomaly at finite density. In this presentation, we propose the formation reaction of the η′-mesic nuclei in order to investigate the η′ properties, especially its mass shift, at finite density. We apply the NJL model to describe η′ properties in nuclear medium, and show the clear relations between NJL parameters and expected reaction spectra, which should be the first step to get deeper insights on U(1) anomaly at finite density from experimental data. The η′ mass in the medium should provide us important information on the properties of the U(1) anomaly in the nuclear medium.

10:45AM EK.00008 Neutron spectra from the in-flight 16O(K−, n) and 12C(K−, n) reactions, T. HAYAKAWA, T. KISHIMOTO, A. SAKAGUCHI, S. AJIMURA, Y. SHIMUZU, T. ITABASHI, Y. MITOMA, K. TERAI, F. KHANAM, H. NOUMI, H. TAKAHASHI, T. FUKUDA, S. MINAMI, W. IMOTO, Osaka University, KEK, Osaka Electro-Communications University, KEK-PS E548 COLLABORATION — We carried out an experiment to study kaonic nuclei at K2 beam line of KEK 12GeV Proton Synchrotron in this spring. We employed the in-flight (K−, N) reaction to excite the kaonic nuclear state since expected that almost the highest energy nucleon made background ineffective. Water, carbon, and polyethylene were used as targets. We would like to show the preliminary result of the mass spectra and the energy spectra of the 16O(K−, n) and 12C(K−, n) reaction and discuss kaonic nuclei by spectra in the bound region.

11:00AM EK.00009 Semirelativistic calculations of exotic systems, HIDEKATSU NEMURA, Advanced Meson Science Laboratory, DRI, RIKEN, CHOKI NAKAMOTO, Suzuki National College of Technology — Recent experimental report on a new observation of strange tribaryon S0(3115) has had a significant impact on nuclear physics. The existence of deeply bound K- nuclear systems has been predicted by Akashi and Yamazaki, based on an assumption of Λ(1405) being a bound state of K + N. However, the S0(3115) is different from that was originally predicted since the isospin (I = 1) of S0(3115) determined by the isospin conservation does not match the isospin (I = 0) predicted by the theory. Moreover, the mass of S0(3115) is about 100 MeV lighter than the value by the theoretical prediction. Towards a description of the strange tribaryon, we calculate the exotic systems (e.g., Λ(1405)) using a semi-relativistic hamiltonian, that includes a semi-relativistic term of the kinetic energy (v2p2 + m2).
11:45AM EK.00012 Search for medium effects on light vector mesons, RAKHSHA NASSERIPOUR, CHADEN DJALAL, CLARISSE TUR, University of South Carolina, MICHAEL WOOD, University of Massachusetts, Amherst, DENNIS WEYGAND, Jefferson Laboratory, CLAS COLLABORATION — Theoretical calculations predict the modifications of properties of vector mesons such as their masses and widths in dense nuclear matter. These modifications can be related to more fundamental physics such as partial restoration of chiral symmetry at high density. An experiment was performed using the CEBAF Large Acceptance Spectrometer (CLAS) at Jefferson Lab. The data were taken with a tagged photon beam of energies up to 4 GeV on various nuclear targets. The properties of light vector mesons, \( p, \omega, \) and \( \phi \), have been investigated through their rare leptonic decay to \( e^+e^- \). This decay channel is preferred over the hadronic modes in order to eliminate the final state interactions in the nuclear matter. Preliminary results will be shown and discussed.

12:00PM EK.00013 Study of two pion photoproduction on deuteron, KENTAROU HIROSE, Department of Physics, Tohoku University, THE NKS COLLABORATION — We studied the \( \gamma d \rightarrow pn\pi^+\pi^- \) reaction at \( E_\gamma = 0.8 \sim 1.1 \) GeV. It was carried out at the tagged photon facility of the Laboratory of Nuclear Science, Tohoku University. Neutral Kaon Spectrometer was used for detection of charged particles and liquid deuterium was used for a target. The spectrometer consists of a pair of drift chambers in the 0.5 T magnetic field, inner and outer scintillation hodoscopes. Four veto counters were installed to reduce QED background. The geometrical acceptance of the spectrometer is \( \pi \) sr. The \( pn\pi^+\pi^- \) events in the final state were selected. The \( \gamma d \rightarrow pn\pi^+\pi^- \) events were derived by missing mass distribution. The neutron momentum was used to determine whether the reaction was a quasi-free kinematics or not. Since the detection threshold for protons is about 0.2 GeV/c, the proton spectator reaction cannot be measured. The \( N\pi \) invariant mass spectra suggest that the \( \gamma d \rightarrow \Delta^+\pi^- n_{sp} \) reaction is dominant in the quasi-free kinematics region and the \( \gamma d \rightarrow \Delta^+\Delta^- \) reaction may exist in the non quasi-free kinematics region. From detailed comparison of the measured data with the results of Monte Carlo simulations, we’re going to deduce the total cross section for the reaction \( \gamma d \rightarrow \Delta^+\Delta^- \).

Wednesday, September 21, 2005 9:00AM - 10:30AM — Session EL JPS: JPS Award Talks by Distinguished Young Researchers Ritz-Carlton Hotel Plantation 1/2/3

9:00AM EL.00001 Hadron Physics at RHIC, TATSUYA CHUJO, Vanderbilt University — From the first five years of the relativistic heavy ion runs at RHIC, several key experimental discoveries brought a new understanding of the matter created in relativistic heavy ion runs at RHIC, several key experimental discoveries brought a new understanding of the matter created relativistic heavy ion runs at RHIC, several key experimental discoveries brought a new understanding of the matter created.

9:30AM EL.00002 Experimental finding of the anomalous quadrupole collectivity in unstable nucleus \(^{16}\text{C}\), NOBUAKI IMAI, Institute of Particle and Nuclear study, KEK — The electric quadrupole transition from the first \( 2^+ \) state to the ground \( 0^+ \) state in \(^{16}\text{C}\) is studied through measurements of the lifetime. The measured mean lifetime \( \tau = 77 \pm 14 \) (stat) \pm 19 (syst) ps. The central value of \( \tau \) corresponds to a \( B(E2; 2^+_1 \rightarrow 0^+) \) value of 0.63e2fm\(^4\), or 0.26 Weisskopf units [1]. The transition strength is found to be smaller than the empirically predicted value by one order of magnitude. This is the first application of recoil shadow method (RSM) to the lifetime measurement using an intermediate-energy RI beam. For nuclei located far from the stability line, the method of the intermediate energy Coulomb excitation has widely been used for their \( B(E2) \) measurements. In the case of small \( Z \) nuclei, however, a cross section of the nuclear excitation is comparable with that of the Coulomb excitation. To avoid difficult treatment of the nuclear excitation, we adopted the RSM for measurements of \( \tau \), which is inversely proportional to \( B(E2) \). To account for the quenched \( B(E2) \), two theoretical pictures have been proposed. One is based on the shell model calculation. The other is on the antisymmetrized molecular dynamics (AMD) calculation. The shell model treatment has mainly ascribed the quenching to the combined effects of increased proton sub-shell gap between \( 1p_{3/2} \) and \( 1p_{1/2} \) and reduced \( E2 \) effective charges for neutrons, while the AMD treatment has ascribed it mainly to the difference between favored deformed shapes for protons and neutrons. Both calculations reproduce the sudden decrease of \( B(E2) \) in carbon isotopes. I will show the detailed experimental setup and the experimental result together with the theoretical works.


10:00AM EL.00003 Partial restoration of chiral symmetry in the nuclear medium, KEN SUZUKI, Technische Universität München — Study of pionic atom has been revisited by a recent discovery of deeply bound pionic states in the context of possible sensitivity to the partial chiral restoration in the nuclear medium. The chiral symmetry breaking in QCD is considered to be a driving mechanism of how hadrons acquire their masses. Exploring the QCD phase diagram towards high density regime is believed to experience highly non-trivial chiral phase transition. A quark condensate, \(<\bar{q}q>\), is an “order parameter” of this symmetry breaking and is expected to diminish as a consequence of chiral symmetry restoration. Efforts of detecting this precursor are being made intensively these days. The deeply bound pionic states provide unique laboratory in this context. In the hadrons mass spectrum as quasi particle excitations of the condensate, pions are identified to be Nambu-Goldstone bosons, which are the lowest energy excitation modes. Isovector part of their s-wave interaction with nucleons is determined by the pion decay constant, \( f_π \), which is directly connected to the magnitude of \( <\bar{q}q>\) through the Gell-Mann-Oakes-Renner relation. Since the pionic orbits of low-lying states have certain overlap with nucleus, a property of pion can be influenced by a nuclear medium. We performed a systematic measurement of 1s \( \pi^- \) states in \(^{115,119,123}\text{Sn}\) by hiring \(^{116,120,124}\text{Sn(d,He)}\) reactions at GSI SIS-FRS system, from which we determined the 1s binding energies and widths precisely. These are used to deduce the isovector s-wave interaction, \( b_1 = 0.115 \pm 0.005 \text{fm}^{-2}\). The observed magnitude is significantly enhanced over the free \( \pi N \) value, which is translated into a reduction of \( <\bar{q}q>\) by \( \sim 35\% \) at normal nuclear density.

1:00PM - 1:00PM — Session FR DNP JPS: CEU Poster Session Ritz-Carlton Hotel Ballroom Foyer 1:00pm - 3:00pm
FR.00001 High-resolution gamma-ray spectroscopy with a NASA/GSFC microcalorimeter at the Lawrence Livermore National Laboratory, GREG BROWN, BRETT BECK, JOHN BECKER, PETER BEIERSDORFER, LLNL, KEVIN BOYCE, RICH KELLEY, CAROLINE KILBOURNE, F. SCOTT PORTER, NASA/GSFC, ANDY SZYMKOWIAK, Yale University — A 32 pixel laboratory microcalorimeter spectrometer built by the NASA/Goddard Space Flight Center and in operation at the Lawrence Livermore National Laboratory is now being used for gamma-ray spectroscopy. The second generation laboratory instrument, dubbed the XRS/EBIT, has been used to measure up to 60 keV gamma rays with a resolution of 60 eV or less. The microcalorimeter makes it possible to resolve many gamma-ray spectral lines for the first time. An overview of the operating parameters and measurement capabilities will be given, as well as example spectra. Work by the Univ. of California Lawrence Livermore Nat’l Laboratory was performed under the auspices of the D.O.E. under contract No. W-7405-Eng-48.

FR.00002 Vibrational to Rotational Structure Evolution in Medium Mass Nuclei, MICRELA S. FETEA¹, JOE HANLEY², PHILIP PENDLETON², U. of Richmond, WRIGHT NUCLEAR STRUCTURE LABORATORY AT YALE UNIVERSITY COLLABORATION¹, UNIVERSITY OF SURREY, GUILDFORD, ENGLAND COLLABORATION¹ — A recently introduced empirical method is used to follow the evolution from vibrational to rotational structure in nuclei as a function of spin. EGOS (E-Gamma Over Spin) plots connect the relation between the gamma-ray energy and spin with the shape of the nucleus. In the E-GOS plots the trajectory for a vibrator decreases hyperbolically, while the trajectory for a rotor slightly increases to become almost flat for any higher spin. Results of the EGOS analysis for the medium mass transitional nuclei will be presented. The work was completed in collaboration with groups from the Wright Nuclear Structure Laboratory at Yale University, and from the University of Surrey, Guildford, England and was supported by the NSF Grant No. PHY 0204811 and Research Corporation Grant No. CC5494.

¹Professor
²Undergrad Student
³group of researchers
⁴group of researchers

FR.00003 Backbending phenomena in light nuclei at A~60 mass region. S. EL-KAMESSEY, Department of Physics and Astronomy, King Saud University, Saudi Arabia, H. ALHARBI, National Centre for Mathematics and Physics, KACST, Saudi Arabia, H ALHENDI, Department of Physics and Astronomy, King Saud University, Saudi Arabia — Recent studies of the backbending phenomena in medium light weight nuclei near A~60 expanded greatly our interest about how the single particle orbits are nonlinearly affected by the collective motion. As a consequence we have applied a modified version of the exponential model with the inclusion of paring correlation to describe the energy spectra of the ground state bands and/or the backbending phenomena in mass region at A~60. A firm conclusion is obtained concerning the successful validity of the proposed modified model in escribing the backbending phenomena in this region. Comparison with different theoretical descriptions is discussed.

FR.00004 The Evolution of Vibrational to Rotational Structure in Nuclei, JOE HANLEY, M.S. FETEA, V. NIKOLOVA, Department of Physics, University of Richmond — For more than 25 years, phase and shape evolution that are ultimately related to the mechanisms by which atomic nuclei generate angular momentum have been major themes in nuclear structure research. In certain circumstances, the motions of the individual protons and neutrons making up the nucleus couple, give rise to collective vibrations or rotations of the nucleus as a whole. This presentation focuses on a new method to discern the nuclear evolution from vibrational to rotational structure in nuclei, as a function of spin. The E-GOS (E-Gamma Over Spin) plot is an empirical approach that describes the structure of the nucleus circumventing all of the parameters and model dependencies that had to be assumed in past research. The work was completed in collaboration with groups from the Wright Nuclear Structure Laboratory at Yale University, and from the University of Surrey, Guildford, England and was supported by the NSF Grant No. PHY 0204811, Research Corporation Grant No. CC5494.

FR.00005 Charm study via electron-hadron azimuthal correlations in p+p and d+Au √s_{NN} = 200 GeV collisions, SOTIRIA BATSOULI, OakRidge Labs, PHENIX COLLABORATION — PHENIX data on single electron production indicate an excess of electrons over known light hadronic sources that has been attributed to open charm and beauty decays. The non-photonic electron yields are consistent with two different scenarios. One is the creation of a medium completely transparent to heavy quarks. The other is the creation of a highly opaque medium with the heavy quarks rescattering and hadronizing in the system. We can distinguish between these different scenarios by studying the electron-charged hadron azimuthal correlations with respect to the system size. The correlations in p+p and d+Au collisions provide a direct observation of the heavy quark jets and the baseline for possible shape modifications in the Au+Au central collisions. The method for extracting the non-photonic azimuthal correlations and the current results for p+p, d+Au at √s_{NN} = 200 GeV PHENIX data will be presented.

FR.00006 High percentage 3He polarizer using spectrally-narrowed external-cavity high power multi-array stack diode laser, MICHAEL MASON, WILLIAM HERSMAN, University of New Hampshire — Parity-violating asymmetry experiments involving polarized slow neutrons, including the present NPDGamma experiment, require a large flux of polarized neutrons. Sources of neutrons from spallation targets moderated to cold temperatures provide a large amount of unpolarized slow neutrons. The unpolarized neutron beam can then be polarized by passing it through the polarized 3He cell, taking advantage of the greater attenuation of neutrons anti-aligned with the 3He than those that are aligned. The thickness of the up and down helium states determines the transmission of the down and up neutron states, and hence the transmitted neutron polarization and flux. Precision measurements of beta-decay asymmetries planned for the Spallation Neutron Source, including the abBA experiment, impose the additional requirement of small uncertainties in the neutron polarization. One way of accomplishing high precision in the neutron polarization is to force the neutron polarization close to unity by passing the neutron beam through many attenuation lengths of a thick polarized 3He spin-filter. The simultaneous requirements of high polarization, low uncertainty, and high flux demand the highest 3He polarization attainable. This can be accomplished with large volume cells by using our newly developed spectrally-narrowed external-cavity high power multi-array stack diode laser.

FR.00007 Development of a Mossbauer Spectrometer, JUSTIN KING, MICHAEL VINEYARD — A Mossbauer spectrometer is being developed for use in an undergraduate experimental physics course and for research projects. A Co-57 provides 14.4-keV gamma rays which are detected with a krypton gas proportional counter. The source is mounted on an electromechanical drive that is operated in constant velocity mode using a Mossbauer drive controller. A circuit is being developed to operate the drive in constant acceleration mode so that Mossbauer spectra can be acquired with a multi-channel analyzer in a computer. Curricular materials are also being developed to use the Mossbauer spectrometer in the experimental physics course to measure changes in nuclear energy levels such as isomer shifts, hyperfine splitting, and quadrupole splitting due to an external magnetic field.
A critical component of this new nEDM experiment involves detecting the scintillation light from the neutron decay. To solve the muon background problem, thin plastic scintillator detectors are situated essentially flush with the back of the beta detectors. Cosmic muons pass through both detectors without stopping, producing a “coincidence” signal that is used to reject background. Wave-shifting fluorescent fibers direct light into a wire mesh photomultiplier tube (PMT). Wire mesh PMTs are insensitive to the magnetic field strengths present in our spectrometer detector, which approach 1 Tesla, and prevent normal PMTs from functioning. Our muon veto systems will be installed in the UCNA experiment in the summer of 2005.

A desktop accelerator employing a pyroelectric crystal. The electric dipole moment of the neutron (nEDM) is predicted to be on the order of $10^{-26}$ m·e·Vs. A new experiment has been proposed aiming at improving the current experimental limit by two orders of magnitude. A critical ingredient in understanding of CP violation. The bound charge and associated electric field are directly related to the temperature change, making large voltages possible. Due to the compact size of the crystal and the absence of a large power supply, pyroelectric crystals offer a potential means for developing portable particle accelerators and x-ray sources. It has been recently reported that using pyroelectric crystals to accelerate a deuterium ion beam into a deuterated target can produce D+D fusion. The objectives of the present work are to (a) verify the results of the D+D fusion experiments mentioned above, (b) optimize the conditions for particle acceleration, and (c) assess the possibility of extending this method to other nuclear reactions.

Collisional Energy Loss of Energetic Particles. MARGARET STEWART, Purdue University — RHIC has collided gold nuclei at 200 GeV per nucleon-nucleon pair. Upon a head-on collision about 10,000 particles are produced, a small fraction of them is energetic. However, experiments at RHIC have observed fewer energetic particles than expected from theory. This led to the conclusion that a new state of matter, possibly a quark-gluon plasma (QGP), is created in those collisions. When this hot and dense matter expands and cools down clustering into hadrons, the hadrons that are still energetic collide elastically and lose energy before reaching the detector. We have created a computer program that uses several physical concepts to simulate collisions between an incident energetic particle and hadrons in a thermal bath. This allows us to study the probability distributions of both the scattering angle and the energy of the incident particle after several collisions. That way, we will gain an understanding of the degree of collisional energy loss due to the late stage of hadron-hadron collisions, thereby quantifying the early stage energy loss of energetic particles in the created matter, which will give us a better understanding of the early universe.

Beam Polarization Correction for Neutron-Deuteron Scattering Cross Section. BERLY BODDY, TAYLAN AKDOGAN, MAXIM CHTANGEEV, WILBUR FRANKLIN, JOHN HOUGH, JUNE MATTHEWS, Massachusetts Institute of Technology — An MIT-led collaboration has performed a measurement of the differential cross section for neutron-deuteron elastic scattering at the WNR facility of the Los Alamos Neutron Science Center. The linear accelerator provides an 800 MeV, unpolarized proton beam, which is directed toward a tungsten spallation source to produce beams of high energy neutrons. The neutrons are polarized due to spin-orbit interactions between the proton beam and the tungsten nuclei. In our experiment, a collimated neutron beam is incident on a liquid deuterium target, and the incident neutron energy is determined from time of flight information. The neutron-deuteron scattering cross section is measured by observing the scattered neutrons and recoiling deuterons in coincidence using an array of plastic and CsI scintillators. After a correction to the data to take the polarization of the neutron beam into account, the results are compared to previous nd and pd experimental results and to theoretical predictions that suggest the differential cross section at large angles is sensitive to a three-nucleon force.

Search for Pre-Existing Delta States at BLAST from $^2\text{D}(\text{e}, e'\Delta^{++})$. CHANA GREENE, Massachusetts Institute of Technology, BLAST COLLABORATION — At the MIT-Bates Linear Accelerator Center a comprehensive study of low-Q$^2$ spin-dependent electron scattering from deuterium is being carried out using the Bates Large Acceptance Spectrometer Toroid (BLAST). This experiment has employed a polarized electron beam from the MIT-Bates linear accelerator incident on an internal polarized deuterium target and the BLAST detector. Deuterium’s simple composition is an important factor in understanding the structure of the inter-nucleon potential. The pion production region has a resonant structure and is a promising location to search for pre-existing delta states in deuterium. Theoretical calculations predict that delta resonant states account for anywhere from 0.25 to 3.60% of the nuclear wave function more realistic predictions for deuterium range from 0.3 to 1.0 %. We present here a preliminary report on the search for pre-existing deltas in the BLAST data. In the pursuit of this study Monte Carlo, data filtering and data quality techniques have been employed in order to ensure the best quality of data.

Measurement of charge distribution of $^{16}\text{O}$ through a C-foil for $^4\text{He}(^{12}\text{C},^{16}\text{O})\gamma$ experiment at stellar energy. HISATO TANIMOTO, Department of Physics, Kyushu University. K. SAGARA, T. TERANISHI, H. OBA, K. NISHIDA, M. KOZUMA, S. KAMIBEPPU, T. KAWADA, A. MATSUMOTO COLLABORATION, K. TAMURA, H. ISHIKAWA AND N. IKEDA COLLABORATION — Measurement of charge distribution of $^{16}\text{O}$ passed through a C-foil is in progress at Kyushu University tandem laboratory so as to measure $^4\text{He}(^{12}\text{C},^{16}\text{O})\gamma$ cross section at stellar energy by detecting $^{16}\text{O}$ particles in a charge state. Downstream the helium windowless gas target, we put a thin C-foil to make the charge distribution of $^{16}\text{O}$ observable. Energy of $^{16}\text{O}$ is 2-8 MeV, and existing data for the charge distribution of $^{16}\text{O}$ in the energy range are different to each other by 15 % at most. We measure simultaneously (1) the intensity of a $^{16}\text{O}$ beam which is incident on a C-foil by counting $^{12}\text{C}$ recoils by a Si-detector, and (2) the intensity of the $^{16}\text{O}$ beam in each charge state by a Faraday cup downstream the C-foil. An electric deflector and a magnetic deflector are used to separate a $^{16}\text{O}$ beam in a charge state from other beams in different charge states.

Measurement of light detection using VLPCs for a new search of the neutron electric dipole moment. AMBER NELSON, Washington and Jefferson College and TUNL, DIPANGKAR DUTTA, TUNL and Duke University, HAIYAN GAO, TUNL and Duke University — The electric dipole moment of the neutron(nEDM) is predicted to be on the order of $10^{-31}$ e·cm. by the Standard Model. Currently, the experimental limit of this quantity is $6 \times 10^{-26}$ e·cm. Any non-zero nEDM is a direct violation of time-reversal symmetry, which may lead to a new understanding of CP violation. A new experiment has been proposed aiming at improving the current experimental limit by two orders of magnitude. A critical component of this new nEDM experiment involves detecting the scintillation light from the $^3\text{He}^+$ reaction at 300mK. A new light detection technique using a visible light photon counter (VLPC) is being developed for this experiment. The VLPCs are doped silicon based solid state photo multipliers with a high quantum efficiency and are normally operated at 6.5K. The scintillation light is wave-shifted from XUV to blue using deuterated tetraphenyl butadiene(TPB) and then to green using wavelength-shifting(WLS) fiber. Over the summer, the bench set-up was constructed and preliminary results of these tests will be presented.
FR.00015 In-Medium Effects and HBT “Fireball” Size in Ultrarelativistic Heavy-Ion Collisions, LANIECE MILLER, Clarkson University & Texas A&M University, RALF RAPP, HENDRIK VAN HEES, Texas A&M University — Standard equations of HBT interferometry determining the size of a fireball formed in heavy-ion collisions at RHIC do not easily match with experimental data. In a recent paper, G. A. Miller et al. have added an in-medium pion optical potential to help correct this discrepancy, resulting in a rather dense freeze-out configuration within their calculations. In the present project we investigate the effects of a more elaborate in-medium pion potential that more closely reflects the conditions expected for a fireball resulting from Au-Au collisions at RHIC. This model function takes into account differences in chemical behaviors and hold-up time to compare release yield data from the proton-induced fission of different actinide targets acquired experimentally using an on-line test facility. This facility includes a continuing research effort exists to develop new beams and beams with higher intensity and purity. As a part of that effort, the goal of this project is to determine the form and constants of an in-medium pion potential in connection with fireball conditions which more closely parallel the expected freezeout properties in heavy-ion collisions.

FR.00016 Kell_Wire Drift Chambers, ANNA KELL, MEP University of Houston — Wire Tracking Chambers are used to determine the track of charged particles through space. This project is to construct two multiwire proportional chambers, to write the data acquisition program to acquire data, and to track cosmic rays with the chamber system. The tracking chamber system will be used to test the efficiency and position resolution of other detectors placed between the tracking chambers. Information gained with these detectors will be used for the MECO and other experiments. The most prevalent cosmic rays at sea level are energetic muons, which are minimum ionizing particles. These particles are of most interest for our tests, thus muon signals are relevant for testing purposes. Drift chamber testing has revealed problems involving leakage currents across the detector frames which have been traced to the “O” ring seals. These have been replaced and the drift chambers are now being reassembled. The report of this project will present their operational parameters, including their efficiency, and tracking resolution as a function of voltage and gas.

FR.00017 Monte Carlo Simulations of Type I X-Ray Bursts*, LUKE ROBERTS, Colorado College, MICHAEL SMITH, WILLIAM R. HIX, ORNL, JACOB FISKER, Notre Dame — Type I x-ray bursts (XRB) occur on the surface of a neutron star (NS) in a binary system. Matter is accreted onto the surface of the NS and becomes extremely hot and dense. Once the envelope reaches a sufficiently high temperature, breakout from steady state CNO cycle thermonuclear burning occurs and a thermonuclear explosion powered by the np- and rp-processes ensues. Almost all reaction rates involved in these processes have never been experimentally measured, and theoretically determined rates used in XRB models generally have large uncertainties. To understand how these uncertainties affect final nuclear abundances and energy generation throughout the burst, a Monte Carlo (MC) approach using a post-processing nuclear synthesis code is employed. In the MC simulation, all of the reaction rates are varied simultaneously and independently for each of 48,000 element synthesis calculations. The results are tested for significant correlations between specific reactions and final nuclear abundances. Preliminary results for one zone — which reaches a peak temperature and minimum density of 1.02 GK and 1.166 x 10^5 g/cm^3 — indicate that the rates of several positron decays, proton captures, and (α, p) reactions, as well as α(2α, γ)αC, have significant correlations with many final abundances. Uncertainty estimates for predicted final nuclear abundances will also be presented. ORNL is managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR2275.

FR.00018 Selective Population Shown by Five-Particle Transfer Reactions1, A.M. CRISP, N. KEELEY, K.W. KEMPNER, O. MOMOTYUK, B.T. ROEDER, M. WIEDEKING, Florida State University, J. LIENDO, Simon Bolivar University, F. MARECHAL, Strasbourg, France, K. RUSEK, Warsaw, Poland — Spectra and angular distributions were obtained for the reactions 16O(p,d)17O, 14N(Li,d)15O, 13N(Li,He)17O, 12C(Li,d)17O, and 12C(Li,p)17O. Excitation functions were also measured for 12C(Li,d) in the energy range 32-35 MeV and for 12C(Li,p) in the energy range 26-32 MeV. These data were collected using the FSU Tandem/LINAC accelerator. Selective population of states in 17O was observed in each of these reactions, and the states populated in each reaction type did not vary with energy. This result indicates a direct, single-step transfer in each case. Further evidence for single-step transfer in the five-particle transfer reactions is provided by DWBA calculations performed on the selectively populated levels. In addition, characteristic of particular 17O levels above 11 MeV will be presented. The most strongly excited state is at 11.82 MeV and its spin has been determined to be 7/2.

1Work supported by the National Science Foundation and the State of Florida

FR.00019 Completeness of the Coulomb eigenfunctions, AKRAM MUKHMEDZHAVANOV, Cyclotron Institute, Texas A&M University, MYLES AKIN1, Cyclotron Institute, Texas A&M University and University of Georgia — Completeness of the eigenfunctions of the two-body Hamiltonian has been proved only for short-range interactions. In this work we present the first proof of completeness of solutions of the two-body Schrödinger equation with repulsive Coulomb potential for arbitrary orbital angular momentum. We use Newton’s complete integral containing the Coulomb Green function [1]. The proof is based on the analyticity of the Coulomb regular and singular solutions in the complex momentum plane. The most difficult part is to investigate the behavior of the integral around k=0. The presented proof allows one to apply the Berggren’s method [2] to include resonant states into the complete set of eigenfunctions for particles interacting via Coulomb potentials. It makes legitimate the usage of the so-called Gamow Shell Model [3] for nuclei with valent protons. The inclusion of the resonant states into the complete set calls for an extension of the Hilbert space, in which the norm of the eigenfunctions is determined. We demonstrate that the scalar products containing the resonant states for charged particles can be well defined using Zel’dovich regularization factor. [1] R. G. Newton, J. Math. Phys. 1, 319 (1960). [2] T. Berggren, Nucl. Phys. A109, 265 (1968). [3] N. Michel et al., Nucl. Phys. A752, 335c (2005).

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FR.00020 Effect of quark momentum spread on hadron elliptic flow in relativistic heavy ion collisions, COLIN YOUNG, Tulane University, CHE MING KO, Cyclotron Institute, Texas A&M University — In the naïve quark coalescence model, which allows for the coalescence into hadrons only of quarks with the same momentum, the elliptic flow of hadrons produced in relativistic heavy ion collisions would scale with their constituent quark content. Including the momentum distribution of quarks within hadrons is expected to lead to a violation of the quark number scaling of hadron elliptic flow. In a blast wave model, we have derived an analytical expression for the correction to the quark number scaling due to this effect and evaluated its value for heavy ion collisions at the Relativistic Heavy Ion Collider.

FR.00021 Production Of Neutron-Rich Isotopes For Radioactive Ion Beam Development, ABBIGAIL GADDIS, ANDREAS KRONENBERG, EUGENE SPEJEWSKI, H.K. CARTER, Oak Ridge Associated Universities, DAN STRACENER, Oak Ridge National Laboratory — The Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory provides accelerated radioactive ion beams (RIBs) for nuclear structure and astrophysics experiments. Its ability to provide a variety of beams with sufficient intensity and purity for those experiments is necessary. Therefore, a continuing research effort exists to develop new beams and beams with higher intensity and purity. As a part of that effort, the goal of this project is to compare release yield data from the proton-induced fission of different actinide targets acquired experimentally using an on-line test facility. This facility includes a new separator and uses the same target and ion source configuration as in the production of RIBs. Release data from targets such as uranium carbide are compared quantitatively by yields, chemical element by chemical element and isotope by isotope. After data analysis, a model function can be fitted to the data so that the results can be extrapolated to isotopes farther from stability. This model function takes into account differences in chemical behaviors and hold-up times. Comparisons from on-line tests with different actinide targets as well as the release data will be presented.
FR.00022 Development of read-out electronics for time projection chamber (TPC), ASUKA SAITO, Nuclear Physics, SHIGERU KIUUCHI, Nuclear Physics — A time projection chamber (TPC) is being developed for a cosmic ray test bench. The TPC (20*20*20cm, P10 gas, 5 micro seconds maximum drift) is used as 3D tracking device to determine the position and the angle of the incoming cosmic ray and has been tested with a prototype readout electronics. The purpose of this R&D is to build an electronic circuit that reads out full 8*9 (=72) signals from the TPC with 10 nano seconds sampling time and to evaluate the performance of the TPC. The electronic circuit is made up of pre amplifier, high speed flash analogue to digital converter (FADC), digital signal processor (DSP) with data storage memory, and computer interface. The circuit will be installed upon a printed circuit board for every 4 input channels. The TPC is triggered by external scintillation counter to read-out the data, the stored data will give 3D coordinates of hits along the trajectory after a calibration, then the charged particle tracks are reconstructed in order to investigate the position resolution and efficiency of the TPC and to be used for the cosmic ray test bench.

FR.00023 Comparison between Simulations and Data for Neutral Meson Photoproduction on the Proton1, FATIMA MAHMOOD, MICHAEL VINEYARD, Union College, CLAS COLLABORATION — The photoproduction of $\pi^0$ and $\eta$ mesons from the proton over an incident photon energy range of 0.5-2.3 GeV is being studied using data from the CLAS detector in Hall B at Jefferson Lab. This work is part of a systematic study of neutral meson photoproduction from the proton and light nuclear targets to investigate nuclear medium modifications of nucleon resonances and the meson-nucleon interaction. The $\pi^0$ and $\eta$ mesons are reconstructed from their two-photon decay and from the $\gamma + p \rightarrow p + x$ missing mass. Monte Carlo simulations are being performed to determine the acceptance of the CLAS detector. The physics distributions generated from the simulations are being compared to those obtained from the data to tune the simulations. The results will be described and comparisons between the data and simulations will be presented. 

1Supported by the U.S. Department of Energy under contract number DE-FG02-03ER41252.

FR.00024 Hardware Upgrades to Increase Performance of Muon Tracking on PHENIX, DALLAS MAY, Abilene Christian University, PHENIX COLLABORATION — After the proton-proton run of 2005, it was decided to implement a hardware upgrade for the higher luminosity runs of the heavy ions. By making the upgrades to low voltage distribution and the Glink/Clink crates of the Muon Tracker on the north and south arms, we increase the performance of the detector by decrease the down time needed for repairs. Each of these upgrades make it far easier and quicker to service individual circuit boards if and when they fail. These upgrades allow for increased uptime so that the most data can be acquired from the heavy ion collisions produced in RHIC. These collisions produce the very exotic $1/P_s$ particles. These particles are desired for the exploration of the Quark-Gluon Plasma, which is believed to be the state of matter existing in the universe shortly after the Big Bang.

FR.00025 Analysis of the Astrophysically Important, $^{28}$Si($p, t$)$^{26}$Si Reaction1, J.A. HOWARD, R.L. KOZUB, Tenn. Tech. U., D.W. BARDAYAN, J.C. BLACKMON, M.S. SMITH, ORNL, K. CHAE, U. Tenn., M.S. JOHNSON, ORAU, K.L. JONES, S.D. PAIN, J.S. THOMAS, Rutgers, R.J. LIVESAY, Col. School Mines, D.W. VISSER, UNC — Study of $^{26}$Al in astrophysical environments is important to models of Galactic chemical evolution because the observation of this long-lived radioactive nucleus in the Galaxy indicates that stellar nucleosynthesis has occurred “recently” (in the last million years). However, the source of $^{26}$Al production in nature is still an open question, in large part due to uncertainties in the $^{26}$Al($p, \gamma$)$^{27}$Si reaction rate arising from a lack of information on the $^{26}$Si level structure above the proton threshold. To rectify this, the $^{28}$Si level structure was measured at the Holifield Radioactive Ion Beam Facility through study of the $^{28}$Si($p, t$)$^{26}$Si reaction. A 40 MeV proton beam was used to bombard a natural Si target, and the energy and angular distributions of tritons were measured to reveal important $^{28}$Si level information. Details of the data analysis will be presented.

1Research sponsored by the DOE and NSF.

FR.00026 Mathematically Modeling Accretion Discs around a Black Hole, NICOLE SABBATINO, REBECCA SURMAN, Union College — A gamma ray burst is thought to occur when a massive, rotating star collapses on itself, and the energy released forms jets of very energetic photons. The outer layers of the collapsed star can form an accretion disc while the center forms a black hole. In order to understand this system fully, we must first gain an in depth understanding of the disc itself. We recalculate current accretion disc models to allow the exploration of a larger range of parameters. In order to use this disc model to calculate the luminosity, we must first understand the disc itself. We recalculcate current accretion disc models to allow the exploration of a larger range of parameters. In order to use this disc model to calculate the luminosity, we must first understand the disc itself. We recalculcate current accretion disc models to allow the exploration of a larger range of parameters. In order to use this disc model to calculate the luminosity, we must first understand the disc itself. We recalculcate current accretion disc models to allow the exploration of a larger range of parameters. In order to use this disc model to calculate the luminosity, we must first understand the disc itself. We recalculcate current accretion disc models to allow the exploration of a larger range of parameters. In order to use this disc model to calculate the luminosity, we must first understand the disc itself. We recalculcate current accretion disc models to allow the exploration of a larger range of parameters.

FR.00027 Double-Beta Decay Studies of $^{100}$Mo to Excited 0$^+$ States in $^{100}$Ru1, R.C. REMINGTON, Oglethorpe Univ., J.H. ESTERLINE, M.F. KIDD, W. TORNOW, Duke Univ. and TUNL — We are in the process of analyzing 1 kg x year of two-neutrino double-beta ($2\nu\beta\beta$) decay data recently obtained at TUNL for $^{100}$Mo. Transitions to excited 0$^+$ states in $^{100}$Ru have half-life times which are at least one order of magnitude larger than those to the ground state of $^{100}$Ru. Our experiment features a 1kg sample of $^{100}$Mo placed between two HPGe detectors with a surrounding NaI annulus to veto background events. Passive shielding and coincidence techniques were used to minimize BG events. As the $^{100}$Mo nucleus double-beta decays to the first excited 0$^+$ state in $^{100}$Ru, two gamma rays of 590.8 keV and 539.5 keV are subsequently emitted and detected in coincidence in our two HPGe detectors. We identified 15 ($2\nu\beta\beta$) events for this transition, therefore, improving the statistical accuracy of the previously reported results of $T_{1/2} = 5.9^{+1.7}_{-1.2} \times 10^{20}$ yrs of DeBraekeleeart et al1. We also give improved limits on $T_{1/2}$ for the transitions to the $2^{nd}$ and $3^{rd}$ excited 0$^+$ states in $^{100}$Ru.


1Supported in part by DOE grant # DE-FG02-97ER41033 and by NSF grant # NSF-PHY-02-43776

FR.00028 Coulomb Excitation of $^{50}$Mn and Isospin Symmetry in the A = 50, T = 1 Multiplet1, D.C. MCGLINCHEY, J.W. KREMENTAK, L.A. RILEY, Ursinus College — The 2$^+_1$ of $^{50}$Mn has been studied using intermediate energy Coulomb excitation at 61 MeV/nucleon at the National Superconducting Cyclotron Laboratory at Michigan State University. Here a preliminary $B(E2) : 0^+_1 \rightarrow 2^+_1$ value for $^{50}$Mn is presented. Using this result and $B(E2)$ values previously determined for $^{56}$Fe and $^{54}$Cr, a test of isospin purity in the Mass 50, $T = 1$ multiplet is performed.

1This work was supported by NSF grant No. PHY-0355129.
FR.00029 Development of gain-matching algorithms for a Double-Sided Silicon Strip Detector

David Simpson, Robert Grzymkowski, University of Tennessee — Proton radioactivity experiments almost exclusively employ the recoil-decay correlation technique which require the use of Double-sided Silicon Strip Detectors (DSSD) [Sellin]. Proper gain matching of detector strips, a basic requirement for such measurements, is of critical importance in “fine structure” experiments [KarnyPRL], where the uncalibrated strips could lead to artificial “discoveries.” Current gain matching techniques done manually on a strip by strip basis are time consuming and require a discrete source of radiation in which to line up the measured values. If performed during experiment, the calibrations interfere with the data taking time. New iterative methods of gain matching have been developed and tested using a computational algorithm that relies only on the equality of particle induced signals on the front and back side of the silicon detector. This allows for faster gain matching, and can be used with any external radioactive source, even with continuous energy spectrum, like that generated by any particle radiation detected by the DSSD during the experiment. The algorithms were tested and bench-marked with data taken during recent proton radioactivity experiments at HRIBF.

References:

FR.00030 Improving Efficiency of Active Pixel Sensors through Digital Signal Processing

Jeffrey Lesquesne, Rensselaer Polytechnic Institute, Howard Matis, Lawrence Berkeley National Laboratory, STAR Collaboration — High energy nuclear collisions at the Relativistic Heavy Ion Collider (RHIC) produce an abundance of subatomic particles. STAR, one of four experiments at RHIC, currently has modest capabilities for detecting heavy flavor hadrons. By upgrading STAR with an active pixel sensor (APS) detector, we can significantly improve its ability to measure these short-lived particles. High detection efficiency for heavy flavor will allow measurements of quark thermalization and flow. This will lead to a better understanding of the hot, dense matter system created in collisions, presumably quark-gluon plasma. Our group is investigating several algorithms and digital signal processing techniques to determine which are best for detecting minimum ionizing particles in APS data. We obtain actual noise data from prototype APS chips at expected leakage current levels, and then embed Monte Carlo charge distributions within the noise to simulate particle hits. Efficiencies of the signal extraction methods are quantitatively compared. We will present the results of these investigations.

FR.00031 Kinematical analysis of \( \Xi^- \) hyperons stop event in KEK-E373 experiment

Hiroyuki Nakamura, Gifu University, KEK-PS E373 Collaboration — The purpose of the E373 experiment is to study \( S=2 \) nuclear systems with hundreds of hyperons. \( \Xi^- \) hyperons are captured in the emulsion, interacts with a proton, and two \( \Lambda \) hyperons are produced, in usual. In this experiment, we found a track that was identified as the production and decay of \( \Xi^- \) hyperon and \( \Lambda \) hyperon among seven candidate events of double hypernucleus. We found several hundreds of events showing the emission of charged particles at the \( \Xi^- \) stoppage points. Among them, there are two events having very characteristic decay topology. Only two charged particles were emitted from \( \Xi^- \) hyperon capture point, and one of those particles associated with an energetic charged particle. By the kinematical analysis, one event was identified as a non-mesonic decay of \( \Lambda^+ \) from \( \Xi^- \), and another one is probably a decay of \( \Sigma^- \) from \( \Xi^- \) which is produced by week interaction between double strangeness.

FR.00032 Modeling and Optimization of a Discrete Cos Theta Coil for a New Neutron Electric Dipole Moment Search

Michael Betancourt, W.K. Kellogg Radiation Laboratory, California Institute of Technology, EDM Collaboration — The goal of the new neutron dipole moment experiment is to improve the limit on the current measurements of the neutron EDM by two orders of magnitude, resulting in the discovery of a finite EDM or the reduction of the limit on its value to the order of \( 10^{-28} \) e cm. Ultra cold neutrons, produced via downscattering of 8.9 A cold neutrons from superfluid \( ^4\text{He} \), will be bottleneck in static electric and magnetic fields where they will process at a frequency \( \omega = (\mu_0 B + d_\text{E} E)/Jh \). Neutron capture by surrounding \( ^4\text{He} \) atoms produces scintillation light from which the neutron EDM can be extracted. Nonuniformities in the fields, however, induce a geometric phase in the neurons that induces a false EDM signal. In order to minimize these errors, the uniformity of the fields, especially the magnetic field, must be optimized. To this end an analytical model of the discrete \( \cos \theta \) coil that will generate the magnetic field for this experiment was developed and its validity tested with experimental measurements made on a prototype coil. Finally the model was used to optimize the final geometry of the \( \cos \theta \) coil.

FR.00033 Double-sided Silicon Strip Detector for the study of Double Hypernuclei I

Takehiro Ishikawa, Kyoto University — The DSSD has an effective area of 64 mm x 32 mm, the thickness of 300 \( \mu \text{m} \) and 50 \( \mu \text{m} \) strip pitch. A number of strip-readout are 1280 channels in p-side and 640 channels in n-side, which corresponds to 10 and 5 VA chips installed on the DSSD. We use a V550 C-RAMS (CAEN Readout for Analog Multiplexed Signals) ADC module as an ADC and a V551B C-RAMS module as a controller. In order to evaluate the performance of the DSSD in terms of the S/N ratio, we measured the pulse height distribution of \( \beta \)-ray passing the DSSD from a \( ^90\text{Sr} \) source. We took about 100,000 events data at various source voltages, in order to check the depletion depth. At the bias voltage of \( \pm 10 \) V, we have obtained the S/N ratio as 33.76 ± 0.14 at p-side and 22.49 ± 0.09 at n-side for the minimum ionizing particles. The present results show the DSSD has sufficient S/N ratio to detect both \( \Xi^- \) and \( K^+ \).

FR.00034 Double-sided Silicon Strip Detector for the study of Double Hypernuclei I

Takayasu Sekihara, Kyoto University — Double-sided Silicon Strip Detector (DSSD) has been designed for the study of double hypernuclei. This DSSD is a key detector in BNL-E964, which uses a new emulsion-counter hybrid method to find 10 times more double hypernuclei than before. In BNL-E964, \( \Xi^- \) hyperons produced in the target (\( ^2\text{He} + \gamma \rightarrow K^- + e^- + \Xi^- \) reaction, are stopped in the emulsion and double strangeness nuclei are produced. The two DSSD's are placed within 5 mm distance between the target and the emulsion. The DSSD is the best detector of tracking \( \Xi^- \) because of its high position resolution and thiness which allows \( \Xi^- \) passing the DSSD with minimum decay rate of \( \Xi^- \). High position resolution of two DSSD’s enables to trace the track of \( \Xi^- \) with high scanning efficiency in the emulsion to find double hypernuclei. Design criteria and details of its construction are presented.

FR.00035 High Energy Cosmic Ray Air Shower Events Studied through Radio Emission

Michael Deaton, Abilene Christian University — One of the great mysteries remaining in astrophysics today is the unknown production mechanism of high-energy cosmic rays (HECRs). Since their initial discovery in the early 20th century, much greater energy cosmic ray events have been documented, some exceeding 10^{15} eV. In 1962 G. A. Askaryan proposed that air showers of elementary particles produced by HECRs entering the atmosphere would emit a coherent radio signature (Sov. Phys. JETP 14, 441-443). The electronics available at the time, however, were largely incapable of handling such signals. Innovative research in this field is only recently possible with the advent of a new species of interferometric software radio telescopes. Within this category, the LOPES phased array (Low Frequency Array Prototype Station), operating within the range of 40-80 MHz, seeks to further study the processes of high energy cosmic ray air showers. The LOPES collaboration has recently reported a breakthrough correlation between HECR air shower events and predicted radio flashes as explained by so-called geosynchrotron radiation (Falcke, H. et al. Nature 435, 313-316, 2005). This presentation will briefly describe the LOPES project and the software development that was completed for LOPES-Tools, the software package that is used for data analysis and mitigation of radio frequency interference for the LOPES project.
FR.00036 Upgrades to the PHENIX Calibration Software, TRAVIS HUNTER, Abilene Christian University, PHENIX COLLABORATION — To ensure the greatest accuracy and precision of reconstructed data from the PHENIX detector at RHIC, periodic calibrations must be taken for each of its detector subsystems. Each of these subsystems contributes an integral part to our understanding of the very high density high temperature state of matter created in heavy ion collisions at RHIC. Any given calibration is only valid for a certain length of time, and then a new calibration must be taken. The storage of these calibration validity times is in a large database, which makes the task of verifying its integrity very tedious. We present a new graphical method of retrieving these data which makes the task of ensuring the appropriate calibrations are applied much easier and more reliable, thus improving the quality of the reconstructed data taken by PHENIX. We also present improvements to the low voltage control interface to the muon tracking subsystem that allow the logging of power cycles to its electronics in order to examine correlations between the calibration data from the muon tracker and power cycles of its electronics.

FR.00037 Level 2 Filtering for the PHENIX Experiment at RHIC, AUSTIN BASYE, Abilene Christian University, PHENIX COLLABORATION — During the recently completed Run 5 of the PHENIX detector, located on the RHIC ring at BNL, the collaboration began recording data from the 200GeV polarized proton-proton beam. Throughout the run, multiple triggers were used to sort through the data to tag various rare events, such as a heavy di-muon event signifying the probable decay of a J/ψ. The level 2 filters were primarily used to isolate these events from the raw data. This filtering system allowed the collaboration a unique opportunity to view the data emerging from the best polarized proton collisions to date in near-real-time. This is a definite advantage in that problems can be identified quickly and results can be produced within 48 hours of data-taking. Significant work was done with respect to the monitoring, maintenance, and improvement of this crucial subsystem which resulted in more efficient uses of resources.

FR.00038 Coulomb Exertion of 46V and Testing Isospin Symmetry in the A = 46, T = 1 Multiplet, J.W. KREMENAK, D.C. MCGLINCHEY, L.A. RILEY, Ursinus College — A beam of the rare isotope 46V was studied via intermediate energy Coulomb excitation at 60 MeV/nucleon at the National Superconducting Cyclotron Laboratory (NSCL). BI(E2; 00 → 20) value of 46V was used to calculate the M0 value for the nucleus. The extracted M0 value in 46V was compared with the isoscalar multipole matrix element extracted from the previously determined B(E2; 00 → 21) of 46Cr and 46Ti. Preliminary results will be presented.

FR.00039 Gas gap optimization of MRPC Time-of-Flight detector for high-energy heavy ion experiment, YASUAKI TAKAHASHI — The charged particle identification (PID) provides us an essential tool to investigate a hot and dense matter created in high-energy heavy ion collisions. Recently Multi-gap Resistive Plate Chamber (MRPC) has been proposed as a cost effective, a wide coverage, and a high resolution Time-of-Flight detector for PID. MRPC has similar timing resolution compared to a conventional scintillation counter with photo-multiplier tube and a large area MRPC is relatively inexpensive and the choice of segmentation of the MRPC is also flexible. MRPC is basically the stack of glasses as the resistive plates, and gap between the glasses are filled with the non-flammable gas. The electrodes and readout pads are located on the most outer glass surfaces on both sides. Among the various control parameters, the number of gas gaps in MRPC is one of the important key conditions to be determined the detector performance. In this research, the choice of size and shape of the read pad and the number of gaps of the MRPC are varied in order to optimize design parameters and operating conditions of the MRPC. The performance of the MRPC especially on the timing resolution is studied by a cosmic ray test bench with a good timing reference signal from trigger scintillation counters and with a good pointing position accuracy from tracking chamber.

FR.00040 Production of 178m2Hf Isomeric Nuclei with High Energy Monoenergetic Neutrons, M. PARKER, University of Minnesota and TUNL, A. TONCHEV, B. FALLIN, W. TORNOW, A. HUTCHESON, Duke University and TUNL, J. KELLEY, NC State University and TUNL, J. CLARK, Hillsdale College and TUNL — The 31-year high-spin isomeric state 178m2Hf (Jπ = 16+) provides an opportunity to study high-spin nuclear structure phenomena as well as future energy storage opportunities. Unfortunately, experimental data on its population via neutron induced reactions is very scarce. In order to study the yield of this isomer in the 178Hf(n,2n)177m2Hf reaction, monenergetic neutrons of energies 10, 12.14, and 18 MeV from the TUNL tandem accelerator were produced and impinged on a 178Hf target sandwiched between Al and Ag foils serving as monitors. The residual activity of the irradiated Hf and monitor foils was measured with a shielded HPGe detector. To provide better understanding of the population and decay of levels in Hf, complementary in-beam measurements of γ-ray emissions were also taken at En = 12.5 MeV using BGO-shielded clover HPGe detectors. Analysis of these spectra allow the determination of the (n,2n) production cross sections of 178m2Hf.

FR.00041 Simulations of effusion rates from generic ISOL target geometries, SHANKAR ARUL, NSCL, DR. PAUL MANTICA’S GROUP TEAM — The objective of this study was to simulate the effusion of isotopes from proposed isotope separation on-line (ISOL) target geometries using the computer program SIMION. ISOL is one of two rare isotope production methods that will be used at the Rare Isotope Accelerator (RIA). Many short-lived radioactive species are produced in the ISOL target, and must be extracted rapidly to produce a useful radioactive beam. With SIMION, various ISOL target geometries were modeled to determine effusion times. By analyzing variations of the proposed geometry, we have determined the most efficient geometry that would provide the lowest effusion times to optimize extraction of short-lived species. The configuration that was found to be the most efficient was the one with the effusion space placed on the outer edge inside the target.

FR.00042 Detector Characterization for a Parity-Violation Experiment, BLAIR CARDIGAN SMITH, University of Winnipeg, G0 TEAM — The G0 experiment at Jefferson Lab uses parity-violating elastic electron scattering to extract the strange quark contribution to the charge and magnetization distributions within the proton. The backward-angle phase of the experiment will begin acquiring data in December 2005. In this phase of the experiment, the trajectories of recoiling electrons will be reconstructed with plastic scintillator detectors. Aerogel threshold Cherenkov counters will be used for particle identification. Owing to the small asymmetries that must be measured in parity-violating experiments, the detectors function at a high rate and with high efficiency. Each detector must therefore be characterized in terms of light yield and timing resolution. Cosmic rays were used for this purpose, simulating the response to high energy electrons. Results of the calibration process will be presented.

FR.00043 Angular distribution of the 4He(3He,γ)7Be reaction, ALIESHA ANDERSON, Hamline University, YANNIS PARPOTTAS, MOHAMMAD AHMED, Duke University, RICHARD PRIOR, North Georgia College and State University, HENRY WELLER, Duke University — The 4He(3He,γ)7Be is key reaction in high energy solar neutrino production. A measurement of the gamma-ray angular distribution provides insight into the reaction mechanism and allows better extrapolation of the cross section to low energies. A gas cell experiment has been designed and built to study the angular distribution. This work reports on the design and construction of the gas cell and the gas handling system as well as energy loss measurements in the cell. The cell was designed to reduce the background due to beam interaction with the entrance and exit foils. The detector geometry was studied and calculated to optimize response and efficiency. Results of preliminary gamma ray measurements with a 3He beam will be presented.

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3Supported by DOE (DE-FG02-97ER41033) and NSF (NSF-PHY-02-43776)
FR.00044 Determination of $^{13}$C($\alpha,\gamma$)$^{16}$O Reaction Rate at Stellar Energies Using Sub-Coulomb $\alpha$-transfer Reaction. , BERT GREEN, GRIGORY ROGACHEV, KIRBY KEMPER, BRAUN ROEDER, SIMON BROWN, ERIC JOHNSON, Florida State University, AKRAM MUKHAMEDZHAHOV, Texas A & M University — The reaction $^{13}$C($\alpha,\gamma$)$^{16}$O is considered to be the main source of neutron flux formation in low-mass stars which produces roughly half of the total elemental abundances in the universe. The rate of the reaction depends on the density of $^{12}$C in the cells, which is necessary for the experiment; however, the densities can neither be open nor contain pressure sensors. The polarization technique requires a small amount of rubidium and N$_2$ in the cell along with the $^3$He. The width of the D1 and D2 absorption lines in rubidium are linearly related to the density of $^3$He gas in the cells. Observing this widening of the absorption spectrum is achieved by using a tunable laser controlled by LabView software and measuring the power transmitted over a range of wavelengths. Preliminary results will be obtained and analyzed before the end of the summer.

1 This work is supported in part by DOE grant DE-FG02-97ER41033 and NSF grant NSF-PHY-02-43776.

FR.00045 Measuring $^3$He Cell Density Using a Tunable Laser1, HANNAH DEBERG, University of Arkansas, KEVIN KRAMER, Duke University, HAIYAN GAO, Duke University and TUNL — Compton scattering experiments using polarized $^3$He targets and the High Intensity Gamma Ray Source at the Duke Free Electron Laser Laboratory have been designed to investigate the spin polarizabilities of $^3$He and the neutron. The targets will consist of high-pressure $^3$He gas in glass cells that has been polarized by spin-exchange with optically pumped rubidium vapor. A precise knowledge of the number density of $^3$He in the cells is necessary for the experiments; however, the cells can neither be open nor contain pressure sensors. The polarization technique requires a small amount of rubidium and N$_2$ in the cell along with the $^3$He. The width of the D1 and D2 absorption lines in rubidium are linearly related to the density of $^3$He gas in the cells. Observing this widening of the absorption spectrum is achieved by using a tunable laser controlled by LabView software and measuring the power transmitted over a range of wavelengths. Preliminary results will be obtained and analyzed before the end of the summer.

FR.00046 Background Mitigation in a Highly-Segmented HPGe Detector1, M. PERRY, A.W. POON, R. HENNING, Lawrence Berkeley National Laboratory, K. VETTER, D. CAMPBELL, Lawrence Livermore National Laboratory — We present the first study of a highly-segmented HPGe detector with pulse shape discrimination in a low background environment. The detector consists of a 8x5 highly-segmented HPGe crystal, shielded with 5 cm of normal lead. Data was collected at the Orroville low-background facility to study backgrounds applicable to the proposed Majorana neutrinoless double-beta decay experiment. An analysis of the efficiency of highly-segmented detectors to eliminate these backgrounds will be presented.

FR.00047 The Time of Flight Technique for Nuclear Lifetime Measurements, AARON CHESTER, RYAN MCKENDEE, Michigan State University, KRZYSZTOF STAROSTA, WILHELM MUELLER, ANA BERCERRIL, HEATHER OLLIVER, RUSS TERRY, CHRIS CAMPBELL, JON COOK, CRISTIAN DINCA, NSCL — The onset of deformation in even-even nuclei is known to be manifested by a decreasing energy of the 2$^+$ excited state, E (2$^+$), correlated with an increase in the associated reduced transition probability B(E2). It is surprising to observe for $^{A_{110}}$Pd nuclei that as E (2$^+$) decreases, so does B (E2). It is proposed to reinvestigate this trend using the time of flight technique, which is undergoing development at the NSCL. With this method, a fast beam of degraded nuclei of interest produced in a fragmentation reaction is Coulomb excited to the 2$^+$ state on a moveable target. A stationary detector is positioned downstream to further slow the nuclei. Gamma-rays emitted during the de-excitation process before and after the degrader are measured at a different Doppler shift. The SEGA array of segmented germanium detectors is used for gamma-ray detection as it provides an optimal balance of sensitivity to changes in velocity and energy resolution. The ratio of intensities of the measured peaks yields information about the lifetime at the measured velocity. The results of a proof of principle experiment performed with the primary beam of $^{124}$Xe will be presented.

FR.00048 Analysis Needs for Parity-Violation Experiment. ALANA LAJOIE-O’MALLEY, University of Winnipeg — The G0 experiment at Jefferson Lab measures parity violating asymmetries in elastic electron-nucleon scattering to separately determine the electric and magnetic spin form factors over a broad range of Q$^2$. The next phase of the G0 experiment, performed at backward angles, will use two arrays of plastic scintillators, and aerogel Cherenkov counters to detect elastically scattered electrons. Two arrays are required in order to perform tracking and hence to differentiate between elastic and inelastic electrons. Fast scaler counting coincidences are read and cleared at the helicity reversal rate, giving rise to “helicity-reversal” events. In addition, “detector-checkout” events are acquired periodically to digitize pulse heights and timing spectra from the detectors. The detector-checkout events are essential for monitoring the performance of the detectors as well as individual photomultiplier tube (PMT) rates. For example, efficiency for electron detection and contaminations from backgrounds can be estimated using these events. In addition, aging of the detectors due to radiation damage is monitored. The most important aspect of the detector-checkout events will be that they will allow characterizing the success of the detectors to reject backgrounds. A custom C++ code converts raw data files into data summary files. The data summary files are analyzed using custom analysis tools (developed using the ROOT toolkit). The G0 analysis scheme will be discussed, with particular emphasis on detector-checkout events.
FR.00051 Determination of Depletion Depths and Non-Uniformities in Thick Large Area Resistive Strip Silicon Detectors. MARK SIKORA, S.D. PAIN, J.A. CIZEWSKI, J.S. THOMAS, K.L. JONES, Rutgers Univ., D.W. BARDAYAN, J.C. BLACKMON, M.S. SMITH, ORNL, J.M. JAMES, R.L. LIVESAY, Colorado School of Mines, M.S. JOHNSON, ORAU, R.L. KOZUB, Tenn. Tech, B.H. MOAZEN, C.D. NESARAJA, Univ. of Tenn. — High quality radioactive beams available at the HRIBF at ORNL enable the study of neutron-rich nuclei far from the valley of stability using (d,p) reactions performed in inverse kinematics. Obtaining data on nuclei in this region is important to our understanding of the development of nuclear structure away from stability, and is of interest to nuclear astrophysics. To perform these reactions requires proton detection with high solid angular coverage, with high resolution in energy and position. The Oak Ridge Rutgers University Barrel Array (ORRUBA) is a silicon detector array under development, comprised of two rings of resistive-strip silicon detector telescopes. Alpha-particle tests on the thick (1000 µm) prototype detectors have indicated regions of poor charge collection, present at near full-depletion bias voltages. However, such alpha-particles only penetrate 3% of the thickness of the detector. Measurements currently being carried out with elastically scattered protons will test the detector response throughout its entire volume and will benchmark the dependence of the position resolution on the deposited energy in the ΔE detector. The analysis of these measurements will be reported.

FR.00052 Simulation of Cosmogenic Background’s at Underground Facilities1, KAI HUDEK, ALAN POON, REYCO HENNING, Lawrence Berkeley National Laboratory, MAJORANA COLLABORATION — Fast neutrons produced by cosmic muons in rock surrounding an underground detector can induce reactions in the surrounding matter, leading to a background for experiments that detect weak interactions. Simulations of the total muon-induced neutron background and spectrum as a function of depth, and the response of the proposed Majorana experiment will be presented. Simulations were conducted using the GEANT4-based Monte Carlo package MaGe, a joint development between the Majorana and Gerda collaborations. The measurements of (d,p) reactions on heavy nuclei, which yield information of interest to nuclear structure and astrophysics, are now possible using high quality radioactive beams, such as the ones at the HRIBF at ORNL. These reactions are necessarily performed in inverse kinematics which, along with the relatively low beam intensities, require the detection of proton ejectiles with large solid-angle coverage, a large dynamic range (between 1 and >10 MeV), and good resolution in energy and position. Particle identification is necessary at angles forward of 90°. To meet these requirements, the Oak Ridge Rutgers University Barrel Array (ORRUBA) is currently under development, consisting of two rings of large-area resistive-strip silicon detector telescopes. Tests on the prototype 140µm thick ΔE detectors, using necessarily short shaping times, exhibit non-linearities in the signals due to the varying rise-times associated with the high capacitance and the large position-dependent resistance. Data are being obtained and analyzed, and techniques for performing off-line corrections of these position dependent non-linear signals are being developed.

FR.00053 Development of techniques for off-line corrections of non-linear signals from thin large area resistive-strip silicon detectors. J.M. JAMES, J. LIVESAY, Colorado School of Mines, S.D. PAIN, J.A. CIZEWSKI, M.A. SIKORA, K.L. JONES, J.S. THOMAS, Rutgers University, D.W. BARDAYAN, J.C. BLACKMON, M.S. SMITH, ORNL, B.H. MOAZEN, University of Tennessee, C.D. NESARAJA, University of Tennessee/ORNL, M.S. JOHNSON, ORAU, R.L. KOZUB, TTT — The measurement of (d,p) reactions on heavy (Z=50) fission fragments, which yield information of interest to nuclear structure and astrophysics, are now possible using high quality radioactive beams, such as the ones at the HRIBF at ORNL. These reactions are necessarily performed in inverse kinematics which, along with the relatively low beam intensities, require the detection of proton ejectiles with large solid-angle coverage, a large dynamic range (between 1 and >10 MeV), and good resolution in energy and position. Particle identification is necessary at angles forward of 90°. To meet these requirements, the Oak Ridge Rutgers University Barrel Array (ORRUBA) is currently under development, consisting of two rings of large-area resistive-strip silicon detector telescopes. Tests on the prototype 140µm thick ΔE detectors, using necessarily short shaping times, exhibit non-linearities in the signals due to the varying rise-times associated with the high capacitance and the large position-dependent resistance. Data are being obtained and analyzed, and techniques for performing off-line corrections of these position dependent non-linear signals are being developed.

FR.00054 Modeling x-Ray bursts with New Nuclear Physics. KARL SMITH, ALEX BROWN, JARED DUNNMON, ALEXANDER HEGE, EMILY JOHNSON, ALAN KRUZIGENZA, THOMAS RAUSCHER, PETER REDL, ALEXANDER SAKHARUK, HENDRIK SCHATZ, MICHAEL WIESCHER, MARK WALLACE, National Superconducting Cyclotron Laboratory — Multi-zone x-ray burst models simulate thermonuclear explosions on the surface of accreting neutron stars. The underlying nuclear reaction sequence in the x-ray burst is the rp-process. We used an updated nuclear reaction network, in which we updated mostly rp-process reactions, in a one-zone model and observe its impact on x-ray bursts, using the x-ray light curve and final produced ashes. We also explored the validity of one-zone approximations as tools to investigate nuclear physics by comparing to a full 1D multi-zone model.

FR.00055 Improving Energy Resolution for Neutron-Transfer Experiments at the HRIBF1, B.A. SCHWER, J.A. HOWARD, R.L. KOZUB, N.D. SMITH, Tennessee Tech. Univ., A. KRONENBERG, M.S. JOHNSON, ORAU, D.W. BARDAYAN, J.C. BLACKMON, C.D. NESARAJA, D.C. RADFORD, M.S. SMITH, ORNL, J.A. CIZEWSKI, K.L. JONES, S.D. PAIN, J.S. THOMAS, Rutgers Univ., R.L. LIVESAY, Carnegie, of Mines — Theories of the formulation of heavy elements by the γ-process require information on neutron-capture reactions. To better understand these, (d,p) reactions using radio-active ion beams in inverse kinematics are being studied at the Holifield Radioactive Ion Beam Facility (HRIBF) at Oak Ridge National Laboratory. In such experiments, the proton energy resolution is degraded by energy loss effects in the deuterated polyethylene (CD2) targets. To improve the energy resolution, γ-rays in coincidence with the protons are detected with a segmented germanium detector array. While the γ-ray energy resolution is not affected by the thickness of the target, the energy spectrum of the γ-rays is Doppler broadened, because of the high velocity of the heavy recoil nucleus. GEANT simulations were performed to find methods of correcting for the Doppler effect with the segmented germanium detectors. A (d,pγ) test run using a 352-MeV 86Sr beam with CD2 targets of various thicknesses will soon be conducted at the HRIBF. The progress of this run and the results of the GEANT simulations will be presented.

FR.00056 Using GEMINI to study multiplicity distributions of LCP’s in heavy ion collisions, ADIL BAHALIM, Davidson College, JOSEPH NATOWITZ, SEWERYN KOWALSKI, Cyclotron Institute, TAMU, NATOWITZ GROUP TEAM — There is a multifragmentation process that occurs in heavy ion collisions. At sufficiently low densities and high temperatures, this process creates primary fragments that are usually in excited states. These primary fragments decay into secondary fragments while emitting charged particles (LCP’s) and releasing energy. Given the time it takes to make direct experimental observations on the primary fragments, therefore, we must combine experimental observables from the secondary fragments with results from computer simulation programs, such as GEMINI, to reconstruct and identify the primary fragments and their conditions. This, in turn, gives us a better understanding of the nuclear equation of state. GEMINI calculates the decay of compound nuclei by sequential binary decays, until the resulting products are unable to undergo further decay. Decay simulations are run for nuclei with Z=3 to Z=40 at excitation energies from 2 to 5 MeV/amu at 0.5 MeV/amu intervals. At each excitation energy, 1000 events are simulated. The multiplicity distributions of each of the six LCP’s protons, p, d, t, 3He, 4He) are extracted to ROOT. Unfit data gathered by the simulations. The correlation between the mean multiplicity and the width of multiplicity distribution will be used in the reconstruction model input parameters.

FR.00057 Exploring Neutron Dosimetry. JOHN KEITH — Despite the relative difficulty detecting neutrons, there are several possible considerations we have to make when designing our neutron dosimeter. A polyethylene layer could be put to interact with neutrons to produce a proton or heavy ion which would then interact with a charged particle sensitive scintillator or have a scintillator directly sensitive to neutrons such as a liquid scintillator or one made of ZnS(Ag) doped hydrogenous plastic. This can then be put into connection with a phototube, or, as our choice was, a photocathode followed by an array of Gaseous Electron Multiplier (GEM) foils. The final component is the electronics readout catered to the specific application. We are going with a simple quad readout (4 squares of equal size) to determine the homogeneity of the incident neutron beam created in the 88-inch cyclotron at LBNL. This configuration consisting of ZnS(Ag) doped hydrogenous plastic, a photocathode sensitive to 450nm light (wavelength emitted by the scintillation), an array consisting of 4 GEM foils, and the electronics readout will be used for fast neutrons of about 14MeV.

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1Work supported in part by US DOE and NSF
FR.00058 Modification of Magic Number through Mass Formula with Shell Correction, SHINYA ITO, YUMA KIKUCHI, AKIRA OHNISHI, KIYOSHI KATO, Hokkaido University — We study how single particle energies depend on the asymmetry of protons and neutrons. In most of former researches, single particle energies are not considered to be dependent on the asymmetry. In our research, the energy of each orbit is assumed to be a function of the asymmetry, \((N-Z)/A\). This assumption is based on the experimental fact that new magic numbers appear in neutron-rich nuclei\(^1\). We introduce this effect in a similar way to the shell correction by Myers and Swiatecki\(^2\), and apply the correction to the Weisszäcker-Bethe mass formula. Energy levels are obtained by fitting to the nuclear masses at the ground state. Analyzing the obtained functions of single particle energies, we confirm the appearance of the new magic numbers which have been already indicated by the experiment, and find additional magic numbers at higher energy states.

References

FR.00059 Extracting the Eta Signal for Comparisons in Au+Au and Cu+Cu Collisions, KAREN KOOP, University of Muenster, Institute for Nuclear Physics — The Pioneering High Energy Nuclear Interaction Experiment (PHENIX) is an experiment collecting data from the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratories. The goal of PHENIX is to study the Quark-Gluon Plasma, a new state of matter formed in the high energy densities created by the RHIC. PHENIX collected data in Au+Au, Cu+Cu, d+Au and p+p collisions at various energies. An interesting observation from the experiment has been the suppression of neutral pions with high transverse momentum (pT) in central Au+Au collisions relative to expectations from proton-proton results. By comparing eta particle production to neutral pion production, the suppression of particles can be evaluated for dependence on particle species. Comparisons of eta production can also be made between Au+Au and Cu+Cu reaction systems. In order to make these comparisons, the eta signal must be extracted. Techniques such as event mixing and background subtraction make this possible. As a participant in the Research Internships for Scientists and Engineers program, I had the opportunity to work with graduate students at the University of Münster, Germany in their analysis of data taken from the PHENIX experiment.

FR.00060 PPAC characteristics for unstable nuclear beams of intermediate energy II, KENICHI KARATSU — The parallel-plate avalanche counter (PPAC) is a detector that utilizes an ionization avalanche mechanism. We have constructed a model to explain the avalanche mechanism. Inside the PPAC, an electron is accelerated by a large electric field, which is present between the anode and cathode. Each time an electron travels its mean free path, colliding with a gas molecule, it loses all of its kinetic energy. With \(n(x)\) as the number of electrons at position \(x\), there are a few among them that do not collide at all; collecting enough energy to ionize a gas molecule. The number of such electrons is \(n(x)\exp(-l/\lambda)\). While these electrons advance by \(dx\), it collides with a gas molecule by a probability of \(dz/\lambda\); liberating another electron. Therefore we obtain the relation
\[
\frac{dn}{dx} = \pi \exp(-l/\lambda) dx/\lambda
\]
This yields a relation similar to the empirical rule. In order to discuss the adequacy of this model, we must compare the parameters included in both equations. This calls for further testing of the operation of the PPAC with different gases and bias voltages. The experiments are being done at the tandem accelerator at Kyoto University.

FR.00061 PPAC characteristics for unstable nuclear beams of intermediate energy I, SHOHEI OKUMURA — High-energy unstable nuclear beams produced by projectile fragmentation contain a variety of particles with a wide range of energy. Therefore, in elastic scattering experiments using unstable nuclear beams, the separation of inelastic processes is essential. The particles must be tagged by their momentum. For momentum analysis, we insert a position detector at the focal plane of the beam line spectrometer. The parallel-plate avalanche counter (PPAC) is a detector used to measure the positions of ion beams in the beam line. The PPAC is highly reliable and versatile in that it can be applied to a wide range of energetic ions. As it is often used in low-energy experiments, the detection characteristics are well known in those ranges. Our objective is to reveal the yet unknown PPAC characteristics for unstable nuclear beams of intermediate energy. Our main interests are the detection efficiency, time and position resolutions, and their beam rate dependency, which are being tested with 6 GeV \(^{20}\)O beams at the National Institute of Radiological Sciences.

FR.00062 Precision tests of calculated internal-conservation coefficients: the case of \(^{134}\)Cs, W.E. ROCKWELL, Mount Holyoke College, H.I. PARK, J. GOODWIN, N. NICA, V.E. IACOB, J.C. HARDY, Cyclotron Institute, Texas A&M University — Internal conversion coefficients (ICC) play an important role in nuclear decay schemes. Yet, the tabulated results of ICC calculations are only known to agree with experiment on average to within a few percent, and there are some cases of much more significant discrepancies. In particular, for transitions with energies close to an atomic-electron binding energy, the calculated ICC values depend strongly on how the theory deals with the hole left by the departing conversion electron. One approach assumes that it is filled instantaneously, while the other considers that it stays empty throughout the entire conversion process. To date there are few exact measurements of ICCs with an uncertainty below one percent and this lack of precision makes it difficult to be definitive about the validity of either theory. We are embarked on a program to rectify this situation. In our present experiment we aim to measure the K-shell ICC for the 134-keV E3 transition in \(^{134}\)Cs with a precision of one percent or better. The experimental value of its ICC, as currently evaluated, does not fit particularly well with any available theory [see S. Raman et al, Phys. Rev. C 66, 044312 (2002)].

FR.00063 Gamma-Coincidence Modeling with MCNPX, JENNA DEAVEN, ANNE EMERSON, JAMIE LEITER, SHARON STEPHENSON\(^1\), KRISTEN TOSKES, Gettysburg College — Tertiary neutrons produced in self-sustaining Inertial Confinement Fusion reactions can activate a carbon target through \(n + ^{12}\)C \(\rightarrow ^{11}\)C + \(\beta^+\). The subsequent positron-electron annihilations lead to 511-MeV coincidence gammas, and therefore the tertiary neutron yield can be determined by a gamma-coincidence detection experiment. Monte Carlo N-Particle eXtended transport code (MCNPX) is used to model the \(^{12}\)C experiment, and through a comparison with real data, the geometry for the detector system can be determined. MCNPX is also used to model the non-uniform neutron activation of the \(^{12}\)C. Results will be presented.

\(^1\)Faculty Advisor
FR.00064 Commissioning the Neutral Meson Spectrometer at the High Intensity Gamma-Ray Source (HIGS) for Photo-Pion Experiments. DANE GRASSE, St. Norbert College, MOHAMMAD AHMED, TUNL/Duke University, RICHARD PRIOR, TUNL & North Georgia College and State University, HENRY WELLER, TUNL/Duke University — An experimental program to study pion-nucleon interactions at the upgraded High Intensity Gamma-ray Source (HIGS) at the Duke Free Electron Laser Lab is being developed. The pions are produced via the reactions, \( \gamma + p \rightarrow \pi^0 + p \) and \( \gamma + p \rightarrow \pi^+ + n \), using polarized gamma rays. The Neutral Meson Spectrometer (NMS) and the Blowfish neutron detector array will be used to study the pion kinematics. This work reports on the calibration and testing of the NMS. The 120 CsI crystals in the NMS were systematically gain calibrated using cosmic rays. The efficiency of a layer of scintillating veto detectors in front of the CsI array was analyzed by coincidence timing techniques. To test the system, the angular distribution of cosmic ray flux was measured. A Monte Carlo simulation was also performed for the \( \gamma + p \rightarrow \pi^+ + n \) reaction to study the feasibility of \( \pi^+ \) detection by the NMS.

1This work is supported by National Science Foundation grant NSF-PHY-02-43776 and Department of Energy grant DE-FG02-97ER41033

FR.00065 Initial Measurements of the Total Cross-Sections of the Reactions \( K^- + p \rightarrow \Sigma(1385) + \gamma \) and \( K^- + p \rightarrow \Sigma(1385) + \pi^- \) in the Crystal Ball JASON SUMMERLOTT, Valparaiso University, CRYSTAL BALL COLLABORATION — The first ever measurements of the total cross-sections for the reactions, \( K^- + p \rightarrow \Sigma(1385) + \gamma \) and \( K^- + p \rightarrow \Sigma(1385) + \pi^0 \), are being determined for kaon momenta ranging from 514-750 MeV/c. These studies provide new insight into the states of excited Sigma and Lambda particles. Analysis is being done using data collected by the Crystal Ball Spectrometer in the AGS at Brookhaven National Laboratory. The Crystal Ball is primarily a photon detector, consisting of 672 NaI crystals. Kaons were incident on a liquid hydrogen target with the reaction final-state particles registering in the detector crystals. Charged particles were vetoed using plastic scintillators, thus restricting analysis to neutral particles. The primary background reactions for \( K^- + p \rightarrow \Sigma(1385) + \pi^0 \) include \( K^- + p \rightarrow \Sigma(1385) + \pi^0 \) and \( K^- + p \rightarrow \Lambda + 2n \); these backgrounds, along with several others, were studied using GEANT Monte Carlo simulations. Measurements of the total cross sections for both reactions will be presented.

FR.00066 Fiducial Cuts on CLAS for the E5 Data Set KRISTEN GREENHOLT, University of Richmond, Virginia, CLAS DETECTOR COLLABORATION — The Thomas Jefferson National Accelerator Facility, in Newport News, Virginia, is home to CLAS (CEBAF Large Acceptance Spectrometer) which observes the scattering of an electron beam on a nuclear target. The acceptance of the detector is the ratio between the events we expect to observe in an ideal detector and the data that we actually measure with CLAS. In order to analyze data from regions of well-understood acceptance, we generated electron and proton fiducial cuts on CLAS, fitting a trapezoidal function to the azimuthal dependence in a particular scattering angle bin. Previously, we analyzed the 2.56-GeV, normal torus polarity data from the E5 run period. Our current analysis extends the method to the 2.56-GeV, reversed-torus polarity and the 4.23-GeV normal- polarity data sets of the E5 running period. We will compare the effects of fiducial cuts under these different running conditions. These results are consistent with our expectations, validating the use of fiducial cuts to isolate stable efficiency.

FR.00067 Two-neutron transfer in the \( ^6\text{He} + ^{209}\text{Bi} \rightarrow ^{209}\text{Bi} \) reaction near the Coulomb barrier PATRICK J. MACE, Hope College, P.A. DEYOUNG, G F. PEASLEE, Hope College, J.J. KOLATA, University of Notre Dame, E.F. AGUILERA, Instituto Nacional de Investigaciones Nucleares, F.D. BECCETTI, University of Michigan — The cross section for \( \alpha \)-particle emission in the \( ^6\text{He} + ^{209}\text{Bi} \) reaction at energies near the Coulomb barrier is remarkably large. Possible reactions that may produce the observed \( \alpha \)-particles include two-neutron transfer, one-neutron transfer, and direct projectile breakup. Each of these mechanisms results in a distinctive angular correlation between the \( \alpha \)-particle and the outgoing neutron(s). A \( \alpha \)-particle coincidence experiment was performed to study two-neutron transfer to unbound states of \( ^{211}\text{Bi} \). It is shown that approximately 55% of the observed \( \alpha \)-particle yield at and beyond the grazing angle is due to this process. This is more than 2.5 times the fraction attributable to single-neutron transfer. This work has been published: Phys. Rev. C 71, 051601 (R) (2005)

FR.00068 Momentum Corrections for the E5 Data Set ROBERT BURRELL, University of Richmond, CLAS DETECTOR COLLABORATION — The Thomas Jefferson National Accelerator Facility located in Newport News, Virginia, is home to the CLAS (CEBAF Large Acceptance Spectrometer) detector, which measures scattered particles from high-energy collisions of an electron beam and a nuclear target. Initial measurement of the momentum of charged particles is done by reconstructing tracks using different detecting elements and a toroidal magnetic field. To improve these momentum measurements, we apply corrections. The quantity \( qB/p \) (\( q \) is charge, \( B \) is proportional to the magnetic field, and \( p \) is momentum) is extracted from elastic ep scattering using tracking and also from the well-measured electron and proton scattering angles. The difference between the two quantities is parameterized to determine the correction factors. We previously applied this technique to the 2.56 GeV normal torus polarity data set of the E5 run period and now will be presenting the results from the other E5 data sets.

FR.00069 Drift Chamber Development for PHENIX Muon Trigger RPC Tests. AARON VEICHT, University of Illinois at Urbana-Champaign, PHENIX COLLABORATION — The PHENIX experiment at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory will measure the flavor dependent quark and anti-quark polarizations in the proton. In proton-proton collisions a quark and anti-quark interaction can be signaled by the formation of a W-Boson. Experimentally in PHENIX, W- Bosons are detected through the presence of a high energy muon. The PHENIX detector presently triggers muons above 2 GeV, including those from meson decays. This trigger condition results in a data flow ten times higher than the available data acquisition bandwidth in PHENIX. We propose to introduce fast first level trigger counters for an on-line measurement of the muon momentum. With this upgrade in place, a trigger condition of muon momenta greater than 10 GeV will decrease the data rate by a factor of twenty. The proposed first level muon trigger will rely on technology developed for the CMS detector at LHC. Application of the CMS RPC’s in PHENIX will require an improvement in position resolution. In this paper we present the design, simulation and construction of a drift chamber package to be used in the PHENIX RPC cosmic ray test stand.

FR.00070 Investigation of Hyperon Polarization in Preparation for ATLAS Lambda-b Data SARAH LUMPKINS, University of Oklahoma, HOMER NEAL, University of Michigan, CERN TEAM — The fact that inclusively produced hyperons are produced with significant polarization was first discovered at Fermilab about thirty years ago. This field of research has seen much experimental work since then, although theoretical understanding is still lacking. One mystery in particular that has eluded explanation is the shape of the lambda polarization vs. transverse momentum curve; the lambda polarization grows to a sizeable negative value for p_t up to around 1.0 GeV/c and then plateaus for the next 2 GeV/c. Currently, there are no polarization models which have been able to successfully account for all known hyperon polarization phenomena. My project surveys all high energy hyperon polarization data in an effort to develop a model that provides a comprehensive explanation of the data. Initial results of this project support a quasi-classical parton-parton scattering model in line with that developed by Neal and Nielsen in 1974 in explanation of high energy elastic proton-proton scattering data. This analysis of lower mass hyperons is crucial in preparation for anticipated data on lambda-b hyperon polarization in ATLAS; due to the mass of the lambda-b hyperon, certain physical models predict even larger polarization effects for the lambda-b. Thus, future lambda-b studies have an even greater potential for providing insight into fundamental processes of nature.
FR.00071 Design, Construction and Test of Resistive Plate Counters for the PHENIX Muon Trigger. YONGSUN KIM, University of Illinois at Urbana-Champaign, PHENIX COLLABORATION — Polarized proton-proton collisions used in the PHENIX experiment at Brookhaven National Laboratory's Relativistic Heavy Ion Collider will accurately determine the spin contribution of quarks and antiquarks to the proton spin. Sensitivity to quark and antiquark polarizations arises in W-production which experimentally is characterized by the detection of high momentum muons. The effective cross section (including PHENIX acceptance) for W-production is about 1 nb and collision rates of 10 MHz are required to accumulate sizable W-boson samples. The high collision rate requires an upgrade of the PHENIX muon trigger system. It was decided to use RPC's as dedicated first level trigger detectors. RPC's are fast detectors, simple in structure and cheap in construction. The PHENIX RPC design is based on the CMS muon trigger RPC's. Before constructing large scale RPC's at PHENIX, prototype RPC's of several designs will be tested using test beam and cosmic ray muons. We present our work to improve the position resolution of the CMS-designed RPC's and our results on RPC efficiency, timing resolution and rate capabilities.

FR.00072 Forward Calorimeter for the Compact Muon Solenoid. ADURAMIGBA SOPEJU, Benedict College, CHRISTOPHER COWDEN, MARIO SPEZZIGA, NURAL AKCHURIN, CERN/CMS TEAM — In 2007, the Large Hadron Collider (LHC) at CERN in Geneva would be turned on and then used to study the collision of protons and lead ions at extremely high energies. The purpose of these high energy collisions is to study the origin of mass and recreate the conditions of the first few moments of the universe. The Compact Muon Solenoid (CMS) is one of the experiments at LHC. I am presently working on the Forward Calorimeter (HF) of the CMS. Electrons, Photons and hadrons would be stopped by the calorimeters allowing their energies to be measured. The Calorimeter is made up of very sensitive materials mostly thin quartz fibers embedded in blocks of steel. The particles shower in the blocks and produce Cherenkov radiation in the optic fibers. This provides an energy measurement for both particles interacting electromagnetically and hadronically. The current goal for this calorimeter is to increase the forward coverage of CMS, improving the measurement of transverse energy, especially for high energy forward jets, which are a signature of some important physics processes.

FR.00073 A New Experiment to Study Transverse Proton Spin Structure through the Drell-Yan Process in Polarized Proton Collisions at RHIC. HYE RYONG KIM, University of Illinois at Urbana-Champaign, PHENIX COLLABORATION — Over the past 30 years, significant progress has been made in understanding longitudinal proton spin structure through polarization deep inelastic scattering experiments at SLAC, CERN, DESY, and Jefferson Laboratory. In contrast, the helicity flip transversity distributions of quarks inside a transversely polarized proton are completely unknown. Thus, the transverse spin physics of RHIC at Brookhaven National Laboratory make it possible to study transversity through the Drell-Yan process in high energy polarized proton-proton collisions. An initial study by Vogelsang et al. showed that measurement of spin asymmetries in Drell-Yan at RHIC will only have poor statistical resolution. Based on simulation studies using the event generator PYTHIA, we will demonstrate that the RHIC luminosity upgrade with electron cooling and special focusing magnets (RHIC II) in combination with a new large acceptance calorimeter will lead to precise measurement of transverse single and double spin asymmetries, and thus the transversity quark distributions.

FR.00074 Thermal Analysis of Heavy Ion Collisions. LAURA STILES, University of Kansas — At Brookhaven National Laboratory, the Relativistic Heavy Ion Collider accelerates heavy ions and protons to relativistic speeds to create extreme condition collisions. Detectors study these collisions, the ultimate goal being the study of a new form of matter, the quark-gluon plasma. One of the detectors, BRAHMS, or the Broad Range Hadron Magnetic Spectrometer, measures only a small number of particles, but over a wide range of momentum and angles. One question being studied is if different regions of the hot partonic matter created in these collisions lose contact with each other before they reach chemical equilibrium. A thermal model package, THERMUS, has been created that can be run in the object oriented data analysis framework, ROOT. THERMUS is a C++ implementation of a grand canonical ensemble model developed at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. We present our work to improve the position resolution of the CMS-designed RPC's and our results on RPC efficiency, timing resolution and rate capabilities.

FR.00075 Determining the effect of magnetic fields on the relative biological effectiveness of gamma rays. BEVERLY LAU, Reed College, FREDERICK BECCHETTI, YU CHEN, University of Michigan - Ann Arbor — Experiments at the Phoenix Memorial Labs were done to compare the effect of an 8.9 kCurie Cobalt-60 source on Saccharomyces cerevisiae (baker's yeast) with and without a 0.78 Tesla magnetic field. At a distance of 30 centimeters from the source, the yeast cells were irradiated with a dose rate of 56 kRad per hour, and doses of 20 and 30 kRad were sufficient to produce a survival rate of 50 percent or less. It was discovered that the magnetic field causes the relative biological effectiveness of incident gamma rays to change slightly. Successful trials of this experiment have shown reproducible effects.

FR.00076 Electron Identification in the EEMC at STAR. JOSHUA VREDEVOOGD, THEODORE HOPKINS, Valparaiso University, STAR COLLABORATION — The Endcap Electromagnetic Calorimeter (EEMC) at STAR provides a new tool to probe the origins of nucleon spin. In particular, the spin contribution of up and down sea antiquarks can be studied through charged intermediate vector boson (W) production in quark-antiquark annihilation. The W bosons are identified in STAR by the observation of a single electron track from their decay. By measuring the particle-varying helicity sensitivity of the yield of these electrons, one can infer information about spin preferences of sea antiquarks in the proton. A prerequisite for this, and several other studies, including J/Ψ production, is the ability to efficiently differentiate between electrons and hadrons as they pass through the calorimeter. Measurements of the transverse and longitudinal evolution of the electromagnetic and hadronic showers in the EEMC provide distinguishing characteristics that permit the separation of these two shower types. We have developed a method that provides electron identification and charged pion background suppression that surpasses the design requirement for EEMC signals alone. Further efforts are underway to discriminate against prompt photon and neutral pion backgrounds, both of which also produce electromagnetic showers in the EEMC. An overview of our identification method and results are presented.

FR.00077 Angular Distribution of Gamma Rays in Neutron-Rich Hafnium Nuclei. STEVEN SHEPPARD. University of Massachusetts Lowell — The HISPIN research group at UMass Lowell conducts Heavy Ion Spectroscopic Investigations of Nuclei to learn about the physics of nuclear rotation. In this experiment, performed at the 88” Cyclotron at Lawrence Berkeley National Lab, a 750 MeV beam of 139Xe was incident upon a 180Hf target in order to excite 180Hf nuclei to high angular momenta. Gammasphere, an array of 110 Compton-suppressed germanium detectors, with CHICO (Compact Heavy Ion Counter), a large solid-angle, position-sensitive, heavy-ion detector, was used to record, in multi-parameter event mode, the recoil angles, flight times and gamma emissions of the nuclei. This allows event-by-event Doppler correction for the gamma rays, to restore the intrinsic detector resolution in the spectra. The gamma-ray angular distribution was measured with respect to the direction of both the beam and the recoiling nucleus, using the CHICO data to identify the flight path. These angular distributions can identify the nature of the transition responsible for the characteristic gamma emission, and yield knowledge of the excited level structure of a nucleus and the governing physics.

1Supported by USDOE Grants DE-FG02-94ER40848 and UMass Lowell Faculty/Student Collaborative Research Grant
FR.00078 Determination of Energy Loss of 3-MeV alpha particles in Ni foil and $^3$He Using a Mg($\alpha, \gamma$) Resonance. K.P. MICHNICKI, C. BORDEANU, J.D. LOWREY, K.A. SNOVER, D.W. STORM, University of Washington Department of Physics — The largest nuclear physics uncertainty in calculating the neutrino flux from the sun is presently in the value of $^3$He + $^4$He S-factor. The cross-section for the reaction depends on the energy of the alpha particle. As the alpha particles pass through the $^3$He gas cell, they lose energy, both in the foil window and in the gas. In order to minimize uncertainty in the measurement of S($^3$He($\alpha, \gamma$)), it is important to understand the energy distribution at different locations in the gas chamber. Excitation functions for the $^{24}$Mg($\alpha, \gamma$) resonance at 3.1998MeV were obtained for various gas pressures and beam currents as well as without the gas and foil. By analyzing the excitation functions, we determine the separate energy losses in the foil and gas. We also measured the dependence of the energy loss on the beam current, thereby finding the effect of beam heating on the density. From the observed resonance width, we determined the total beam energy spread, due to straggling and foil nonuniformity.

FR.00079 Development and Benchmark Studies of the Indiana Rf Photocathode Source Simulator*, DANIEL BOLTON1, CHONG SHIK PARK, MARK HESS, Indiana University Cyclotron Facility — The Indiana Rf Photocathode Source Simulator (IRPSS) code is being developed to calculate the electromagnetic fields created by an electron beam in a photoinjector, and to simulate the effects of these fields on the beam using time-dependent Green’s function methods. In this poster, we show initial IRPSS simulation results for a simplified photoinjector geometry consisting of a semi-infinite cylindrical pipe and cathode using the experimental parameters for the BNL 1.6 GHz photocathode gun [1]. We also show the excellent agreement within a benchmark study between the IRPSS code operating with the same simplified geometry and the analytical solution for a disk-like bunch and its “image” bunch propagating with uniform velocities in opposite directions with free space boundary conditions. Our benchmark study has demonstrated that the effects of self-fields reflecting from the pipe, as well as the electromagnetic shock fronts due to causality conditions, may be significant in understanding the physics of photoinjectors. * This research is supported in part by the NSF REU program. [1] K. Batchelor et al, “Development of a High Brightness Electron Gun for the Accelerator Test Facility at Brookhaven National Laboratory”, EPAC’88, Rome, June 1988.

1Present address: Colorado School of Mines

FR.00080 Total cross section of Single-Quantum Annihilation, YUSHI TSUBOTA, SYOGO IDA, SACHIO D. IMABEPPU — Positron annihilation with electron usually produces two 511 keV photons in a final state. There were intense experimental studies on the two and more photons in the final states although little studies have been carried out on a single-quantum annihilation (SQA). Here we report an experimental study of SQA. When an electron is bound in a nucleus, momentum can be carried away by the nucleus and SQA is allowed. There are theoretical and experimental studies on the dependence of positron kinetic energy and target atomic numbers (Z) where energetic positrons were used for the study. We carried out an experiment to search for SQA by a positron provided by a radioactiv positron source of 22Na. We have low energy (~100 keV) positron and SQA spectrum represents and initial positron energy and binding energy of atomic electron with which the annihilation takes place. We discuss mechanism of SQA based on observed event rate and SQA energy spectrum.

FR.00081 A 3D Liquid Scintillator Neutrino Detector, DANIEL PASSMORE, University of Tennessee, Knoxville, REX TAYLOE, Indiana University, Bloomington — The Fine-grained Intense Neutrino Scattering Scintillator Experiment (FInESSE) is a proposed liquid scintillator detector that will measure track coordinates in 3D using WLS optical fibers. FInESSE proposes to use high intensity charged and neutral current neutrinos scattering to precisely measure the strange quark spin component, delta s, of the nucleon. A FInESSE 1D prototype was measured using the 200MeV proton beam at the Indiana University Cyclotron Facility (IUCF). Results for position and angular resolution of charged particle tracks measured in this device will be presented.

1This work was supported by the National Science Foundation summer REU program at Indiana University.

FR.00082 $\phi$ meson production in Deuteron-Gold Collisions at $\sqrt{s} = 200$ GeV at PHENIX. SUNGHO YOON, University of Illinois at Urbana Champaign, PHENIX COLLABORATION — Surprising nuclear effects from $J/\psi$ and light meson productions at forward rapidity region have been observed in d+Au collisions at $\sqrt{s} = 200$GeV in PHENIX using the forward muon spectrometers. The $J/\psi$ signals were reconstructed through the dimuon decay channel, and the light mesons ($\pi, K$) were detected through their decays to muons as well as through the ‘punch-through’ hadrons. To understand the origin for the nuclear effects, it would be very useful to detect the $\phi$ meson which contains a pair of strange and anti-strange quarks. The measurement of $\phi$ production at PHENIX will also help us to understand the nuclear effects as a function of the mass of the produced hadrons. The $\phi$ production could be measured via $\phi \to \mu^+ \mu^-$ decay channel using the muon spectrometers at PHENIX. However, the current trigger system is optimized for the measurement of $J/\psi$. An improvement to the trigger system will allow the study of $\phi$ production. We have calculated the production of $\phi$ in the d+Au reaction at $\sqrt{s} = 200$ GeV. The acceptance of the PHENIX detector for the $\phi$ events, and the kinematic coverage and the anticipated statistical accuracy for the accepted $\phi$ events have also been studied. In this talk, we present the results of this study.

FR.00083 Excited States in the Nucleus $^{73}$Br. RAFAEL YAH, DePaul University, SUSAN FISCHER, DePaul University and Argonne National Laboratory, KIM LISTER, Argonne National Laboratory — The nucleus $^{73}$Br was produced in the reaction $^{40}$Ca ($^{36}$Ar,3$p$) using the ATLAS accelerator at Argonne National Laboratory. Gamma rays from the decay of excited states in this nucleus were detected by the Gammasphere array, and the recoiling nuclei were identified according to mass at the focal plane of the Fragment Mass Analyzer. Gamma-gamma coincidence data gated by mass have been analyzed. Prior to this work, three rotational bands were observed in $^{73}$Br, and later extended to high angular momentum. The current study has identified several additional rotational bands which begin at low angular momentum and excitation energy. The new bands will be compared with the known band structures in $^{75}$Br and $^{71}$Br.

1This research is supported by National Science Foundation grant number PHY-0244895 and U.S. Department of Energy, Office of Nuclear Physics contract number W-31-109-ENG-38.

FR.00084 Gas-Filled Recoil Separation of Heavy Ions at Intermediate Energies, MATTHEW STERNBERG — Current capabilities for the capture of fusion products produced at the Argonne Tandem Linear Accelerator System (ATLAS) and used for mass measurements at the Canadian Penning Trap are limited. The facility can capture reaction products emitted at angles up to 4 degrees off axis. In many reactions that take place the majority of recoil products are emitted at angles within 4 degrees of the axis. However, there are many desirable reactions where the majority of products fall outside this window. The use of a large bore solenoid magnet has been investigated as a means of capturing a larger range of recoil products. A Monte Carlo simulation was developed to model the transport of ions through a gas-filled solenoid magnet and different means of disposing of the primary beam have been investigated. A method was developed in which a large range of recoil products at various energies could be efficiently separated from the primary beam. Simulations suggest that recoil products could be captured at angles as large as 12 degrees, improving the current efficiency by as much as 1000%. Design and construction of the proposed apparatus are currently underway at Argonne National Laboratory.

1Work completed under supervision of Guy Savard (Argonne National Laboratory). Funding was provided by the DOE.
FR.00085 Drell-Yan Measurements of Nucleon and Nuclear Structure with the FNAL Main Injector, DONALD ISENHOWER, RUSTY TOWELL, MICHAEL SADLER, Abilene Christian University — Work preparing for Fermilab E906 will be reported. This experiment is a continuing development of the Fermilab E866/NuSea Drell-Yan experiment that determined the light anti-quark asymmetry in the proton. In the Drell-Yan process, a quark (anti-quark) in the beam hadron annihilates with an anti-quark (quark) in the target, which produces a lepton pair. Thus the D-Y interaction is able to probe the sea quarks. E906 will significantly improve the results above Bjorken x of 0.2, where statistics were limited in E866/NuSea. Using the Main Injector at Fermilab at 120GeV/c, an improvement of a factor of 50 will be possible.

FR.00086 Target Thickness Optimization of 12C for Tertiary-Neutron Activation at OMEGA, KRISTEN TOSKES, ANNE EMERSON, JENNA DÖVEAN, JAMIE LEITER, LAUREN KATE MCNAMARA, SHARON STEPHENSON, Gettysburg College — One way to determine the γ/r (areal density) of IFC capsules is through tertiary-induced neutron activation of elements with appropriately high thresholds such as 130Cu or 12C. Since the tertiary neutron yield is many orders of magnitude lower than the primary yield, the experiment demands modeling to determine the optimal target thickness. Codes such as MCNPX seem well suited for such a project; however, activation eventually causes gamma-coincidences, which cannot be “talled” in MCNPX. MCNPX can be used to provide particle track information for a known geometry for single gammas. External coding is utilized to fabricate pairs (i.e. coincidences). This allows for the determination of the transmission of both gammas in varied thicknesses of 12C. The optimal thickness depends on the solid angle, the activation, and the attenuation factor appropriate for each gamma. Results will be presented.

FR.00087 Quadrupole moment of the γ-soft 196Pt, E. NOVITSKI, WNSL, Yale University, V. WERNER, WNSL, Yale University — The 196Pt nucleus is considered to be one of the best examples of the O(6) γ-soft symmetry in the Interacting Boson Model (IBM) based on energies and B(E2) values, especially the 2+ → 0+ / 2+ → 2+ B(E2) ratio, which is close to the O(6) limit of 0. However, the quadrupole moment of 196Pt (and that of neighboring 194Pt) is known to be positive and sizable, which hints at a considerable oblate deformation of the nucleus. It is impossible to describe the O(6)-like features and the nonzero quadrupole moment simultaneously within the commonly-used consistent-Q formalism in the IBM-1, in which the same quadrupole operator is used in the Hamiltonian and the E2 transition operator. Therefore, IBM-1 calculations were performed breaking the consistent-Q formalism. An alternative approach was taken in the proton-neutron version of the IBM (IBM-2), choosing different parameters for the proton and neutron quadrupole operators, thus introducing triaxiality by different deformations of the proton and neutron bodies. Work supported by US DOE grant number DE-FG02-91ER-4069 and the Perspectives on Science Program of Yale University.

FR.00088 Is Gravity a Long-Range Manifestation of Short-Range Nuclear Forces?, SHANTILAL GORADIA, Gravity Research Institute, Inc. — Consistent with Einstein's paper (1919), I propose gravity is a long-range manifestation of nuclear forces, too tiny to be detected beyond short-ranges by particle accelerators (physics/0210040). The implicit “strong gravity” at the edges of slits in double slit experiments would impact the curved space-time, and subsequently, the entire network of geodesics downstream of the slits as a function of the number of OPEN slits. This makes the screen pattern a function of the number of open slits, independent of a particular slit or the total number of slits selected to shoot the photons. My proposal may also explain the quantum uncertainty. The quantum wormholes in my later proposal (www.gravityresearchinstitute.org) between the “observed” particles and we, “observers”, impact the information passing through them by combining their attributes of quantum time (∆t) and quantum energy (∆E). This gives rise to the observed uncertainty such that the product of these two attributes yields Heisenberg's Uncertainty. The 1/r propagation of gravitons in my later proposal resolves the issue of renormalization of gravity by providing a natural cut-off when “r” equals the Planck length. One implication of my proposal is gravity may not be ideally attractive, as spin-dependent nuclear force contains a tiny repulsive component.

FR.00089 Information Download: Data Management Monitoring and Computing Analysis for STAR at PDSF, ARIEL FLEMING, Tenesse State University, DOUG OLSON, ERC JORG, Lawrence Berkeley National Laboratory — Data management and computing analysis for the Solenoidal Tracker at RHIC (STAR) is an essential effort to ensure efficient use of the limited computing resources. Trying to keep account of the usage of the Parallel Distributed Systems Facility (PDSF) computing facility and the number of files kept at the two different facilities, RHIC Computing Facility (RCF) and PDSF, becomes a very intensive job. The purpose of this research is to find a way to monitor the usage of the PDSF cluster and to keep account of the number of files each facility carries so that the datasets are the same. In analyzing the workload characteristics on PDSF (length of the batch jobs) over 3 years it was apparent that the most jobs were fairly long in the early years. As time progressed the jobs were shorter due to the fact that much of the activity was due to the analysis of the data. The software developed to count the files at RCF and PDSF has been an asset to researchers because now they have access to identifying the files that are needed at the facilities. This development prints the file monitoring results automatically to a web page making it easy to monitor the replication of files from RCF and PDSF.

FR.00090 Isospin (N/Z) dependence of isotopic yield ratios as a function of fragment kinetic energy, CARL SCHRECK, SHERRY YENNELLO, BRIAN STEIN, SARAH SOISSON, Cyclotron Institute, Texas A&M University — Assessing the effect of isospin (N/Z) on nuclear fragmentation is important in understanding the symmetry energy contribution to nuclear reactions. Previous studies have observed that the fragment excitation energy spectra for isotopes with smaller isospin (more neutron deficient isotopes) are significantly more energetic. We present data which utilizes isobaric beams of N/Z > 1 (3He), N/Z = 1 (32Ne), and N/Z < 1 (32Na) to determine the effect of the beam isospin on projectile fragmentation. Beams were obtained at the MARS (Momentum Achromat Recoil Separator) facility at the Texas A&M Cyclotron Institute with F-19, 20Ne=21Ne, and 20Ne=21Ne reactions at 32MeV/A. Fragments were then detected with the FAUST detector (Forward Array Using Silicon Technology), allowing for isotopic identification of charged particles to Z = 6, thus enabling complete reconstruction of the quasi-particle in both charge and mass for peripheral reactions in which there are small numbers of nucleons transferred. For each fragment produced in these reactions, center of mass fragment energy spectra are produced. These isotopic energy spectra will be presented as a function of the isospin of the beam.

FR.00091 Geometrical Isospin, DANIEL C. GALEHOUSE, U. of Akron — A theory of motion based on geometrical mathematics similar to general relativity has been developed for interacting quantum particles. Curvilinear coordinate systems describe smooth interactions due to conformal transformations. Spin can be included, following the Dirac equation, and leads to a description of electrons and neutrinos that interconvert in eight dimensions by hyper-rotation. Particles may have a propagational mass that is detectably different from their rest mass.

FR.00092 The 26Al(p,g)27Si Reaction at DRAGON, HEATHER CRAWFORD, Simon Fraser University — The 26Al(p,g)27Si reaction is important for nuclear astrophysics, as 26Al is directly observable in supernovae explosions due to its decay with a characteristic gamma. This allows comparison of observational data with models, the accuracy of which depends on how well known the reaction rates for the processes involved are. As the only direct destruction pathway for 26Al aside from its beta decay, the 26Al(p,g)27Si reaction is an integral part of the 26Al system, and an accurate measure of its rate, determined mainly by the strength of available resonance reactions, is critical. The strength of the 188 keV resonance is currently being directly studied for the first time in inverse kinematics, using the DRAGON facility at TRIUMF. A 26Al radioactive beam incident on a windowless H2 gas target gives rise to 27Si recoils, which are detected through the coincidence of a prompt gamma, and a heavy ion signal at the end detectors. Data is being analyzed to separate true events from background and determine the thick target yield. Also important is an analysis of beam intensity and composition, using data from DRAGON detectors and faraday cups. Results from these latter aspects of the study will be reported on.
FR.00093 Analysis of Multi-dimensional Data from the YSU Miniball at the SPring-8 Synchrotron, Japan. RONALD PROPRI, Youngstown State University — In recent years, attempts at triggering energy release from long-lived nuclear isomers have been both a scientific and political focus. The study of 178Hfm2 has been of particular interest due to its attractive energetic properties. In light of the controversial nature of claims concerning positive experimental results, much attention was given to the analysis of data from different types of experiments. This poster will illustrate methods of analysis of multi-dimensional data recorded at SPring-8 with the YSU Miniball detector array, including timing characteristics, gamma-gamma coincidences, and the software package specially designed for the unique properties of our system.

FR.00094 USB Control of Multiplexed Shaper Electronic for a Segmented Silicon Array1, M. HOKE2, C.J. METELKO, R.T. DESOUZA, IU CF, A. ALEXANDER, Dept. of Chemistry, Indiana University — We report on an electronic system, MASE (Multiplexed Analog Shaped Electronics), designed to simplify the analog processing and readout from a highly segmented silicon detector array. This system focuses on providing good energy resolution and adequate timing information for up to 1024 channels. It consists of 16-channel boards which can be either used independently or as part of a larger system. The analog portion constructs each channel having high gain shapers with associated leading edge discriminators and peak hold circuits. The logic for readout of the analog signals is performed by two FPGA chips located on each board. Readout of MASE channels is multiplexed, an approach that works well for a broad range of experiments. To aid in the debugging and monitoring of an experiment, signals are also multiplexed for inspection purposes. The gain of each shaper and the threshold of each discriminator is adjustable through DACs. Shaper and discriminator control parameters are transferred through a USB port to an FIP PC. This chip transfers the multiplexed data to the FPGAs, which control the shaper/discriminator circuits and the acquisition sequence. A Tcl/Tk graphical user interface coupled to a C++ source code allows the user to easily provide the control parameters to the MASE electronics.

1Supported in part by the NSF REU Program
2home institution: Bowling Green State University

FR.00095 The search for triggered decay of metastable isomers, DAVID GOHLKE, Youngstown State University — Some nuclear excited states can achieve astounding lifetimes, storing significant amounts of energy for long times. These metastable isomers are of great interest from a purely scientific perspective and have been suggested as potentially supporting various applications. The interaction of externally-produced radiation with isomeric nuclei may provide a means of inducing a release of the stored energy upon demand. This poster will discuss experimental planning for studies of energy-releasing reactions with real photons on 1211Sm and 166mHo.

FR.00096 Search for isomers in 64Ge, BEVERLY LAU, Reed College, ANI APRAHAMIAN, ANDREAS WOEHR, University of Notre Dame, TIMO GRIESEL, Johannes Gutenberg-Universität Mainz, PLAMEN BOUTACHkov, BORIS SKORodumov, SERGIO ALMARAZ-CALDEROn, MATTHEW QUINN, University of Notre Dame — The 64Ge nucleus is produced from collisions of 36 MeV 12C beam on a 54Fe target at the Institute for Structure & Nuclear Astrophysics (ISNAP) located at the University of Notre Dame. The beam was produced using a tandem Van de Graaff accelerator running a pellet charger system. Scintillation counters and Germanium detectors were used to detect neutrons in coincidence with gamma rays for clear channel identification. Comparison to existing data may confirm the presence of 64Ge in the reaction products. Further analysis will be done to determine the existence of isomeric states in 64Ge. This nucleus is thought to be a “waiting-point” nucleus for the rapid proton capture process (rp-process). The identification of isomers will be used to study the impact of isomers on rp-process nucleosynthesis. There are existing theoretical calculations within the projected shell model that indicate the existence of an isomer in this nucleus at an excitation energy of 900 keV. Isomers were recently discussed in Physics Today. References:

FR.00097 Time and Position Calibration of IceCube Optical Modules, WILLIAM ROBBINS, UC@Berkeley/LBNL, ICECUBE COLLABORATION — The IceCube high-energy neutrino telescope uses optical modules (OMs- each containing a photo-multiplier tube) embedded in glacial ice to detect Cherenkov photons in order to reconstruct the path of neutrino-induced muons. To accurately reconstruct muon tracks, and thusly perform neutrino astronomy, the detector must be well calibrated to minimize uncertainties in the optical module (OM) positions and the arrival times of the kilometer-scale detector near the South Pole. The IceCube Collaboration recently deployed a string of sixty OM s deep in the Antarctic Ice and sixteen OM s at the surface above the string. Using down-going cosmic ray muons, it is possible to verify the IceCube time and position calibrations determined by other in situ methods. This work will describe a calibration technique used by IceCube and present results of recent experimental data from cosmic ray muons.

FR.00098 In-flight Calibration of CREST, MICHAEL STRONGMAN, Westmont College, JAMES MUSSER, Indiana University — The Cosmic Ray Electron Synchrotron Telescope (CREST) is a balloon-borne experiment that seeks to measure the cosmic ray electron spectrum. The spatial distribution of sources, such as supernova, is expected to cause a dramatic departure from the power law energy spectrum. CREST identifies electrons from the linear train of synchrotron radiation produced by the electrons motion in the Earth’s magnetic field. A scaled prototype is scheduled to fly the summer of 2005 as a proof-of-concept flight. The details of the implementation of the pulser system, which allows for in-flight calibration of the photodetector array, will be shown.

FR.00099 Tracking Single and Multiple Events in MoNA, ANDREW STUMP, Michigan State University, Michigan State University - REU, ANDREW RATKIEWICZ, Indiana University, Michigan State University - REU, MONA COLLABORATION — The Modular Neutron Array (MoNA) is a large area detector consisting of 144 plastic scintillating bars housed at the National Superconducting Cyclotron Laboratory (NSCL). Used in conjunction with a 4 T sweeper magnet, it is a high-efficiency neutron detector for studying nuclei near or past the neutron drip line. First experiments concentrated on the study of nuclei decaying by single neutron emission. However, future experiments are planned to explore for example the decay of 1321Li into 111Li and two neutrons. Thus it will be necessary to distinguish one-neutron hits from two-neutron hits in MoNA. We used the data from the decay of 25O into 24O and a neutron as well as the decay of excited 11Be into 12Be and a neutron to characterize single neutron events. Subsequently we identified two-neutron events from the decay of excited 12Be into 10Be and two neutrons.

FR.00100 Writing of a GEANT4 simulation of E906 at FNAL Main Injector, ALDO RAELARIJONOA, Abilene Christian University, E866/NUSEA COLLABORATION — Following Fermilab E866/ NuSea, which determined the light antiquark asymmetry in the proton, as well as many other results, Fermilab E906 is an experiment that will measure nucleon and nuclear structure at the parton level using Drell-Yan scattering. With significant improvement on statistical errors above Bjorken x = 0.2, E906 will go further than the E866/ NuSea could on measurements. In order to improve modeling for E906 a new GEANT4 simulation was created in a new code, instead of using the simulation done in FORTRAN in GEANT3. We will report on new calculations to verify the optimal absorber arrangement in the first magnet of the E906 spectrometer.
FR.00101 MoNA Calibration and Neutron Tracking, SHEA MOSBY, EVAN MOSBY, WARREN F. ROGERS, Westmont College, MONA COLLABORATION — The Modular Neutron Array (MoNA) at the NSCL consists of 144 2-m long scintillator-bars stacked 16 high by 9 layers deep. The array, used in conjunction with a large sweeper magnet, is designed to investigate properties of neutron rich nuclei near the drip-line. In order to properly track neutrons resulting from breakup reactions, it is imperative that all bars be carefully calibrated for position. While different PMT response times can be measured and corrected for by applying precise offsets to the data, there remains no method for measuring and correcting for slight physical misalignment of the individual bars. We developed a method which uses the straight-line paths created by cosmic muons passing through the array to "tie" all the bars together into one consistent position calibration. We developed an algorithm which filters high-multiplicity muon events from the data stream and plots their individual tracks through the array. A least square fit is applied to each track and the resulting individual bar offsets from the fitted line are statistically compiled. This method can be extended to provide a tool for distinguishing multiple scatterings of individual neutrons from higher multiplicity neutron events, which will be important for future experiments. Results will be presented. Work supported by NSF grant #PHY05-2010.

FR.00102 Performance Evaluation of Neutron Polarimeter NPOL, SHUMPEI NOJI, KENJIRO MIKI — A high performance neutron polarimeter NPOL has been constructed for the measurement of polarization correlation function for the \((d, pn)(^3S_1)\) reaction for the test of EPR paradox in a system of unlike fermions. The NPOL system consists of 12 planes of two-dimensional position-sensitive neutron detectors with a size of 60 \(\times\) 60 \(\times\) 3.0 cm\(^3\). Neutron polarization is determined from the azimuthal distribution of the elastic \(\vec{n} + p\) scattering in the scintillator. The effective analyzing power of NPOL have been calibrated by using the polarized neutrons from the \(^9\text{Li}(\vec{d}, \vec{n})X\) reaction at \(T_d = 270\) MeV. We will report the effective analyzing power and the double scattering efficiency.

FR.00103 Pion, kaon, proton and antiproton spectra in CuCu collisions at \(\sqrt{s_{NN}} = 200\) GeV at RHIC, JING LIU, RHIC/STAR COLLABORATION — Collisions of unrelativistic nuclei at RHIC provide a unique means to create nuclear matter of high energy density. Study of the various properties of this dense matter requires systematic measurements of identified particle spectra. The combination of STAR time of flight (TOF) based on MRPC (Multi-gap Resistive Plate Chamber) and Time Projection Chamber (TPC) detectors offers particle identification (PID) over a wide transverse momentum (\(p_T\)) range. In this talk, we will present the progress of an analysis of the identified hadron spectra in Cu-Cu collisions at RHIC using state-of-the-art prototype electronics and MRPC TOF. Physics implications will be discussed.

FR.00104 Measurement of the lifetime of an gold isotope, KAZUHIRO KURIHARA — The lifetime of unstable isotopes is one of the most important observables in nuclear physics, because it corresponds to the decay constant, from which we can investigate wave functions of the initial and final states. This measurement was carried out to experimentally demonstrate the exponential decay law and to understand the concept of lifetime. First of all, a sheet of gold sample was irradiated by neutrons which were generated by stopping protons of 12 MeV in Tohoku University cyclotron RI center facility. Then \(\gamma\) ray emitted from the sample were repeatedly measured by a NaI scintillation counter for 8 days, each measurement lasting for 400 seconds. A peak was observed at about 410 keV in the NaI pulse height spectrum. It was consistent with the 411.8 keV energy for the \(\gamma\) with emphasis of the new data of heavy flavor measurements at RHIC. This method can be extended to provide a tool for distinguishing multiple scatterings of individual neutrons from higher multiplicity neutron events, which will be important for future experiments. Results will be presented. Work supported by NSF grant #PHY05-2010.

Wednesday, September 21, 2005 3:00PM - 5:00PM — Session GQ JPS: JPS Nuclear Physics Forum Meeting (Kakudan Soukai) Ritz-Carlton Hotel Plantation

3:00PM GQ.00001 JPS Nuclear Physics Forum Meeting —

Wednesday, September 21, 2005 3:00PM - 5:00PM — Session GS DNP: DNP Town Meeting Ritz-Carlton Hotel Ritz-Carlton Ballroom

3:00PM GS.00001 DNP Town Meeting —

Thursday, September 22, 2005 9:00AM - 12:00PM — Session JA DNP JPS: Exploration of New State of Dense Matter Ritz-Carlton Hotel Salon 4

9:00AM JA.00001 Probing the QGP at RHIC: Lessons and Challenges, STEFFEN BASS, Duke University — Recent data taken at the Relativistic Heavy-Ion Collider has provided strong evidence for the creation of a strongly interacting deconfined phase of quarks and gluons, often referred to as the strongly coupled Quark-Gluon-Plasma (sQGP). In the first part of my talk I will highlight the major findings which have lead to the discovery of the sQGP. However, the quantitative analysis of sQGP properties and their connection to QCD at high energy density is still in its infancy. The second part of my talk will focus on the key challenges faced by QGP theory in characterizing the bulk properties and dynamical evolution of the sQGP phase. In particular I will discuss success, limitations and future perspectives of the hydrodynamic model, parton recombination as standard model of hadronization, and recent transport theory calculations on photons and electromagnetic probes.

9:45AM JA.00002 Hadronic probes of dense matter at RHIC: from light to heavy flavors, YASUYUKI AKIBA, RIKEN, Institute of Physical and Chemical Research — A new state of dense matter has been discovered in collisions of heavy nuclei at RHIC. The matter is characterized by extremely high density, very rapid thermalization, and strong collective flow. The discovery is mainly based on an extensive set of measurements such as particle ratios, momentum distributions and elliptic flow patterns of light flavored hadrons. New measurements of heavy quarks (charm and beauty) at RHIC will start shedding additional new light on the property of the matter. Due to their much larger mass, heavy quarks can interact with the dense medium in a way very different from light quarks. Therefore heavy quark measurements will provide new information on the property of the matter. In this talk, I review the present status and future prospect of the study of the dense matter at RHIC through hadronic probes of light and heavy flavors with emphasis of the new data of heavy flavor measurements at RHIC.
10:30AM JA.00003 Heavy flavor and direct photon measurements at RHIC, DAVID SILVERMYR, Oak Ridge National Laboratory — RHIC energies and luminosities are sufficiently high that, for the first time, elementary partonic processes at high Q^2 take place within heavy-ion collisions at substantial rates. The products of these elementary scatterings will then form well-defined, high-momentum QCD objects that will already exist when an excited medium is created in the space surrounding them. As they then propagate, their interactions will probe the created medium from its very earliest stages. Among the key studied QCD objects are the following, described by their speed through the medium, multiplet and the associated observables: “Slow” / Heavy flavor: color triplet for open charm and bottom production, color octet/singlet for heavy quarkonia via lepton pairs. “Fast” / Prompt direct photons: color-less, studied with isolated high pT photons. To distinguish novel behaviour from competing normal nuclear effects it is very important to systematically measure the production for several collision species, energies and as a function of centrality and rapidity. An overview of heavy flavor and prompt direct photon results obtained to date at RHIC will be presented.

11:15AM JA.00004 Jets at RHIC: The intersection of high-energy and nuclear physics, DANIEL MAGESTRO, The Ohio State University — 30 years ago, the observation of streams of high transverse momentum (p_T) particles (jets) from fragmenting partons produced in high energy proton collisions helped to uncover the parton substructure of hadrons. In high energy heavy-ion collisions, jets have emerged as a tomographic tool of the hot and dense matter formed in the collision. Bjorken first suggested that jets might be suppressed in nuclear collisions, due to energy loss of the outgoing parton traversing the dense medium. At RHIC jets have been studied via azimuthal correlations of high-p_T hadrons, and a series of correlation measurements that support the energy loss picture has provided strong evidence for the predicted phase of partonic matter at high energy densities. I will present an overview of jet and di-jet measurements at RHIC, emphasizing new studies of azimuthal correlations that provide strong constraints on the nature of the medium formed in the collision. I will also discuss future directions of jet studies, both at RHIC and at LHC, where a substantial increase in collision energy will open up a new frontier of jet physics in nuclear collisions.

Thursday, September 22, 2005 9:00AM - 12:00PM — Session JB DNP JPS: Mini-symposium on Low Energy Tests of the SM and Searches for New Physics II Ritz-Carlton Hotel Salon 3

9:00AM JB.00001 Testing CPT using low energy antiprotons, RYUGO HAYANO, University of Tokyo — According to the CPT theorem, physics laws are unchanged under the simultaneous inversion of charge (C), parity (P) and time (T). Since many of candidate theories for unifying gravity and the standard model include effects that violate assumptions for the CPT theorem, such as curved spacetime, nonpointlike interactions and unitarity violation through decoherence, it is important to experimentally test CPT to the highest possible precision. Since the 1s-2s two-photon laser spectroscopy and the ground-state hyperfine splitting microwave spectroscopy of atomic hydrogen have already been carried out respectively to 10^{-14} and 10^{-12} relative precision, high-precision comparison of hydrogen and antihydrogen will be one of the most sensitive CPT tests. For the 1s-2s experiment, we need to make cold antihydrogen atoms in the ground state so that they can be trapped in a magnetic trap. For the hyperfine splitting measurement, a slow antihydrogen beam must be produced. At present, even though antihydrogen atoms can be routinely produced at CERN’s antiproton decelerator (AD) at a rate of some 100 Hz, the produced anti-atoms are neither in the ground state nor cold enough to be useful for spectroscopy. Current status and future directions are discussed. I will also discuss the status of high-precision laser spectroscopy of antiprotonic helium atoms (baryp – e – He), which now offers the best baryonic CPT test.

9:30AM JB.00002 Way to CPT test with cold antihydrogen, RYO FUNAKOSHI, ATHENA Collaboration — The CPT theorem and the Weak Equivalence Principle (WEP) are foundational principles on which the standard description of the fundamental interactions is based. The validity of such basic principles should be tested using the largest possible sample of physical systems. Cold neutral antimatter (low-energy antihydrogen atoms) could be a tool for testing the CPT symmetry with high precision. After several years of experimental efforts, the production of low energy antihydrogen through the combination of antiprotons and positrons is a well established experimental reality. An overview of the ATHENA experiment at CERN will be given and the main experimental results on antihydrogen formation will be reviewed.

9:45AM JB.00003 Experiments on Laser-Induced Radiative Formation of Antihydrogen Atoms, LAWRENCE GENE C. POSADA1, RYO FUNAKOSHI, RYUGO S. HAYANO, The University of Tokyo, MAKOTO C. FUJIWARA, TRIUMF, YASUNORI YAMAZAKI, RIKEN, ATHENA COLLABORATION2 — Spectroscopy of antihydrogen and hydrogen atoms can provide a direct test for CPT invariance and the Weak Equivalence Principle, and perhaps also offer insights to searches for new physics. As a step towards that goal, we report on the ATHENA Collaboration’s experiments on laser-induced radiative formation of antihydrogen. In this process, i.e. e^+ + p + γ → H + γ a positron and an antiproton are induced to form a bound state of antihydrogen by using a photon of a specific wavelength. Our main objective is to use a CW 13C18O2 laser to induce the formation of antihydrogen atoms with the principal quantum number n = 11. Control of the quantum states of antihydrogen will be necessary for future experiments. This experiment has been performed at the CERN Antiproton Decelerator facility.

10:00AM JB.00004 High precision spectroscopy of antiprotonic helium atoms, N. ONO, D. BARN, A.J. DAX, J. EADES, K. GOMIKAWA, R.S. HAYANO, M. HORI, T. ISHIKAWA, W. PIRK, H.A. TORII, T. YAMAZAKI, Univ. of Tokyo, B. JUHASZ, ATOMKI, E. WIDMANN, SMU, D. HORVATH, KFKI, ASACUSA COLLABORATION — Antiprotonic helium is an exotic three body metastable system consisting of an antiproton, an electron and an alpha particle. We have measured the transition energies of the states of this atom with a laser spectroscopy method at the AD (Antiproton Decelerator of CERN). By comparing the results of 2002 experiment with theoretical calculations, we set a limit of the possible differences between the antiproton and the proton charges and masses at 1×10^{-8}. These are the best CPT limits for baryonic masses and charges. In 2004, we developed the laser to improve the experimental precision. We used a narrow-bandwidth (∆f/f < 10^{-9}) single-frequency CW laser. The frequencies of the laser were measured and stabilized by an optical frequency synthesizer with a relative accuracy of 10^{-10}. The CW laser was amplified with dye, and we generated the laser pulses which had high energy and narrow bandwidth thorough enough to measure the transition energies more precise than the experiment in 2002. Using this laser system, we measured the transition frequencies of antiprotonic helium atoms to about a factor 10 better than the experiment in 2002.

Please send all questions and comments to lposada@nuc1.phys.s.u-tokyo.ac.jp

1Homepage at http://cern.ch/athena
10:15 AM JB.00005 New limit on the T-violating transverse muon polarization in $K^+ \rightarrow \pi^0 \mu^+ \nu$ ($K\mu3$) decays, SUGURU SHIMIZU, KEK-E246 COLLABORATION — A search for T-violating transverse polarization (Pt) in the $K\mu3$ decay was performed using kaon decays at rest. Pt is the polarization component normal to the decay plane, and a T-odd observable. A nonzero value would be evidence for violation of time reversal invariance, because spurious effects from final state interaction are known to be small. Moreover, due to negligible contribution from the standard model, Pt would provide important clue to new physics beyond the standard model. The experiment was performed at the KEK 12 GeV proton synchrotron. The decay products were emitted in all directions and detected by a 12-sector ion-core superconducting toroidal spectrometer and a $\pi^0$ calorimeter with large detection acceptance. Pt was measured as the azimuthal muon polarization when $\pi^0$ is tagged in the forward or the backward direction relative to the beam direction. The signature of nonzero Pt is an asymmetry between clockwise and counterclockwise Michel positrons. The final result using all data taken in 1996-2000 was obtained to be $\text{Pt} = 0.0017 \pm 0.0023\text{(stat)} \pm 0.0011\text{(syst)}$. The T-violation parameter was determined to be $\text{Im}(-\xi) = 0.0052 \pm 0.0071\text{(stat)} \pm 0.0036\text{(syst)}$ giving an upper bound $|\text{Im}(-\xi)| < 0.015$.

10:30 AM JB.00006 The emIT Experiment: A Search for Time-reversal Invariance Violation in Neutron Beta Decay, H.P. MUMM, M.S. DEWEY, J.S. NICO, A.K. THOMPSON, National Institute of Standards and Technology, A. GARCIA, J.F. WILKERSON, CENPA, University of Washington, T.E. CHUPP, R.L. COOPER, University of Michigan, C.A. TRULL, F.E. WIETFELDT, Tulane University, S.J. FREEDMAN, B.K. FUJIKAWA, University of California at Berkeley, G.L. JONES, Hamilton College — The emIT experiment tests time-reversal symmetry in the beta decay of polarized free neutrons by searching for the time reversal-odd, parity-even triple correlation between the neutron spin and momentum of both the electron and proton. The detection of this correlation above the small calculable effect due to final state interactions would be a direct indication of time reversal symmetry violation, independent of charge conjugation-parity. In the experiment, a beam of cold neutrons is polarized to better than 90% using a supermirror polarizer. Decays are observed using an alternating array of electron and proton detection paddles. The highly symmetric octagonal geometry both reduces systematic effects and increases the detection efficiency relative to many previous experiments. The emIT collaboration has published a result [1] from its first run. A highly successful second run of the emIT experiment has recently been completed at the NIST Center for Neutron Research. The analysis of this greatly improved data set will be presented along with implications for time reversal violation. [1] Phys. Rev. C. 62, 055501, (2000).

10:45 AM JB.00007 Performance test of the prototype detector for Dark Matter Search, AKIKO YANAGISAWA, Department of Physics, Graduate School of Science, Osaka University, TADA FUMI KISHIMOTO, IZUMI OGAWA, RYUTA HAZAMA, SEI YOSHIDA, SAORI UMEHARA — Extensive observational evidence indicates that non-luminous, dark matter comprises a large fraction of the matter in the universe. Recent observation of cosmic microwave background suggests that dark matter consists predominantly of non-baryonic particles, and Weakly Interacting Massive Particles (WIMPs), neutral dark matter are presently most favored. These WIMPs would interact elastically with nuclei, generating recoil energy of a few tens of keV, at a rate smaller than $\sim\text{1 event/kg/day}$. We have developed a CaF$_2$ scintillation detector system (ELEGANT VI) to search for spin coupled dark matter by elastic scattering of $^{13}$C. Because of the low-energy and low-event-rate, to improve the sensitivity of the detector system, we must achieve more light collection and background reduction. So we have started the study of the new design of the detector system which consists of cubic CaF$_2$ (pure) crystal all sides covered by light guides. In this system, more light collection and less background level are expected for much larger photo-coverage and CaF$_2$ (pure) low radioactivity, respectively. As a first stage, we are developing the prototype detector and testing the photon collection efficiency of the light guide system for the optimization. The performance of the prototype detector will be reported.

11:00 AM JB.00008 EDM Searches in Muons and Deuterons, J.A. MILLER, STORAGE RING EDM COLLABORATION — The observation of a permanent electric dipole moment aligned along the spin of an elementary particle is a violation of both parity (P) and time reversal (T) invariances. So far, no such observation has been made. T violation implies, under the assumption of CPT invariance, that there would be a corresponding violation of CP invariance. Because the properties of CP invariance play important roles in the unraveling of the mysteries of the Standard Model (SM) and in understanding the baryon asymmetry of the universe, much experimental effort has occurred or is planned to search for EDMs in a variety of atoms and elementary particles. Here, high precision searches of the EDMs of the muon and the deuteron will be discussed. The muon sensitivity will be at the level of $10^{-24}-10^{-26}$ e-cm, which is largely limited by available muon fluxes. Models outside the SM predict an EDM as large as a few times $10^{-24}$ e-cm. The much larger available flux of deuterons can lead to a measurement at the $10^{-29}$ e-cm level, which would make it the best EDM limit on any particle. The proposed experiments would employ the thus far relatively unexploited technique of storage rings, which enables the measurement of the EDM of free charged particles to high precision for the first time. All experimental approaches measure the interaction of the putative EDM with a strong electric field. The proposed approach completely circumvents the ‘Schiff suppression’ of the EDM signal when particles are embedded inside neutral atoms.

11:15 AM JB.00009 Nuclear spin maser at low frequency and atomic EDM of $^{129}$Xe, AKIKO YOSHIMI, RIKEN, KOICHIRO ASAHI, Tokyo Inst. Tech., MAKOTO UCHIDA, SACHIKO OSHIMA — A search for electric dipole moment (EDM), which indicates a direct evidence for the violation of time reversal symmetry, is one of the important sites for studying the origin of CP violation. The standard model predicts the EDM value of $5-6$ orders smaller than present experimental upper limits, while predictions of the non-standard models such as supersymmetry are not far from the upper limit. In order to perform the search for atomic EDM of $^{129}$Xe, we have developed nuclear spin maser with optically pumped $^{129}$Xe, which operates at a low magnetic field of mG by using sensitive optical detection of nuclear precession and feedback system of the transverse oscillating field which is synchronized with the spin precession. This low frequency nuclear spin maser which involves the artificial feedback system enables us to measure a continuous nuclear spin precession at a stabilized low magnetic field, and thus the determination frequency precision of spin precession can be dramatically improved. We have developed an atomic magnetometer with Rb and a stabilized current source for the magnetic field control to continuously operate the spin maser under highly stabilized magnetic field. We will report on performance of the new type of nuclear spin maser especially on the frequency stability, and feasibility for EDM search with the experimental sensitivity of 1-2 orders better than the present ones.

11:30 AM JB.00010 Demonstration of Thousands of Successive Bragg Reflections from a Perfect Silicon Crystal and Its Application in the Search for the Neutron EDM, THOMAS DOMBECK, University of Hawaii, HELMUT KAISER, Indiana University, MICHAEL HUBER, Tulane University, DMITRY PUSHIN, Massachusetts Institute of Technology, DANIEL HUSSEY, DAVID JACOBSON, National Institute of Standards and Technology, ROBERT SMITHER, Argonne National Laboratory, DONALD KOETKE, Valparaiso University — Using neutrons from the National Institute of Standards and Technology reactor we have measured the reflectivity from the (220) planes of Si using multiple Bragg reflections from a channel-cut perfect crystal to obtain $R = 0.999949$ with a rms error of 0.000017. This is in good agreement with model calculations and indicates that at least 20,000 reflections are possible before there is significant loss of neutron intensity. We are currently setting up the neutron magnetic dipole moment (MMD) interaction with Si using multiple reflections of polarized neutrons. This interaction results in a rotation of the neutron spin due to the torque on the moving MMD in the atomic electric field. The spin rotations from multiple reflections will be additive yielding a measurable signal. One result of this experiment will be a measure of the atomic electric field experienced by the neutrons which is needed for an Electric Dipole Moment (EDM) search using this technique.
University and Lawrence Livermore National Laboratory — It has been well established that high-quality, realistic nucleon-nucleon (NN) interactions based solely on two-body forces in a many-body system is reproduced by changes of the off shell properties of the nuclear force. We obtain excellent results up to two-body scattering data. Then we perform phase equivalent transformations to find the two-body interaction within this class that best describes light nuclei.

Khabarovsk State Technical University — We use the J-matrix version of inverse scattering theory to obtain an interaction to be used in the no-core shell model (NCSM). We have also improved our shell-model codes to increase the scope of our calculations with three-nucleon interactions to the point where these EFT potentials is a set of parameters; some of which are determined by the EFT NN couplings, while others are chosen to reproduce the binding energies and scattering observables, as derived from some of the low-momentum potentials. These potentials are by construction very soft, and therefore the Coulomb effect on observables is seen at low energies for the whole kinematic regime. In pd elastic scattering at higher energies the Coulomb effect is confined to forward scattering angles, while in pd breakup it always shows up in configurations close to pp FSI. In electromagnetic reactions Coulomb competes with other effects in a complicated way leading to an improved description of the data.

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48. Support from DOE grants SCW0498 and DE-FG02-87ER40371 is acknowledged.

9:30AM JC.00002 Chiral Three-Nucleon Interaction and Structure of Light Nuclei1, V.G. GUEORGUiev, PETR NAVRATIL, ERICH ORMAND, Lawrence Livermore National Laboratory — Modern high-precision nucleon-nucleon (NN) interactions derived from field theory provide a natural scheme to derive inter-nucleon interactions and predict a three-nucleon interaction at next-to-next-to-leading order (N^4LO). A key feature of these EFT potentials is a set of parameters; some of which are determined by the EFT NN couplings, while others are chosen to reproduce the binding energies of A=3 and 4 nuclei. In the past year, we have developed the requisite tools to utilize EFT-based potentials, including the NNN terms, in the ab initio no-core shell model (NCSM). We have also improved our shell-model codes to increase the scope of our calculations with three-nucleon interactions to the point where model spaces up to 6\Omega are now viable. We will show results of large-basis NCSM calculations for p-shell nuclei and highlight the impact the N^4LO TNI and its parameters on their structure.

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9:45AM JC.00003 The structure of light nuclei with Interactions derived from Chiral Effective-Field Theory1, ERICH ORMAND, V.G. GUEORGUiev, PETR NAVRATIL, Lawrence Livermore National Laboratory, JAMES VARY, Iowa State University and Lawrence Livermore National Laboratory — It has been well established that high-quality, realistic nucleon-nucleon (NN) interactions based solely on NN scattering data fail to give an accurate description of the structure of light nuclei. Effective-field theories (EFT) based on chiral-perturbation theory provide a natural scheme to derive inter-nucleon interactions and predict a three-nucleon interaction at next-to-next-to-leading order (N^4LO). A key feature of these EFT potentials is a set of parameters; some of which are determined by the EFT NN couplings, while others are chosen to reproduce the binding energies of A=3 and 4 nuclei. In the past year, we have developed the requisite tools to utilize EFT-based potentials, including the NNN terms, in the ab initio no-core shell model (NCSM). We have also improved our shell-model codes to increase the scope of our calculations with three-nucleon interactions to the point where model spaces up to 6\Omega are now viable. We will show results of large-basis NCSM calculations for p-shell nuclei and highlight the impact the N^4LO TNI and its parameters on their structure.

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10:00AM JC.00004 Can we describe light nuclei without three body forces?2, THOMAS WEBER, Iowa State University, ANDREY SHIROKOV, Moscow State University, JAMES VARY, Iowa State University, ALEXANDER MAZUR, SERGEY ZAYTSEV, Khabarovsk State Technical University — We use the J-matrix version of inverse scattering theory to obtain an interaction to be used in the no-core shell model developed by James Vary and others. Through the J-matrix approach we find a representative of the class of Hamiltonians whose members give the same two-body scattering data. Then we perform phase equivalent transformations to find the two body interaction within this class that best describes light nuclei. We obtain excellent results up to \(^4\)Li and we expect to get good results up to \(^^{10}\)O. We have not explicitly introduced three body forces. But the effect of a three body force in a many body system is reproduced by changes of the off shell properties of the NN interaction.

10:15AM JC.00005 Few-nucleon systems and low momentum potentials2, MICHELE VIVIANI, ALEJANDRO KIEVSKY, INFN-Pisa, LAURA E. MARCUCCI, SERGIO ROSATI, Pisa University — Over the last few years, there has been a noticeable progress in the understanding of the nuclear interaction, in particular in the development of new “low-momentum” potentials, as those based on the chiral effective field theory or the renormalization group approach. All these potential models have to be tested primarily in the A = 3, 4 systems. The hyperspherical harmonic (HH) and the correlated hyperspherical harmonic methods (CHH) are powerful techniques for solving A = 3, 4 bound and scattering problems. For example, the long-range Coulomb interaction between protons can be taken into account straightforwardly. Recently, we have extended these methods to treat non-local potentials given in momentum space, as is the case of the new “low-momentum” potentials. These potentials are by construction very soft, and therefore the direct application of the HH approach is very convenient for them. In this contribution, several properties of the \(^1\)H and \(^4\)He nuclei, and \(N - d\) and \(p - \Delta\) scattering observables, as derived from some of the low-momentum potentials, will be presented and discussed.

10:30AM JC.00006 A systematic study of three-baryon forces based on the SU(3) model, SHOJI SHINMURA, Gifu University — We discuss the systematic behavior of three-baryon forces through a generalization of the three-nucleon force based on the SU(3) model. We consider not only the two-pion exchange mechanism but also heavy-meson exchange mechanisms, including K-meson. In addition, we apply the three-baryon forces to determine the equation of state of high-density baryonic matter like neutron-star matter.
10:45AM JC.00007 Few-nucleon systems with chiral forces, EVGENY EPELBAUM, Jefferson Laboratory. WALTER GLOECKLE, Ruhr-University Bochum, Ulf-G. MEISSNER, University Bonn and Forschungszentrum Juelich, Germany. ANDREAS NOGGA, Forschungszentrum Juelich, Germany. HENRYK WITALA, Jagellonian University Cracow, Poland. HIROYUKI KAMADA, Kyushu Institute of Technology, Japan — I discuss the application of chiral effective field theory to study the dynamics of few-nucleon systems in a systematic and controlled way. This method relies on the low-momentum expansion and allows to derive nuclear forces and current operators from the most general effective Lagrangian for nucleon and pion fields and external sources in harmony with (approximate) chiral symmetry of Quantum Chromodynamics, the underlying theory of the strong interaction. I present some new results for few-nucleon systems based upon the chiral forces.

11:00AM JC.00008 Relation between the separable and one-boson-exchange potential for the covariant Bethe-Salpeter equation, YUICHIRO MANABE, ATSUSHI HOSAKA, HIROSHI TOKI, Research Center for Nuclear Physics, Osaka University, Japan. RCNP THEORY GROUP TEAM — We investigate the Relation between the rank I separable potential for the covariant Bethe-Salpeter equation and the one-boson-exchange potential. Parameters of the two potentials are related in the long wavelength limit. It turns out that it is difficult to reproduce the phase-shifts calculated from a single term of the one-boson-exchange potential, separately by the rank I separable potential. Instead, it is shown that the separable potential is useful to parametrize the total nucleon-nucleon interaction.

11:15AM JC.00009 Two and Three-Body Coulomb Scattering in Nucleus, SHINSHO ORYU, SATOSHI NISHINOHARA, Tokyo University of Science. ORYULAB TEAM — The three-body Coulomb scattering is one of the unavoidable issue in the nuclear reaction problems at low energies. Even for the two-body Lippmann-Schwinger (LS) equation, it could not be solved in the momentum space by the reason that the potential singularity coincides with the Green’s function pole. Recently, we found a method to avoid the long range divergence in the momentum space calculation in which an auxiliary potential (AP) is adopted. The on- and off-shell Coulomb T-matrix can be obtained by the aid of a K-matrix method with respect to AP. By this formulation, it is found that nuclear and charged particle scattering problems are successfully calculated not only for the two-body LS-equations but also for the three-body Faddeev equations.

11:30AM JC.00010 Measurement of the \( ^{1}S_{0} \) Neutron-Neutron Scattering Length Using nd Breakup in Recoil Geometry at 19 MeV, C.R. HOWELL, A.S. CROWELL, J. DENG, J.H. ESTERLINE, M.R. KISER, R.A. MACRI, S. TAJIMA, W. TORNOW, Duke University and TUNL, B.J. CROWE III, North Carolina Central University, R.S. PEDRONI, North Carolina A&T State University, W. VON WITSCH, University of Bonn, H. WITALA, Jagellonian University. — Recent determinations of the \( ^{1}S_{0} \) neutron-neutron (nn) scattering length \( a_{nn} \) suggest that the value obtained from neutron-deuteron (nd) breakup measurements might be geometry and energy dependent [1,2]. González Trotter et al. [1] reported a value of \( a_{nn} = -18.7 \pm 0.6 \) fm from their nn coincidence cross-section measurements at 13 MeV, while Huhn et al. [2] obtained \( a_{nn} = -10.3 \pm 0.4 \) fm at 25 MeV from their nn final-state interaction (FSI) cross-section measurements made at 25 MeV in proton recoil geometry. To gain some insight into the cause of the discrepancy between the two measurements, we have made cross-section measurements of the nn FSI in nd breakup at 19 MeV in both the nn coincidence geometry and the recoil proton geometry. Both measurements were made simultaneously with the same neutron beam, and the data are analyzed using the same theoretical calculations. In this talk, the details of the recoil-geometry measurement will be presented along with preliminary results. [1] D.E. González Trotter et al., Phys. Rev. Lett. 83, 3788 (1999). [2] V. Huhn et al., Phys. Rev. Lett. 85, 1190 (2000).

11:45AM JC.00011 Measurement of the \( ^{1}S_{0} \) Neutron-Neutron Scattering Length in nd Breakup Using a Coincidence Geometry at 19 MeV, A.S. CROWELL, J. DENG, J.H. ESTERLINE, C.R. HOWELL, M.R. KISER, R.A. MACRI, S. TAJIMA, W. TORNOW, Duke University and TUNL, B.J. CROWE III, North Carolina Central University, R.S. PEDRONI, North Carolina A&T State University, W. VON WITSCH, University of Bonn, H. WITALA, Jagellonian University — Measurements of the \( ^{1}S_{0} \) neutron-neutron scattering length, \( a_{nn} \), in neutron-deuteron (nd) breakup were made at Triangle Universities Nuclear Laboratory (TUNL) at an incident neutron energy of 19.0 MeV. A coincidence geometry was utilized so that the momenta of the two neutrons in the final-state-interaction pair were measured along with the energy of the proton. A second detector pair was used to measure the well-established neutron-proton scattering length, \( a_{np} \), as a check of our techniques. The scattering lengths were extracted from the experimental cross sections by comparison to rigorous three-nucleon calculations using the CD Bonn nucleon-nucleon potential for various values of \( a_{np} \) and \( a_{nn} \). Experimental details and our preliminary results will be presented.

This work was supported in part by USDOE Grant No. DE-FG02-97-ER41033

Thursday, September 22, 2005 9:00AM - 12:00PM –
Session JD DNP JPS: Mini-symposium on Chiral and Color Condensation II Ritz-Carlton Hotel Salon 1

9:00AM JD.00001 Strange trybaryon and present experimental program, MASAHIKO IWASAKI, RIKEN — Recently, we have performed an experimental search for deeply bound kaonic states by the kaon absorption reaction at rest in a liquid helium target. We observed very distinctive mono-energetic peak formation in a proton missing-mass spectrum. We denote it as a strange trybaryon, \( ^{0}_{S^{0}}(3115) \), with baryon number 3, charge 0, isospin 1 and strangeness -1. If we attribute the mono-energetic peak to the formation of a deeply bound kaonic state, the separation energy of the kaon should be as deep as about 200 MeV. In the present paper, we will overview the present experimental data, and discuss briefly two experimental programs for more detailed information. Work done in collaboration with the KEK PS E471 Collaboration and the KEK PS ES49 Collaboration.

9:30AM JD.00002 Mass modification of phi meson measured in 12-GeV p+A reaction at KEK-PS E325, FU[MINORI SAKUMA, Kyoto Univ., Japan. KEK-PS E325 COLLABORATION — The experiment KEK-PS E325 has measured \( e^{+}e^{-} \) and \( K^{+}K^{-} \) pairs produced in 12 GeV p+A reaction, in order to study the chiral property of dense nuclear matter through the analysis of invariant mass spectra. We have already reported modification of \( \rho \) and/or \( \omega \) mesons in PRL.86.5019(2001) and nucl-ex/0504016. In this talk, we will present our new results which show the modification of \( \phi \) meson at normal nuclear density. Discussions will be made based on the observations both in \( e^{+}e^{-} \) and \( K^{+}K^{-} \) invariant mass spectra.

9:45AM JD.00003 Future step of pionic atom spectroscopy, KENTA ITAHASHI — High precision spectroscopy of pionic atoms has been yielding precious information on in-medium property of pion and also on the nuclei that are treated as high energy density matter. One of the most remarkable results obtained is quantitative measurement of the chiral order parameter inside the nucleus. However, its deduction still holds large ambiguities. I will briefly introduce the present status of the pionic atom spectroscopy and then proceed to possible future experimental plans in GSI, Germany and in RIKEN, Japan.
10:00AM JD.00004 Structure and Formation of Mesic Atoms and Mesic Nuclei. SATORU HIREZAKI, Department of Physics, Nara Women’s University — The light pseudoscalar mesons are interpreted as the Nambu-Goldstone bosons and their properties, especially meson mass spectra, are explained as the consequences of the symmetry breaking pattern of QCD in vacuum. Thus, it seems very interesting to study the meson properties in nucleus to obtain new information on chiral dynamics at finite density, especially the partial restoration of chiral symmetry around normal nuclear density. In this context, meson-nucleus bound systems (mesic atoms and mesic nuclei) are one of the most interesting systems. We study the structure and formation of these systems and discuss the experimental feasibilities.

10:15AM JD.00005 Self-bound state with kaon condensates and its implications for deeply-bound kaonic nuclei, TAKUMI MUTU, Chiba Institute of Technology — We study the equation of state with kaon condensates in hyperonic matter, where hyperons (Λ) are mixed in the ground state of neutron-star matter, by the use of the effective chiral Lagrangian for the kaon-baryon interaction, combined with the nonrelativistic baryon-baryon interaction model. Due to much softening of the EOS caused by both hyperon-mixing and kaon condensates, it is shown that the energy of the system has a local minimum as a density isomer, which leads to a metastable configuration of a self-bound kaon-condensed star in addition to a usual kaon-condensed star with a two-phase structure obtained by the Maxwell’s construction. Based on the EOS, a possible existence of a kaon-condensed nucleus and its relation to deeply bound kaonic nuclei are also considered in a simple liquid-drop picture.

10:30AM JD.00006 Dense-matter and hypernuclear systems with an SU(3) chiral symmetric relativistic mean field model, KOHSUKE TSUBAKIHARA, AKIRA OHNISHI, Hokkaido University — Hyperons are believed to play important roles in dense matter such as neutron star and supernovae. In studying hyperonic dense matter, we should invoke accumulated knowledges on hypernuclei. Relativistic Mean Field (RMF) models is one of the way to understand dense matter and hypernuclei consistently. In this model, it is possible to introduce chiral symmetries directly. In order to reduce ambiguities further, we introduce chiral symmetry in RMF. However, we haven’t succeeded in constructing satisfactory RMF Lagrangian with chiral symmetry. We can also well explain the binding energies of normal nuclei and single Λ hypernuclei by coupling limit lattice QCD as SU(3) chiral symmetry. This extension enables us to get information of hyperons in hyperonic dense matter and hypernuclei from the bond energy of ΛΛ in finite nuclei, ΔB_{ΛΛ} of $^8_4$He. In this time, we’ll report our recent results about single and double Λ hypernuclei and hyperdense matter.

10:45AM JD.00007 Systematic study of dense $\bar{K}$ nuclei with a revised $\bar{K}N$ potential, AKINOBU DOTE, IPNS/KEK, YOSHINORI AKAISHI, Nihon University, TOSHIMITSU YAMAZAKI, RIKEN — Due to the strongly attractive $\bar{K}N$ interaction, a $K^-$ meson can be deeply bound in nuclei. So far, we have investigated $\bar{K}$ nuclei with a phenomenological $\bar{K}N$ interaction. According to my study with the method of antisymmetrized molecular dynamics, we have found that a $K^-$ meson can be bound by about 100 MeV below nucleus-K threshold in various light nuclei and makes nuclei drastically shrunk. $\bar{K}$ nuclei are very dense (over 4 times normal density) and have so interesting structures that we have never seen in usual nuclei. Recently, a few experimental groups have discovered $\bar{K}$ nuclei; $\bar{p}pK^-$ and $\bar{p}nK^-$ by Iwasaki et al and $p\bar{p}K^-$ by Nagae et al. According to these results, $\bar{K}$ nuclei are more deeply bound than our prediction. Taking account of this, $\bar{K}$ nuclei should be a bound state in $\bar{K}$ nuclei. Potential should be somewhat enhanced than original one in case of my calculation. In addition, Nucleon-Nucleon $LS$ interaction is found to give large contribution by the study of $\bar{p}nK^-$ which seems to have $J^P=0^+(0^+)$ nucleon configuration. Taking these points into consideration, we have confirmed that binding energies of various $\bar{K}$ nuclei increase to about 200 MeV measured from nucleus-K threshold. We expect that their structures should change much more drastically. Moreover, we have interests in double $\bar{K}$ nuclei, which have two $K^-$ mesons. They are expected to be so deeply bound. I will report on these issues. If possible, I’d like to mention other types of interaction and analysis from the viewpoint of quarks.

11:00AM JD.00008 Formation of Kaonic Atoms and Kaonic Nuclei by In-flight ($K^-, p$) reactions. JUNKO YAMAGATA, Department of Physics, Nara Women’s University, HIDEKO NAGAHIRO, RCNP, Osaka University, SATORU HIREZAKI, Department of Physics, Nara Women’s University — We study the kaonic atom and kaonic nucleus formation by the in-flight ($K^-, p$) reactions for $C$, $O$, $Si$ and $Ca$ target cases theoretically. Deeply bound kaonic states were predicted to exist as quasi-stable states and were expected to be observed in some proper experimental methods. Kaonic nuclear states are also expected to exist with large decay widths. We evaluate the formation cross sections of the kaonic atoms and kaonic nuclei using the Green function method with the appropriate energy dependent optical potentials. We will discuss the possibilities to observe the kaonic states in the ($K^-, p$) reactions based on the realistic theoretical calculations.

11:15AM JD.00009 Search for deeply bound kaonic nuclei in the $^4$He (stopped $K^-$, $N$) reaction. MASAHARU SATO, Tokyo Institute of Technology, KEK PS ES49 COLLABORATION — Recently, we have performed an experimental search for deeply bound kaonic nuclei by mean of time of flight from the $^4$He(stopped $K^-$, $N$) reaction at KEK 12 GeV proton synchrotron (KEK-PS E471). In the obtained proton energy spectrum, a mono-energetic peak was observed and it can be interpreted as a bound state of $K^-pn$ or $K^-nm$ with the isospin $T=1$. For the confirmation and further study of this state, we have carried out an experiment with optimizing the experimental setup for the proton inclusive measurement (KEK-PS ES49). Data taking have been finished in this May-June. In this meeting, I will report very preliminary results of ES49 experiment focusing on the proton spectrum.

11:30AM JD.00010 Search for $\bar{K}NN$ bound states with the FINUDA spectrometer. HIROYUKI FUJIOKA, Department of Physics, University of Tokyo, FINUDA COLLABORATION — The existence of a deeply-bound kaonic state, which includes an antikaon inside the nucleus, is theoretically predicted by Akashi and Yamazaki, according to their $\bar{K}N$ potential. In their model, the $\Lambda(1405)$ is regarded as a $\bar{K}N$ bound state. We have searched for the lightest kaon-bound system ($\bar{K}NN$) with the FINUDA spectrometer, which is installed at the $e^+e^-$ collider DAΦNE. The $\phi$-meson, abundantly produced by DAΦNE, decays into $K^+K^-$, with the kinetic energy of $K^\pm \sim 16$ MeV. This slow $K^\pm$ stops inside a very thin nucleus target and interacts with a nucleus. We installed five kinds of targets ($^6Li$, $^7Li$, $^{12}C$, $^{27}Al$ and $^{51}V$) surrounding the beam pipe in the first run (2003-2004). In this talk, I will discuss non-mesonic decay modes of a $\bar{K}NN$ bound system, clearly observed in the back-to-back angular correlation between a hyperon and a nucleon emitted from the $\bar{K}N$ reaction vertex.
11:45AM JD.00001 Search for Kaonic Nuclear Clusters in Nuclear Collisions with FOPI
KEN SUZUKI, LAURA FABBRIETTI, Technische Universität München, MICHAEL CARNELL, PAUL KIENLE, JOHANN MARTON, JOHANN ZMESKAL, 
Stefan Meyer Institut, Vienna, NORBERT HERRMANN, University of Heidelberg, TOSHIMITSU YAMAZAKI, RIKEN, FOPI COLLABORATION — Recently, 
exotic nuclear systems involving a $K$, $(K^- \text{ or } K^0)$ as constituent (such as $ppK^-$, $ppnK^-$, $pppK^-$, $pppnK^-$ and $ppnnK^-$) were predicted by Akaishi and 
Yamazaki to have narrow discrete bound states with large binding energies as much as 100 MeV due to the strong $K^- - p$ attraction, which may lead the 
system to have a much higher density than normal nuclear density. We produce and identify such $K$ clusters in heavy-ion collision or proton induced 
reactions by making use of the capability of the FOPI detector at GSI which is enabled to reconstruct invariant-mass from all the charged trajectories of the decay 
particles of K clusters such as $ppK^- \to \Lambda + p$, $ppnK^- \to \Lambda + d$ and $pppK^- \to \Lambda + p + p$. $ppK^-$ is produced with proton induced reaction on $d$ target as 
$p + d \to [\Lambda(1405) + p] + K^0 + p - ppK^- + K^0 + p$, where $\Lambda(1405) \equiv pK^-/nK^0$ works as a doorway to form $K$ cluster. We can identify the $ppK^-$ in 
the missing mass spectrum, and simultaneously study its decay pattern by invariant mass method. With light nuclear target more heavier $K$ clusters can be 
produced by $\Lambda(1405)$ production and successive $K$ transfer / knock-on reactions.

Thursday, September 22, 2005 9:00AM - 12:15PM —
Session JE DNP JPS: Mini-symposium on Orbital Motion of Quarks in Hard Scattering  Ritz-
Carlton Hotel Amphitheatre

9:00AM JE.00001 Measurements of quark transversity and orbital motion in hard scattering
, YOSHIYUKI MIYACHI, Tokyo Institute of Technology — The spin structure of nucleon has been one of the most important topics of QCD for about two 
decades. Recent results in hard scattering processes from the various experiments shed light on 'quark transverse motion' for understanding the structure of 
nucleon. It implies that parton distribution and fragmentation functions are extended so that the transverse momentum of the parton is incorporated into the 
framework. Single spin azimuthal asymmetries of hadron production in polarized lepton deep inelastic scattering at HERMES, JLab and COMPASS offer an access to such 
distribution functions, quark transversity and Sivers function, in conjunction with the corresponding fragmentation function. Measurements in hadron collisions 
such as at a proton collider at RHIC are also essential approaches to study these quantities. One of the novel fragmentation function, Collins function, could be extracted in electron-position collider experiments. The expected results from BELLE would 
be a key for the extraction of the quark transversity from the experimental observables in other experiments. 

Generalized parton distribution (GPD) has been proposed to unify the standard quark distribution functions and the nucleon form factors. It was also pointed that the 2nd moment of GPDs is related with orbital angular momentum of the parton and can be extracted from hard exclusive productions, such as deeply virtual compton scattering (DVCS). The measurements of hard exclusive photon or meson productions have been performed at HERMES and JLab. Recent experimental progress on these topics and its interpretation are presented.

9:30AM JE.00002 GPDs and single-spin asymmetries , MATTHIAS BURKARDT, New Mexico State University — Generalized parton distributions (GPDs) contain a wealth of information about hadron structure. I will focus on the connection between GPDs and impact parameter dependent parton distributions. For transversely polarized targets, the distribution of partons as a function of the impact parameter shows a significant deviation from axial symmetry. Together with attractive final state interactions at RSC, jet production in semi-inclusive deep-inelastic scattering experiments (HERMES). Chirally odd GPD describe the quark transversity distribution for an un polarized target. The same mechanism that gives rise to the Sivers effect may also give rise to the Boer-Mulders effect, except that sign and magnitude are now governed by chirally odd GPDs. The same linear combination of chirally odd GPDs that governs the quark transversity distribution for an un polarized target can also be used to determine the correlation between quark angular momentum and transversity.

9:45AM JE.00003 GPD extraction - Experimental aspects, WOLF-DIETER NOWAK, DESY-Beuthen — Generalized Parton Distributions are very briefly introduced. The observables in Deeply Virtual Compton Scattering and Deeply Virtual Meson Production are explained, and the complementary ways they offer to access various GPDs. First experimental results from HERMES and JLAB are reviewed and a collaborative effort is recommended towards a global analysis of GPDs.

10:00AM JE.00004 Study of Generalized Parton Distributions at Jefferson Lab, LATIFA ELOUADRHIRI, 
Jefferson Lab — Generalized Parton Distributions (GPDs) provide a rich and unifying picture of the nucleon structure. The GPDs can be accessed through hard 
scattering processes such as Deeply Virtual Compton scattering (DVCS) and Deeply Virtual Meson Production (DVMP). Experiments are starting to test these 
concepts. I will present first results from experiments conducted at Jefferson Lab and outline the future program with 12 GeV upgrade.

10:15AM JE.00005 Generalized Parton Distributions in Nuclei, SIMONETTA LIUTI, University of Virginia —
We will present an analysis of the structure of generalized parton distributions in spin 0 nuclei within a microscopic approach for nuclear dynamics. GPDs can 
be used on one side as tools to unravel the deep inelastic transverse structure of nuclei in terms of both transverse spatial and spin momentum degrees of freedom. On the other hand, one can obtain information on GPDs themselves by observing how they become modified in the nuclear environment. Our study encompasses several nuclear observables: from Color Transparency, to nucleon overlap probabilities, to Mellin moments in nuclei, with particular emphasis on the behavior with the four-momentum transfer $t$ of the total momentum carried by quarks in a nucleus. The latter provides an important element for the evaluation of nuclear hadronization phenomena which are vital for interpreting current and future data at RHIC, HERMES and Jefferson Lab.

10:30AM JE.00006 Study of nucleon spin structure with a transversely polarized target in COMPASS 
, TAKAHIRO IWATA, Yamagata University, COMPASS COLLABORATION — The nucleon spin structure is studied in COMPASS at CERN by the measurement of the double spin asymmetry of the semi inclusive deep inelastic scattering of a polarized muon at 160 GeV/c off of a polarized $^6$Li target. 
The target can be polarized transversely, as well as longitudinally, with respect to the longitudinally polarized muon beam. This allows the measurement of the Collins and Sivers asymmetries and two-hadron production asymmetries. The Collins and the two-hadron production asymmetries have a connection to the transverse spin distribution function $\Delta r_q (x)$, referred to as transversity. Approximately 20% of the beam-time in 2002, 2003 and 2004 was spent in the transverse configuration. The preliminary results of the analysis of the data obtained in 2002 and 2003 are presented.
10:45AM JE.00007 Accessing quark orbital motion in semi-inclusive DIS experiments at Jefferson Lab Hall A and Hall C. 

Accessing quark transversity distributions in the proton. A program of semi-inclusive deep-inelastic scattering experiments at Jefferson Lab Hall A and Hall C has been developed to access quark orbital motion in a nucleon. This program includes: 1. Single-spin asymmetry $A_{UT}^{el}$ measurements in Jefferson Lab Hall A through $\bar{n}(e,e'\pi^\pm)$ reactions on a transversely polarized $^3$He target to access quark transversity distributions in the neutron. 2. Single-spin asymmetry $A_{UT}^{el}$ measurements through $p(e,e'\pi^\pm)$ reactions on a transversely polarized proton target in Jefferson Lab Hall C to access quark transversity distributions in the proton. 3. Double-spin asymmetry $A_{UT}^{el}$ measurements with a longitudinally polarized electron beam scattered off a transversely polarized proton target in $p(e,e'\pi^\pm)$ reactions in Jefferson Lab Hall C to access the leading-twist quark transverse-momentum dependent distribution functions $g_1 T(x)$.

11:00AM JE.00008 Factorization for Semi-inclusive Processes, FENG YUAN, RBRC, Brookhaven National Laboratory. In this talk, I will address the important question for the semi-inclusive processes: the factorization. I will demonstrate the QCD factorization works for these processes, and the cross sections can be factorized into transverse momentum dependent parton distributions and/or fragmentation functions, soft and hard factors.

11:15AM JE.00009 Single-spin asymmetries of two hadron production in polarized deep inelastic scattering at HERMES, TOMOHIRO KOBAYASHI, Tokyo Institute of Technology, HERMES COLLABORATION. HERMES has been taking data with a 27.6GeV positron beam at HERA and polarized gas targets (H, D). A pion pair produced in DIS was detected. Single spin asymmetries in the azimuthal distribution around the virtual photon direction have been measured. These asymmetries can be explained in terms of quark transversity distribution in conjunction with the interference fragmentations. The transversity is one of the three fundamental leading twist distribution functions. The other ones are the unpolarized quark number density and the helicity distribution function. Until recent years, the transversity has not been measured due to experimental difficulties arising from its chiral odd nature. It requires other chiral odd object in the process such as the interference fragmentation function. First results for these measurements will be shown.

11:30AM JE.00010 Measurements of chiral-odd fragmentation functions at Belle, AKIO OGAWA, BNL, BELLE COLLABORATION. The Collins fragmentation function connects the transverse quark spin with a measurable azimuthal dependence of the produced hadrons around the quark’s momentum axis. Therefore, it can be used as a transverse spin analyzer in semi-inclusive DIS and proton-proton collisions. While in those measurements the Collins function appears convoluted with the so far unknown quark transversity distribution, it is directly accessible in $e^+e^-$ collisions, where one measures a combination of a quark and an antiquark fragmentation function. We present measurements of azimuthal asymmetries for certain charge combinations of hadrons in which it is possible to minimize other systematic effects that could obscure the effect of spin-dependent fragmentation.

11:45AM JE.00011 Single Spin Asymmetry with a Transversely Polarized Hydrogen Target at HERMES, TOSHI-AKI SHIBATA, Tokyo Institute of Technology, HERMES COLLABORATION. Single spin asymmetry in meson productions with a transversely polarized hydrogen target was measured by HERMES experiment at DESY-HERA. Deep inelastic scattering of the 27.6 GeV positron off an internal hydrogen gas target was used. In addition to the scattered positron, produced hadrons were detected. Pions, kaons and protons were identified with Ring Imaging Cherenkov Counter(RICH). Azimuthal angle dependence of produced mesons was analysed in terms of Collins effect and Sivers effect. The separation of these effects became possible for the first time because of semi-inclusive measurement. Collins effect provides an access to a new, so far unmeasured structure function from which one can extract the transversity quark distribution. Sivers effect might have a link to the orbital motion of quark. The orbital angular momentum of quarks in the proton could contribute to the proton spin. In view of ‘nucleon spin problem’ started by EMC, the orbital angular momentum of quarks is an important subject to be studied.

12:00PM JE.00012 Transversity in single spin and azimuthal asymmetries, LEONARD GAMBERG, Penn State Berks. One of the persistent challenges confronting the QCD improved parton model is to account for the large azimuthal and single spin asymmetries that emerge in semi-inclusive electro-production, and di-lepton production in Drell Yan scattering. Going beyond the collinear approximation in PQCD recent progress has been achieved in characterizing these asymmetries in terms of absorptive scattering. Central to this understanding are the correlations between transversely and transverse spin in QCD hard scattering. These asymmetries provide a window to explore novel quark distribution and fragmentation functions which constitute essential information about the spin, transversity and generalized momentum structure of hadrons. Along with the chiral odd transversity time-reversal even (T-even) distribution function, existence of the time reversal odd (T-odd) distribution and fragmentation functions can provide an explanation for the substantial asymmetries that have been observed in these scattering processes.

Thursday, September 22, 2005 9:00AM - 11:15AM –

Session JF DN1 JPS: Studies of Nuclear Symmetries Ritz-Carlton Hotel Plantation 3

9:00AM JF.0001 Possible E(5/4) Symmetry in $^{135}$Ba. M.S. FETEVA, Department of Physics, University of Richmond, and Wright Nuclear Structure Laboratory, R.B. CAKIRLI, Wright Nuclear Structure Laboratory, and Yale University, R.F. CASTEN, Wright Nuclear Structure Laboratory, O.D. WARNER, SERC Daresbury Laboratory, UK, and Wright Nuclear Structure Laboratory. The case of a liquid drop with quadrupole deformation coupled to a particle with $j = 3/2$ was recently presented as a special solution E(5/4) to dynamic supersymmetries of differential equations. This development prompted the search for odd-A candidates for an E(5/4) symmetry at the critical value of the spherical to γ-unstable transition. Energies and E2 transitions have been calculated for $^{135}$Ba in the Interacting Boson-Fermion Model, Particle Vibrator Model and in the Shell Model frameworks and compared with the E(5/4) predictions and with the data. A comparison of the results will be shown as well as an identification of key data that are needed. This work was supported by NSF Grant PHY 0204811, the Research Corporation, grant CC5494, and DOE Grant No. DE-FG02-91ER-40609.

9:15AM JF.0002 New band mechanism of doubly-odd nuclei in the medium-heavy mass region. KOJI HAGASHIYAMA, Department of Physics, University of Tokyo, NAOYUKI YOSHINAGA COLLABORATION. In recent years, many experimental studies on the doubly-odd nuclei in the mass $A \sim 130$ region show two nearly degenerate $\Delta I = 1$ bands built on the unique-parity $0_{11/2}$ valence neutron and proton orbitals. From the theoretical side, these bands were extensively investigated in terms of mean field approaches. However, there was very few theoretical study which preserves both rotational symmetry and particle number conservation of the interactions. A few studies of them have been made using a pair-truncated shell model, where the shell model basis states are restricted to the collective subspace. This approach reproduced well experimental energy spectra and electromagnetic transitions of the doublet bands. From analysis of the wave functions and transition rates, it was found that the level scheme of the doubly-odd nuclei arises from different angular momentum configurations of the unpaired neutron and the unpaired proton, weakly coupled with the quadrupole collective excitations of the even-even part of the nucleus. In this talk, the results of these calculations will be presented and discussed.
9:30AM JF.0003 Pair-truncated shell-model approach to the mass $A \sim 130$ region, NAOYAKA YOSHINAGA, Department of Physics, Saitama University, KOJI HIGASHIYAMA COLLABORATION — There exist two prominent features in even-even nuclei in the mass $A \sim 130$ region. First, low-lying states of these nuclei exhibit the $\gamma$ instability, which manifests in the energy staggering of even-odd spin states in the quasi-$\gamma$ bands and also in some forbidden $E2$ interband transition rates. Second, at high-spins yrast bands of these nuclei show anomalous behavior, the so-called backfolding phenomenon. It arises due to band crossing between the ground-state band and a band originating from the alignment of two neutrons in the $\Omega_{11/2}$ orbitals. For a description of both the low-lying states and backfolding phenomena, we proposed a new version of the pair-truncated shell model, where the even-even nuclear states were constructed from angular momenta zero ($S$), two ($D$) and four ($G$) collective pairs, and non-collective $H$ pairs, which were made by two nucleons in the $\Omega_{11/2}$ or $\Omega_{9/2}$ orbitals. The model was applied to the even-even nuclei in this mass region, and reproduced well experimental energy spectra and electromagnetic properties.

9:45AM JF.0004 Deformation of excited states in collective nuclei using quadrupole shape invariants, E. WILLIAMS, V. WERNER, Yale University — Quadrupole shape invariants, formed by the isoscalar electric quadrupole operator, have been shown to provide a model-independent signature of nuclear deformation in a given eigenstate [1,2]. These invariants are of particular interest in cases where few lifetime data are available, as only a few absolute $B(E2)$ values are needed to approximately determine the lowest quadrupole invariants for the ground state. In this work, we have extended earlier studies of quadrupole shape invariants by investigating their general behavior for excited states and band structures in addition to the ground state, as well as exploring the behavior of these invariants at and between various limits of deformation (vibrational, rotational, and $\gamma$-soft) within the framework of the interacting boson model (IBM-1). Preliminary results of this investigation will be presented. [1] K. Kumar. Phys. Rev. Lett. 28, 249 (1972). [2] D. Cline. Annu. Rev. Nucl. Part. Sci. 36, 683 (1986). [3] V. Wern et al. Phys. Rev. C 61, 021301 (1999). Work supported by US DOE grant number DE-FG02-91ER-40609.

10:00AM JF.0005 Investigating the B(E2) anomaly in $^{144}$Nd by relative Coulomb excitation, C.R. FITZPATRICK, WNSL, Yale University and University of Surrey, UK, V. WERNER, R.F. CASTEN, H. AI, R.B. CAKIRI, A. HEINZ, E.A. MCCUTCHAN, D.A. MEYER, J. QIAN, E. WILLIAMS, R. WINKLER, WNSL, Yale University, G. GÜRDIN, WNSL, Yale University and Clark University — Previous work has shown that for a few non-magic nuclei, $B_{1/2} = B(E2; 4^{-} \rightarrow 2^{-})/B(E2; 2_{1}^{+} \rightarrow 0_{1}^{+})$ is less than one; this is anomalous in the context of collective models. $^{144}$Nd is a non-magic nucleus with a particularly low $B_{1/2}$ ($0.73 \pm 0.09$) and as such merits further investigation. A Coulomb excitation experiment was carried out using the 20MV tandem Van de Graaff accelerator at Yale using $^{138}$Cs ions in the range 170-202 MeV on two composite targets: one a mix of $^{142}$Nd and $^{144}$Nd, the other a layered target of $^{138}$Sm and $^{144}$Nd. These data facilitate a relative measurement of $B_{1/2}$ for $^{144}$Nd, and also provide a check that the data in this region is self-consistent. Data analysis is in progress; results of this work will be presented. Work supported by US DOE grants DE-FG02-91ER-40609, DE-FG02-88ER40417 and DE-FG03-03NA00081.

10:15AM JF.0006 Investigation of Vibrational Structure using SAUTs, CORNELIUS BEAUSANG, University of Richmond, R.B. CAKIRI, Yale University and University of Surrey, UK, R.F. CASTEN, Yale University, V. NIKOLOVA, University of Richmond — A recent paper by Cakiri et al. [1] investigating the vibrational structure of the nucleus $^{184}$Ru pointed out the importance that limits on intensities of Spin Allowed Unobserved Transitions (SAUTs) can have on the interpretation of specific levels and indeed the entire structure of the nucleus. SAUTs, refer to transitions, which are allowed by angular momentum selection rules, but whose intensities are too weak to be observed, between various levels of suggested multi-phonon multiplets. In some cases the ratio of $B(E2)$ values, obtained from the intensity limits set from the non-observation of otherwise allowed transitions, e.g. between suggested levels of a three-phonon multiplet and levels in a two-phonon multiplet allowed for the reinterpretation of these states. In this work we undertake a (partial) survey of existing data in the literature to determine if meaningful, useful limits on SAUTs can aid in the interpretation of other vibrational and transitional nuclei. [1] R.B. Cakiri et al., Phys. Rev. C 70 044312 (2004).

10:30AM JF.0007 Ground-band doubling and chiral doublets in $^{110}$Ru, J.H. HAMILTON, Vanderbilt U., S.J. ZHU, Tsinghua U./Vanderbilt U., Y.X. LUO, LBNL/Vanderbilt U., J.O. RASMUSSEN, LBNL, A.V. RAMAYYA, J.K. HWANG, Vanderbilt U., Z. JIANG, Z. ZHANG, R.Q. XU, S.D. XIAO, X.L. CHE, Y.N. U, Tsinghua U., W.C. MA, Mississippi State U., J.D. COLE, Idaho National Lab, I.Y. LEE, LBNL, R. DONANGELO, U. Federal Rio de Janeiro — Bands in neutron-rich $^{110}$Ru were reinvestigated by measuring high-fold prompt $\gamma$-ray coincidence events following the spontaneous fission of $^{252}$Cf with Gammasphere. The ground-state band and the $\gamma$-vibrational band have been confirmed and expanded with spin up to 20 and 13 h respectively. Another side band built on a 10$^+$ state has been established. Its energies are nearly degenerate with the ground band. This is the first case of ground band doubling. Two new sets of $\Delta I=1$ negative parity bands are observed and have the characteristics of chiral vibrational bands. Evidence for their interpretation as chiral band doublets will be presented. These bands are very similar to chiral doublets we found in $^{116}$Nd by relative Coulomb excitation.

10:45AM JF.0008 Proton-Neutron Mixed-Symmetry States of Vibrational Nuclei Near the $N = 82$ Shell Closure, NORBERT PIETRALLA, T. AHN, B. BOCHEV, A. COSTIN, K. DUSLING, T.C. LI, S. PONTILLO, G. RAINOVSKI, Y. RONG, Nuclear Structure Lab, SUNY, Stony Brook — Proton-neutron (pn) mixed-symmetry states (MSSs) have been defined in the pn-version of the interacting boson model (IBM-2). They are quadrupole-collective structures with wave functions that contain antisymmetric parts with respect to the pn contribution. This makes them sensitive to isovector parts of the effective pn interaction in the valence shell. Multiphonon structures with mixed-symmetry $^{144}$Sm and $^{144}$Nd, the other a layered target of $^{138}$Sm and $^{144}$Nd. These data facilitate a relative measurement of $B_{1/2}$ for $^{144}$Nd, and also provide a check that the data in this region is self-consistent. Data analysis is in progress; results of this work will be presented. Work supported by US DOE grants DE-FG02-91ER-40609, DE-FG02-88ER40417 and DE-FG03-03NA00081.

11:00AM JF.0009 Investigation of $0^+$ states in Rare Earth Region Nuclei, D.A. MEYER, WNSL, Yale Univ., G. GRAW, R. HERTENBERGER, LMU München, H.-F. WIRTH, TU München, R.F. CASTEN, WNSL, Yale Univ., P. VON BRENTANO, IKP Köln, D. BUCURESCU, NIPNE, Romania, C.R. FITZPATRICK, WNSL, Yale Univ., J. JOLIE, IKP Köln, R. KRÜCKEN, M. MAHGOUB, TU München, O. MOLLER, D. MÜCHER, P. PEJOVIC, C. SCHOLL, IKP Köln, V. WOOD, WNSL, Yale Univ. — The nature of $0^+$ excitations, especially in transitional and deformed nuclei, has recently attracted new attention with experiment studying $^{154}$Gd [1]. Additional nuclei in the rare earth region were studied via the $(p, t)$ pickup reaction using the Q3D magnetic spectrograph at the University of Munich MP tandem accelerator laboratory. Outgoing tritons were recorded at three lab angles, and their relative cross sections are compared to those calculated using the distorted wave Born approximation (DWBA). Using the unique shape of the $L = 0$ angular distribution, more than double the number of $0^+$ states than were previously known are identified. The distribution of $0^+$ energies and cross sections is discussed. This work supported by the U.S. DOE under Grant No. DE-FG02-91ER40609, and DFG (C4-Gr894/2-3, Jo391/2-1). [1] S. R. Lesher et al., Phys. Rev. C 66, 051305(R) (2002).
9:00AM JG.00001 Assessing the quality of waveforms from the neutral current detectors in the final phase of the Sudbury Neutrino Observatory experiment, NIKOLAI TOLICH, Lawrence Berkeley National Laboratory — The Sudbury Neutrino Observatory (SNO) has recently started its third experimental phase with the deployment of $^3\text{He}$ proportional counters throughout the detector. These proportional counters allow event-by-event separation of neutral current and charged current events. Oscilloscopes connected to these proportional counters record the waveforms, which can be used to distinguish alpha background events from neutron signals. Some of the acquired waveforms are instrumental noise that needs to be removed. I will present results on the identification of these noise events, and the general quality of the waveform data.

9:15AM JG.00002 SNO Neutral Current Detectors: Electronic Calibration, GERSENDE PRIOR, Lawrence Berkeley National Laboratory, SNO COLLABORATION — The Sudbury Neutrino Observatory (SNO), in Ontario, Canada, has provided in the last few years results favoring neutrino oscillations as an explanation for the deficit observed in measuring the solar neutrino flux. The Neutral Current Detector array, which consists of 36 $^3\text{He} - CF_4$ and 4 $^4\text{He} - CF_4$ vertical counters arranged symmetrically around the center of the heavy water target, has been deployed recently. Two years of data taking would accumulate enough statistics for an improved measurement of the total solar neutrino flux. In order to best understand data provided by this new set of detectors, electronic calibration are performed on a regular basis. The electronic calibration program consists both of a dedicated calibration campaign, where the electronic circuitry from the analogic to the digital conversion is probed by sending a pulse signal, and regular calibration data taking for electronic and detector performance monitoring. In this talk, electronic calibrations will be discussed with specific attention to the determination of the ballistic deficit, which produces correlations between pulse amplitude and duration in shaping amplifiers.

9:30AM JG.00003 Neutrons, a Trouble-Maker for Double-Beta Decay and Dark Matter Experiments, ANDREW HIME, DONGMING MEI, Los Alamos National Laboratory — Neutrons and neutron-induced cosmogenic radioactivity are an important background for underground experiments in rare events search for double-beta decay and dark matter. The problem of neutron-induced cosmogenic activation at sea level in materials is studied. We perform a Monte Carlo simulation to evaluate the neutron-induced background underground for double-beta decay and dark matter experiments. The $(\alpha,n)$ neutrons are studied in terms of the radio-purity of rock composition and muon-induced neutrons are evaluated according to the depth. The shielding of $(\alpha,n)$ neutrons as a function of thickness of polyethylene is modeled. The correlation of the underground muon flux seasonal variation and the annual modulation signal for dark matter experiments is examined. We present a depth-sensitivity relation (DSR) for underground experiments.

9:45AM JG.00004 Radioactive background studies for the CUORE neutrinoless double beta decay experiment, MICHELLE DOLINSKI, Lawrence Berkeley National Laboratory and University of California, Berkeley, CUORE AND CUORICINO COLLABORATION — The proposed CUORE experiment will use an array of $\sim 1000$ TeO$_2$ bolometers to search for neutrinoless double beta decay at the Gran Sasso Laboratory in Italy. The currently operating Cuoricino experiment, a 62 bolometers, is both a prototype for CUORE and an independent neutrinoless double beta decay experiment. In order for CUORE to reach a five year sensitivity on the effective neutrino mass on the order of 30 meV, a background of less than 0.01 counts/keV/kg/y in the double beta decay region is needed. We have examined the contributions to the radioactive background from copper, TeO$_2$ powder, and the tellurium that supports the crystals and provides a weak thermal link to the cold reservoir. In particular, we have used neutron activation analysis and low background gamma ray spectroscopy to determine the concentrations of uranium and thorium in the tellurium used in Cuoricino. In this talk, we will present our findings.

10:00AM JG.00005 Background Reduction in the Majorana Neutrinoless Double-Beta Decay Experiment, REYCO HENNING, LBNL, MAJORANA COLLABORATION — Majorana is a proposed, scalable, 180-kg array of enriched germanium crystals that will search for neutrinoless double-beta $(0\nu\beta\beta)$ decay in $^{76}\text{Ge}$. The focus of this talk is the reduction of backgrounds in Majorana, a vital aspect of any low-background experiment. The first step is identification of possible backgrounds, including radioactive contamination in the detector and cosmic-ray induced backgrounds. The next step is estimating background reduction from mitigating techniques, including ultra-pure material manufacturing, shielding, detector granularity, crystal segmentation, pulse-shape analysis, time correlations, and underground manufacturing and operation. Finally, all these components are assembled into a background model. With this background model, we are confident we can improve the current half-life limit of $0\nu\beta\beta$ decay in $^{76}\text{Ge}$ from $2 \times 10^{25}$ years to about $5.5 \times 10^{26}$ years, in the absence of a $0\nu\beta\beta$ decay signal.

10:15AM JG.00006 Pulse Shape Analysis in Segmented Detectors as a Technique for Background Reduction in Ge $\beta\beta$ Decay Experiments, VICTOR M. GEHMAN, Los Alamos National Laboratory/University of Washington, MAJORANA COLLABORATION — The immense improvement in the sensitivity of $\beta\beta$ decay experiments has led to the need to use a variety of advanced signal processing techniques to further reduce experimental backgrounds. These techniques are primarily concerned with discerning single-site from multiple-site energy depositions. One such technique especially effective when using Ge detectors (for experiments utilizing $^{76}\text{Ge}$ as a $\beta\beta$ decay source) is pulse shape analysis. An exciting extension to this technique is the inclusion of detector segmentation. We present current status and results in support of the Majorana Project (a proposed next-generation $\beta\beta$ experiment using a large array of 86% enriched $^{76}\text{Ge}$ crystals as both source and detector), in which we study the effectiveness of this combination in discriminating between single and multiple-site energy depositions on an event-by-event basis. We performed this work using a commercial detector from Canberra known as a “Clover” (a Clover is a close-packed array of four 800g, two-fold segmented natural germanium detectors) on our test bench at Los Alamos National Laboratory. We report on our efficiency in distinguishing between single and multiple-site energy deposition as well as estimates of our effective spatial resolution using these techniques.

10:30AM JG.00007 Muon-Induced Production of $^{16}\text{N}$, NOAH OBLATH, University of Washington, SUDBURY NEUTRINO OBSERVATORY COLLABORATION — The Sudbury Neutrino Observatory (SNO) is a 1000-tonne heavy water Cherenkov neutrino detector located in Sudbury, Ontario, Canada. Cosmic-ray muons pass through SNO at a rate of approximately 2.6 per hour, and they are easily vetoed. However, muon-induced spallation products with long lifetimes represent a background that must be considered. In particular, $^{16}\text{N}$ can be produced by $(n,p)$ and $(\mu^- - \mu_\tau)$ reactions on $^{16}\text{O}$. The $\beta^- \! - \! \nu_\tau$ decay of any $^{16}\text{N}$ ($T_{1/2} = 7.13$ s, $Q = 10.44$ MeV) in the heavy water would represent an important background in SNO’s neutrino measurements. We have investigated the production of $^{16}\text{N}$ by muons in the salt phase of the SNO experiment and found an initial $^{16}\text{N}$ activity in the 391-day salt-phase dataset consistent with zero: $-0.97 \pm 1.3$ kton$^{-1}$. The result will be compared with theoretical expectations.
10:45AM JG.00008 Full-Volume Calibration of KamLAND and Precision Measurement of Oscillation Parameters. KARSTEN M. HEEGER, KAMLAND COLLABORATION — The Kamioka Liquid scintillator Anti-Neutrino Detector (KamLAND) has measured the flux of anti-neutrinos from nearby nuclear power plants in Japan and made the first observation of the disappearance of reactor $\nu_e$. Recent measurements by KamLAND show evidence of spectral distortion, a clear sign of neutrino oscillation, and provide the most precise determination of the oscillation parameter $\Delta m^2_{12}$. KamLAND’s measurement of neutrino oscillation parameters is currently limited by systematics, primarily the determination of the fiducial volume. Calibrations throughout the entire detector volume are required to fully exploit KamLAND’s physics potential. This talk will describe the development of a novel calibration system and the expected improvements to KamLAND’s measurement of $\nu_e$ oscillation parameters.

11:00AM JG.00009 Understanding KamLAND’s Detector Response: Instrumentation for KamLAND’s Full-Volume Calibration System. LINDLEY WINSLOW, Lawrence Berkeley National Lab. KAMLAND COLLABORATION — The KamLAND collaboration has developed a novel deployment system for the positioning of radioactive calibration sources throughout the entire fiducial volume of the detector. This calibration device uses a variety of systems including inclinometers, pressure sensors, and the imaging of infrared LEDs to monitor its position. The calibrationsystem is also fitted with several low-activity Co/NaI to monitor its position. The combination of these methods will provide an accuracy of ~2 cm in the calibration source position. Mapping the vertex reconstruction bias throughout the detector volume is essential for reducing the fiducial volume uncertainty and improving the absolute $\nu_e$ flux measurement. Further studies of the detector’s energy scale and response will help with the measurement of the observed spectral distortion and the associated oscillation parameter $\Delta m^2_{12}$.

11:15AM JG.00010 Spallation-Induced Backgrounds in the KamLAND Detector. DANIEL DWYER, UC Berkeley / LBNL — The KamLAND detector provides a good environment for the study of low-energy backgrounds due to the interaction of cosmic ray muons with the detector material. At 2700 m.w.e overburden a muon rate of 0.3 Hz is measured in the main detector. The rough rates of ~3000 spallation neutrons, ~60 $^{12}$C/11N, and ~1.5 $^{14}$Li/13N per kton-day are measured. The contribution of $^{12}$N is ~1% and $^{8}$He is limited to less than 15% at 90% C.L. The ongoing studies of these backgrounds will be discussed.

11:30AM JG.00011 Event Identification In SNO’s NCD Phase. G. ADAM COX, University of Washington, SUDBURY NEUTRON OBSERVATORY COLLABORATION — In the final phase of SNO, the rate of the total solar neutrino flux can be measured using event-by-event particle identification of events recorded by the newly installed Neutral Current Detectors (NCDs). The NCDs are an array of $^3$He proportional counters constructed mostly from ultra-pure nickel tubes that capture neutrinos produced by the neutral-current interaction between solar neutrinos and the deuterium in SNO’s heavy water. The product of the neutron capture is a back-to-back proton and triton pair which ionize the proportional-counter gas and generate a current on the anode. In order to extract the rate of neutral-current interactions, neutron signals in the NCDs must be distinguished from events caused by ionizing alphas from the decay of U and Th embedded in the NCDs and electronic discharges. Calibration and characterization of the NCD electronics are essential to event identification. The current status of this effort and the role of the NCD electronics calibration will be discussed.

on behalf of the SNO Collaboration

Thursday, September 22, 2005 9:00AM - 11:30AM — Session JH DNPS: JPS: Mini-symposium on Nuclear Physics in Extreme Astrophysical Conditions

II Ritz-Carlton Hotel Plantation 1

9:00AM JH.00001 $\beta^-$-decay properties of r-process nuclei in the region around $^{137}$Sb. J. PEREIRA, NSCL/MSU, R. KESSLER, Inst. fur Kernchemie, Univ. Mainz, F. ATTALACH, GSI, T. FASTERMANN, TU Munich, H. GEISSEL, GSI, U. GIESEN, Univ. of Notre Dame, M. HANNAWALD, Inst. fur Kernchemie, Univ. Mainz, M. HAUSMANN, GSI, M. HELLSTROM, GSI, K.-L. KRATZ, Inst. fur Kernchemie, Univ. Mainz, M. HAMHUD, Univ. of Edinburgh, M.N. MINEVA, Lund Univ., G. MUNZENBERG, GSI, B. PFEFFER, Inst. fur Kernchemie, Univ. Mainz, P. SANTIT, NSCL/MSU, H. SCHATZ, NSCL/MSU, C. SCHEIDENBERGER, GSI, K. SCHMIDT, GSI, R. SCHNEIDER, TU Munich, J. STADLMANN, Univ. of Edinburgh — Studies aimed to explore the $\beta^-$-decay properties of very neutron rich nuclei are very important, since $\beta^-$-decays processes are related to the location and height of the r-process peak abundances. To this end, an experiment has been performed at GSI (Darmstadt) to determine the $T_{1/2}$ and $P_n$ values of nuclei in the region around $^{137}$Sb. Different exotic isotopes, including some important "waiting points" around the $\Delta A=130$ region were produced by fission of a 750 MeV/u $^{238}$U beam. The separated fragments were implanted into a stack of four double sided Silicon strip detectors, allowing a correlation between implantation and $\beta^-$-decays; $\beta^-$-delayed neutrons were measured with the Mainz 4π neutron long counter. Results obtained from this experiment will be presented.

9:15AM JH.00002 Shell model study of odd-odd nuclei with N=81 and their role in astrophysics. KENGO OGAWA, HITOSHI NAKADA, Chiba University, TAKEHITO HAYAKAWA, TOSHIYUKI SHIZUMA, Japan Atomic Energy Research Institute, TOSHIKATA KAJINO, National Astronomical Observatory — An odd-odd nucleus $^{138}$La is a key nucleus to understand the nucleusynthesis process in supernova explosions since it is considered to be synthesized by neutrino-induced reactions in SNe. We have investigated the structures of the odd-odd nuclei near $^{140}$La theoretically. The observed $J=1^+$ ground state in $^{140}$Pr suggests us the strongly correlated proton wave function, since a configuration $(0g_{7/2})^2(1d_{5/2})^1 \times (1d_{3/2})^1$ is predicted by a simple shell model does not favor the $J=1^+$ ground state. Therefore by taking into account more general configurations and truncation based on the seniority scheme, we have carried out the shell model calculation and succeeded in reproducing the lowering level structure of $^{140}$Pr. Other results of the calculation will be presented at the meeting. We will also discuss the astrophysical role of $^{138}$La.

9:30AM JH.00003 Birds and the B(GT)s: Gamow-Teller Strengths from (t,3He) Charge Exchange Measurements. MEREDITH HOWARD, S.D. REITZNER, E.E. SMITH, The Ohio State University, S. AUSTIN, D. BAZIN, A.L. COLE, F. FAMIANO, A. GADE, D. GALAVIZ REDONDO, G.W. HITT, W. MARTINEZ, M. MATOS, H. SCHATZ, B. SHERRILL, C. SIMENEL, A. STOLZ, R.G.T. ZEGERS, National Superconducting Cyclotron Laboratory, B. DAVIDS, TRIUMF, Y. SHIMBARA, RCNP/NSCL, C. SAMANTA, Saha Institute of Nuclear Physics — In pre-collapse and post-bounce stars, electrons excite Gamow-Teller (GT) resonances. Our current understanding of supernova explosion dynamics is guided by models that use data and calculations of GT strength (B(GT)) distributions for many nuclei. While measuring B(GT) for all nuclei is an unreasonable chore, limited charge exchange data can 1) reduce uncertainties for important nuclei and 2) vet assumptions/calculations used in different isotopic regions. The (t,3He) experiments run at the National Superconducting Cyclotron Laboratory (NSCL) use a 450 MeV secondary triton beam to measure strengths with a resolution of about 150 keV from dispersion matching. Preliminary results from a recent experiment on 24Mg, 63Cu and 94Mo targets are discussed. This work is supported by JINNA and the NSF (PHY 0214783, 0110253, 0140255).
9:45AM JH.00004 Isospin Asymmetry in Nuclei and Neutron Stars , ANDREW STEINER, Los Alamos National Laboratory — The role of isospin asymmetry in neutron stars and nuclei is investigated. We discuss the causes of correlations among the neutron skin thickness in heavy nuclei, the pressure of neutron-rich matter near saturation density, the derivative of the nuclear symmetry energy at the same density and the radius of moderate mass neutron stars. The impact of symmetry energy constraints for the mass and moment of inertia contained within neutron star crusts and the threshold density for the nucleon direct Urca process, all of which are potentially measurable, is explored. We comment on the minimum neutron star radius, assuming that only nucleonic matter exists within the star. We discuss these results in the light of recent mass and radius measurements which have the potential to offer tighter constraints on the theory.

10:00AM JH.00005 Nuclear Physics Input to Models of the Supernova Phenomenon , JIRINA RIKOVSKA STONE, Oxford University, ANTHONY MEZZACAPPA, Physics Division Oak Ridge National Laboratory — The density and temperature dependence of the energy per particle of a system (the Equation of State (EOS)) is a fundamental ingredient of all models of nuclear matter and stars. As nucleons and leptons form the main components of all stars, the best possible description of the strong and weak interactions amongst these particles is essential for a correct understanding of birth, life and death of stars. To date, no model predicts the explosion of a core collapse supernova. The problem may lie with the EOS currently used. We give examples of EOS's, based on different models of nuclear interactions, suitable for models of core-collapse supernovae and examine the sensitivity of calculated radial positions of shock waves, mass fractions in the supernova core, pressure and temperature profiles and some other features to the choice of the equation of state. Two new EOSs, one based on a fully selfconsistent Hartree-Fock model, shedding new light on the phase transition between homogeneous and inhomogeneous nuclear matter and the other, based on the quark model, describing high density homogeneous matter with strange baryons, will be discussed.

10:15AM JH.00006 Equations of State for Supernova Simulations , JAMES LATTIMER, Stony Brook University, TERSACLE SUPERNOVA INITIATIVE COLLABORATION — New formulations of dense matter equations of state suitable for use in supernova and neutron star simulations are described. These equations of state are based on the compressible liquid droplet model of Lattimer et al. (Nucl. Phys. A535, 646 [1985]) and contain several modifications and improvements to the models of Lattimer & Swesty (Nucl. Phys. A535, 331 [1991]). Changes include consideration of the nuclear skin, convergence even for arbitrarily low temperatures, electron fraction and densities, and the incorporation of relativistic field-theoretical nuclear interactions in addition to non-relativistic potential nuclear forces. For each nuclear interaction, surface energy parameters are evaluated from Thomas-Fermi semi-infinite calculations, so that surface properties remain consistent with bulk matter properties. Comparisons are made between models with significantly different nucleon-nucleon interaction parametrizations, and with results obtained from conventional “nuclear statistical equilibrium” calculations at lower densities. The properties of cold neutron star matter in the crust of neutron stars and implications for the astrophysical r-process are also discussed.

1Supported by DOE DE-FG02-87ER40317 and DE-FG02-01ER41185
2Sponsored by the Department of Energy’s Office of Science Discovery Through Advanced Computing program

10:30AM JH.00007 The “weak” and “main” r-processes in core-collapse supernovae , SHINYA WANAJO, Univ. of Tokyo, YUHRI ISHIMARU, Kogakuin Univ. — While the origin of r-process nuclei remains a long-standing mystery, recent spectroscopic studies of extremely metal-poor stars in the Galactic halo strongly suggest that it is associated with core-collapse supernovae. In addition, recent comprehensive analysis of such stars implies the presence of the “weak” r-process that is responsible for only lighter nuclei with A < 130. In previous works, we have shown that the heavy r-process nuclei with A > 130 might be produced in neutrino winds in core-collapse supernovae only with a massive proto-neutron star of ∼ 2.0 M⊙. In this talk, we show that the lighter r-process nuclei with A < 130 can be produced with a typical proto-neutron star of ∼ 1.4 M⊙. We compare the nucleosynthesis result with the neutron-capture abundances of the extremely metal-poor, “weak” r-process star that has been analyzed recently with SUBARU/HDS. Implications for the astrophysical sites of the r-process are then discussed.

10:45AM JH.00008 Fission and the Termination of the Astrophysical r-Process , PETER MOLLER, Theoretical Division, Los Alamos National Laboratory, KARL-LUDWIG KRATZ, KHALIL FAROUQI, BERND PFEIFFER, Institut für Kernchemie, Universität Mainz, Mainz, Germany — Recent significant progress in modeling the fission process allows us to model the r-process termination more realistically than previously. In the macroscopic-microscopic approach we now calculate fission potential-energy surfaces as functions of millions of different nuclear shapes [1]. In contrast other calculations have only considered around 1000 shapes. We have used our recently developed approach to calculate barrier heights for more than 1000 nuclei. The inner barrier has been studied in a 3-dimensional deformation space, including axial asymmetry, for the outer barrier region it is necessary to use a 5-dimensional deformation space. Once we have established which of the inner or outer barrier peaks defines the fission-barrier height we perform r-process calculations taking into account fission at the termination of the r-process path. First results and conclusions will be presented.


11:00AM JH.00009 The Galactic chemical evolution and the origins of r-process elements , YUHRI ISHIMARU, Kogakuin Univ., SHINYA WANAJO, Univ. of Tokyo — Abundance analysis of metal-poor stars reveals large dispersions in r-process elements. This may be interpreted as a result of incomplete mixing of the interstellar medium at the beginning of the Galaxy. However, recent studies show considerable small dispersions for abundance ratios of C-Zn. Using an inhomogeneous chemical evolution model, we discuss whether known supernova (SN) yields can account for such observational differences between r-process and C-Zn. If metal-poor stars are enriched by only one or a few SNe, huge dispersions in r-process elements possibly imply that their yields are highly dependent on SN progenitor masses. We, then, attempt to determine the site of r-process. In particular, recent studies show a large enhancement of Sr comparing to Ba at very low metallicity, suggesting that main r-process produces heavier nuclei whereas ‘weak’ r-process produces only lighter ones. Comparing our latest results of Subaru observations with predicted dispersions in Sr, Y, Pb, Ba, La, and Eu, we show that ‘weak’ r-process fraction gradually decreases from Sr towards Ba.

11:15AM JH.00010 Primordial magnetic field, CMB, and BBN , DAI YAMAZAKI, Department of Astronomy, Graduate School of Science, University of Tokyo, KIYOTOMO ICHIKI, TAKA KAJINO, National Astronomical Observatory Japan, GRANT MATHIEWS, Center for Astrophysics, Department of Physics, University of Notre Dame — The cosmic microwave background (CMB)anisotropies give important information to constrain cosmological parameters including the universal baryon density. Recent CMB observations have been extended to higher multipoles l > 1000 to exhibit an excess power than the standard model prediction in cosmological Microwave Anisotropy Probe data at lower multipoles l < 900. This would make another uncertainty in resolving the discrepancy of baryon density determined from CMB and Big-Bang nucleosynthesis. Thus we consider the effect of the cosmological primordial magnetic field that affects strongly the CMB power spectrum. We calculate the CMB temperature anisotropies generated by the power-law magnetic field at the last scattering surface in order to explain the excess power at higher multipoles, and also to try to constrain more accurately the baryon density and upper limit to primordial magnetic field.

Thursday, September 22, 2005 9:00AM - 12:00PM
Session JJ DNP PS: Light Ion Reactions  Ritz-Carlton Hotel Hawaii
9:00AM JJ.00001 Measurement of deep hole states in $^{40}$Ca by 392 MeV (p,2p) reaction. YUSUKE YASUDA, HARUTAKA SAKAGUCHI, SATORU TERASHIMA, SATOSHI KISHI, JUZO ZENIHIRO, Kyoto University, TETSUO NORO, TOMOTSUGU WAKASA, HIDETOMI YOSHIHATA, TAKASHI ISHIDA, SHU ASAJI, TAKAHIKO YONEMURA, YOHSUKE HAGIHARA, Kyushu University, KICHIJI HATANAKA, YASUHIRO SAKEMI, MASARU YOSOI, YOHEI SHIMIZU, KINIHIRO FUJITA, YUJI TAMASHIGE, RCNP Osaka University, HIRONUKI TAKEDA, RIKEN, MASATOSHI ITOH, Tohoku University, TAKAHIRO KAWABATA, CNS University of Tokyo, MAKOTO UCHIDA, Tokyo Inst. of Tech. — We performed $^{40}$Ca(p,2p) experiment with 392 MeV polarized proton beam at RCNP Osaka University and measured recoil momentum distribution of cross section and analyzing power for low and lying deep hole states in $^{40}$Ca. The aim of this experiment is to obtain information on the spectroscopic factor and the width of the deep orbitals states such as the 1s$_{1/2}$ state of medium nuclei for understanding the nuclear structure and correlations in deep hole states. We analyzed deep hole states with L decomposition analysis method which disentangle the contributions of each orbital states from separation energy spectra. We will report the result of $^{40}$Ca measurements.

9:15AM JJ.00002 Neutron Density distributions in $^{204,206,208}$Pb observed via polarized proton elastic scattering at 300MeV. YOSHIHIKO IWAQ, HARUTAKA SAKAGUCHI, TESTUYA MURAKAMI, YUSUKE YASUDA, SATORU TERASHIMA, ZYUZO ZENIHIRO, TAKASHI EMORI, Department of Physics, Kyoto University, MASARU YOSOI, Research Center for Nuclear Physics (RCNP), Osaka University, HIROYUKI TAKEDA, Institute of Physical and Chemical Research (RIKEN), MASATOSHI ITOH, Department of Physics, Tohoku University, HIDETOMI YOSHIHATA, Research and Development Center for Higher Education, Kyushu University, MAKOTO UCHIDA, Department of Physics, Tokyo Institute of Technology — Neutron skin thickness, the difference of root mean square radii of neutron and proton distributions, for $^{208}$Pb provide a key role to discern various effective interactions used in Skyrme Hartree-Fock (SHF) and Relativistic Mean Field (RMF) models. We performed an experiment of elastic scattering of 300MeV polarized protons off $^{204,206,208}$Pb at RCNP and extracted their neutron density distributions in the framework of the relativistic impulse approximation (RIA) with medium modified NN interactions. We will report the results of the neutron skin thicknesses together with the nuclear incompressibility.

9:30AM JJ.00003 An experimental-based model of ternary fission. JOHN LESTONE, Los Alamos — Large amounts of neutron-induced, spontaneous, and heavy-ion induced ternary-fission data are analyzed within the frame work of an evaporation-based model where the complexity of time-varying potentials are included in a simplistic fashion. A free parameter which controls the height above the rupture location beyond where quasi-evaporated particles become ejected ternary-fission fragments following the rapid collapse of the necking material is adjusted to reproduce ternary-fission emission probabilities. The observed dependence of this parameter on the mass and charge numbers of the light charged particles is consistent with a neck collapse time of $\sim 10^{-22}$ s. Without any additional adjustment to model parameters, the observed trends in the energy spectra and angular distributions of the ternary-fission particles are reproduced. The calculated ratio of the first 2$^+$ to ground-state population probabilities for ejected $^{10}$Be ions is 0.155, in agreement with experiment. There are indications that the neck collapse time increases with nuclear temperature. The success of the model implies that ternary fission is caused by the evaporation of particles from a rapidly changing fluid.

9:45AM JJ.00004 Spin distribution effects in neutron induced preequilibrium reactions$^1$. D. DASHDORJ, NCSU/LLNL, G.E. MITCHELL, NCSU/TUNL, P.E. GARRETT, J.A. BECKER, U. AGVAANLUVSAN, R.A. MACRI, W. YOUNES, LLNL, T. KAWANO, M. CHADWICK, M. DEVLIN, N. FOTIADES, R.O. NELSON, LANL — The preequilibrium reaction (PE) mechanism makes an important contribution to neutron induced reactions above about 10 MeV. PE has been studied exclusively via the characteristic high energy neutrons. We are expanding the study of PE through $\gamma$ ray spectroscopy. Cross sections of partial $\gamma$ rays following the neutron induced reaction on $^{10}$Ti for $E_n = 1$ to 200 MeV have been obtained in an experiment using GEANIE array at LANSE/WNR. Using the GNASH reaction code the effect of the spin distribution of the residual nucleus in preequilibrium reactions has been investigated. The preequilibrium reaction spin distribution was calculated using the quantum mechanical theory of Feshbach, Kerman, and Koonin (FKK). The FKK preequilibrium spin distribution was incorporated into the GNASH calculations and the $\gamma$ ray production cross sections were calculated and compared with experimental data. The difference in the partial $\gamma$ ray cross sections using spin distributions with and without preequilibrium effects is found to be significant.

$^1$This work was supported in part by the DOE Grants No. DE-FG03-03NA00076 (SSAAP) and No. DE-FG02-97-ER41042 and in part by DOE by UC, LLNL, and LANL under contract Nos. W-7405-ENG-48 and W-7405-ENG-36.

10:00AM JJ.00005 Surrogate reactions for nucleosynthesis: $^{101,103}$Ru($\alpha,\alpha'$) as surrogate reactions for $^{103}$Ru($n,\gamma$). J.A. CHURCH, L.A. BERNSTEIN, J.T. BURKE, F. DIETRICH, J. ESCHER, C. FORSSER, E. NORMAN, LLNL, J. AI, Yale, L.W. PHAIR, R. CLARK, P.A. FALLON, D. LEE, J.Y. LEE, A.O. MACHIPELLI, P. MCMANAN, S. SINHA, M. STEPHENS, E. R-VIEITEZ, M. WIEDEKING, LLNL — For two-step, neutron-induced reactions proceeding through an equilibrated intermediate state, an alternate, “surrogate reaction” technique (Cramer and Britt) is applicable. Measured decay probabilities for the intermediate nucleus formed via a light-ion reaction are combined with optical-model calculations for the formation of the same intermediate nucleus via the n-induced reaction, and result in the overall ($n,\gamma/n2n$) cross sections. For the first time, we have extended this method to ($n,\gamma$) reactions important in nucleosynthesis. $^{102,104}$Ru($\alpha,\alpha'$) were studied separately as surrogate reactions for $^{101,103}$Ru($n,\gamma$). The test, $^{103}$Ru($n,\gamma$), has been previously measured directly (EXFOR). The unknown, $^{103}$Ru($n,\gamma$), is a branch in the s-process. Energies of scattered $\alpha$ particles were detected in double-sided silicon detectors (STARS) over scattering angles of 42-60 degrees. Ge detector systems (LiBerACE) were used to count $\gamma$-rays in coincidence with $\alpha$ particles scattered at energies corresponding to 0-3 MeV equivalent neutron energy in the desired ($n,\gamma$) reaction. Work performed under the auspices of the U.S. DOE by the Univ. of CA, LLNL contract W-7405-Eng-4, DOE grants DE-FG02-91ER4069, and DE-FG03-03NA00081, and LDRD-04-ERD-057.

10:15AM JJ.00006 Study of $M_1$ Quenching in $^{28}$Si by a $p,p'$ Measurement at 0 Deg. H. MATSUBARA, A. TAMI, K. FUJITA, H. HASHIMOTO, K. HATANAKA, M. ITOH, K. NAKANISHI, Y. SAKEMI, Y. SHIMIZU, Y. TAMESHIGE, RCNP Osaka Univ., T. ADACHI, Y. FUJITA, Osaka Univ. Sci., J. CARTER, Univ. of Witwatersrand, H. FUJITA, F.D. SMIT, iThemba LABS., T. KAWABATA, CNS Univ. of Tokyo, L.A. POPESCU, Gent Univ., H. SAKAGUCHI, J. ZENIHIRO, Kyoto Univ. Sci. — The quenching of Gamma-Teller ($GT$) strengths with respect to the sum rule has been discussed as an opened problem. Similarly the $M_1$ strengths may have the same quenching problem because the transition includes the same operator $"c"\gamma$ with the $GT$ one. Since there are two type transitions in $M_1$ strengths, $IS(\Delta T=0)$ and $IV(\Delta T=1)$, another aspect of the quenching can be found from the difference. The experiment was carried out at RCNP by applying both “dispersion-matching technique” and “under-focus mode” for high resolution measurements at 0°. A 295 MeV unaltered proton beam bombarded natural Si target. After detailed calibrations, an energy resolution of 20 keV and a scattering angle resolution of 0.5° ~ 0.8° were achieved. Background events were subtracted reasonably. In order to select 1+ states, angular distribution of each peak was compared with DWBA calculations. The comparison between the experimental results and theoretical predictions of $IS$ and $IV$ will be discussed.
10:45AM JJ.00008 Using the surrogate ratio method to determine the $^{235}$U(n,f) cross section.

J. T. BURKE, L. A. BERNSTEIN, J. A. CHURCH, F. S. DIETRICH, J. E. ESCHER, E. B. NORMAN, Lawrence Livermore National Laboratory, L. W. PHAIR, P. FALLON, R. M. CLARK, M. DESCovich, M. CROMAZ, M. A. DELEPLANQUE, I. Y. LEE, A. O. MACHiAVelli, M. A. MCMANAHAN, L. G. MORETTO, E. RODRiGUEZ-ViEtTEZ, S. SINHa, F. S. STEPHENS, Lawrence Berkeley National Laboratory, H. C. AI, Yale University, C. W. BEALiSANG, B. CRiDDER, Richmond University — A collaboration of scientists at LLNL, LBLL, and Yale University have deduced the $^{235}$U(n,f) cross section over a neutron energy range of 0 to 20 MeV. The cross-section was determined from the relative fission probability of $^{238}$U($\alpha$,α′f) compared to $^{236}$U(α,α′). Where $^{238}$U(α,α′) and $^{236}$U(α,α′) are surrogates for $^{237}$(n,f) and $^{235}$U(n,f) respectively. The experiment was performed at the 88 Inch Cyclotron at LBLL using the Silicon Telescope Array for Reaction Studies (STARS) spectrometer developed at LLNL. In this talk we will present an overview of the measurement and present the surrogate ratio method. This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

11:00AM JJ.00009 Relativistic Effect and $\alpha$–$^{40}$Ca and $\alpha$–$^{48}$Ca Scattering. JEREMY S. SCOTT, 1Physics Department, Southern Illinois University, R. TRIPATHI, NASA Langley Research Center, F. BARY MALIK, 1Physics Department, Southern Illinois University — Past optical model calculations of elastic differential scattering cross sections of $\alpha$-particles incident upon $^{40}$Ca and $^{48}$Ca have been examined to illustrate the need for relativistic calculations at 1.37 GeV. Khoa et al. and Nakano et al. have constructed potentials that match the experimental data very well in the forward angles using Woods-Saxon and Mexican hat types of potentials using the non-relativistic Schroedinger equation. However, when the potentials are used in the relativistic Schroedinger equation (RSE) to produce scattering cross sections, the fits are no longer that good. At 1.37 GeV, the $\alpha$-particle momentum calculated relativistically differs significantly from the one determined from the non-relativistic-energy-momentum relation. The new $\alpha$–$^{40}$Ca and $\alpha$–$^{48}$Ca potentials determined using RSE, differ from those of Khoa et al. and Nakano, et al. 1D.T. Khoa, M. Nakano et al., Phys. Rev. C 65, 024611, 2002. 2 M. Nakano et al., Phys. Rev. C. 40, 1323, 1989.

11:15AM JJ.00010 Feeding of the 11/2− isomers in $^{191,193}$Ir and $^{197}$Au. N. FOTIAIDES, R.O. NELSON, M. DEVLIN, LANL, J.A. BECKER, P.E. GARRETT, W. YOUNES, LLNL — The $(n, n\gamma)$ reaction was used to study excited states and to measure absolute partial $\gamma$-ray cross sections in $^{191}$Ir, $^{193}$Ir and $^{197}$Au. The data were taken using the GEANIE spectrometer comprised of 26 high-purity Ge detectors with 20 BGO escape-suppression shields. The broad-spectrum pulsed neutron source of the Los Alamos Neutron Science Center’s WNR facility provided neutrons in the energy range from 0.6 to 250 MeV. The time-of-flight technique was used to determine the incident neutron energies. The absolute partial cross sections for hundreds of $\gamma$-rays from several reaction channels were determined. The partial $\gamma$-ray cross sections of several transitions feeding directly the 11/2− isomers and ground states in $^{191}$Ir, $^{193}$Ir and $^{197}$Au were obtained. In the case of $^{197}$Au, where the structure above the 11/2− isomer was not known before, the partial $\gamma$-ray cross sections and the $\gamma$-$\gamma$ coincidence data were used to build the level scheme above the isomer up to ~2 MeV excitation energy. The feeding of the 11/2− isomers, which originate from the odd proton occupying the h11/2 orbital, was found in all three experiments to be very similar and it is compared to the feeding determined for the ground states of $^{191}$Ir, $^{193}$Ir and $^{197}$Au. This work was performed under the auspices of the U.S. Department of Energy by the University of California, Los Alamos National Laboratory under contract No. W-7405-ENG-36 and Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48.

11:30AM JJ.00011 Particle–$\gamma$ Coincidence Measurements of Neutron Transfer Reactions on Neutron-rich Nuclei. MICAH JOHNSON, A. KRONENBERG, ORAU, D.W. BARDAYAN, J.C. BLACKMON, C.D. NESARRAJA, D.C. RADFORD, M.S. SMITH, ORNL, J.A. CIZEWSKI, K.L. JONES, S.D. PAIN, J.S. THOMAS, Rutgers University, J.A. HOWARD, R.L. KOZUB, B.A. SCHWER, Tennessee Tech., R.J. LIVESAY, Colorado School of Mines — Neutron-transfer measurements with $(d,p)$ reactions provide important nuclear structure information such as excitation energies, angular momenta and spectroscopic strengths for neutron single-particle states. Such information can also be used to inform neutron-capture rates for nuclei far from stability, where direct measurements of the $(n,\gamma)$ reaction are not possible because of the short life-times. In particular, neutron-capture measurements on neutron-rich nuclei are important for understanding astrophysical phenomena such as $r$-process nucleosynthesis. Using inverse kinematics for $(d,p)$ reactions enables neutron-transfer measurements to be made using beams of neutron-rich nuclei, which cannot be made into targets. Measurements of $\gamma$-rays using high-resolution $\gamma$-ray detectors in coincidence with $(d,p)$ reaction protons enables more accurate energy determination of excitations and provides further information on $\gamma$-ray strengths, which are important when extracting direct contributions to neutron-capture rates. Prospects for $(d,p\gamma)$ measurements in inverse kinematics with neutron-rich beams at the HIRIF at ORNL will be discussed.

3Work supported in part by US DOE and NSF

11:45AM JJ.00012 Four-body CDCC analysis of $^6$He+$^{208}$Bi scattering near Coulomb barrier energies. TOMOAKI EGAMI, KAZUYUKI OGATA, TAKUMA MATSUMOTO, RIKEN, EMIKO HIYAMA, Department of Physics, Nara Womens University, YASUNORI ISERI, Department of Physics, Chiba-Keizai College, MASAYASU KAMIMURA, MASANOBU YAHIRO, Department of Physics, KyoSho University — In 2003, Keeley et al. analyzed the elastic scattering of $^6$He on $^{208}$Bi target at 19.0MeV and 22.5MeV by the continuum-discretized coupled-channels method (CDCC). In the analysis the $n+^4$He+$^{208}$Bi three-body model, where $^4$He denotes dineutron, was adopted. This three-body CDCC analysis, however, failed to reproduce the experimental data of the elastic cross section of $^4$He+$^{208}$Bi. In the present paper, $^6$He+$^{208}$Bi system is described by $n+^4$He+$^{208}$Bi four-body model and the four-body CDCC analysis, including nuclear- and Coulomb-breakup channels explicitly, is carried out. The three-body ($n+^4$He+$^{208}$Bi) continuum states of $^6$He are discretized by the pseudostate method, i.e., pseudostates obtained by diagonalizing the internal Hamiltonian of $^6$He with Gaussian basis functions are assumed to be discretized-continuum states of $^6$He. We show that the four-body CDCC well reproduces the angular distribution of elastic scattering states and the total reaction cross section at the both incident energies.

alignment due to multiple E2 and E4 Coulomb excitation is substantial and must be taken into account when calculating the fusion cross section with TDHF.

US DOE under grant DE-FG02-91ER-40608.

number of intrinsic excitation quanta. A general procedure is presented for evaluation of the matrix element of an arbitrary

will be discussed in another talk. Ref: A.S. Umar and V.E. Oberacker, Eur. Phys. J. A

fusion using some of the more recent parameterizations of the Skyrme force. The results of applying this code to study heavy-ion fusion for deformed nuclei

energy functional, including spin-currents and tensors. We study a number of systems to understand the effects of time-odd parts of the interaction on heavy-ion

nature of these unrestricted calculations and in particular the effects of no time-reversal invariance. This introduces many additional terms into the Skyrme

VOLKER OBERACKER, Vanderbilt University — We present time-dependent Hartree-Fock (TDHF) studies without any spatial symmetry restrictions as well

as no time-reversal invariance for the Skyrme force. The code uses the basis-spline collocation method for lattice representation. We will discuss the general

excitation

Specific results will be presented for the light system (\(n, \alpha\) RGM formalism). Y. FUJIWARA, Kyoto University — In the momentum representation, incorporating the long-range Coulomb force always poses problems. We propose a simple and accurate method to solve the Lippmann-Schwinger RGM (resonating-group method) equations, with the Coulomb force included at the constituent level. If the cut-off Coulomb force is used, the direct and exchange Coulomb kernels are explicitly evaluated with a reasonable size for the cut-off radius \(R\), without spoiling the effect of the Pauli principle. The direct potential thus obtained becomes a screening Coulomb in the error function form. The cut-off is no longer sharp, but the standard procedure of the cut-off Coulomb problem, proposed by Vincent and Phatka [Phys. Rev. C10, 391 (1974)], can still be used by solving the asymptotic waves down to \(R_{\text{cut}} \ll R\), where the full Coulomb force is acting. We show two examples, \(\alpha\) RGM and the charged cases of the quark-model baryon-baryon interactions fss2. In the latter case, accurate determination of the nuclear phase shifts is very important for evaluating the low-energy parameters, including the inelastic capture ratio at rest for \(^\Sigma^-p\) scattering.

1Supported by Grant-in-Aid for Scientific Research (C) from Japan Society for the Promotion of Science (JSPS), No. 15540270.

9:30AM JK.00003 Proton Elastic Scattering from 60−74Ca Nuclei, KAAKI KAKI, Department of Physics, Shizuoka Univ. — Recent relativistic-mean-field calculations have provided nuclear distributions of Ca isotopes whose mass numbers are 60 through 74. We calculate observables of proton elastic scattering from these unstable nuclei, and plan to show some relations between observables and much more spreading neutron distributions than proton ones. The calculations are based on relativistic impulse approximation (RIA) and the incident energies of proton are chosen 300 and 400 MeV. In these energies predictions of RIA have been known to provide good agreements with experimental data for many kinds of nuclei.

9:45AM JK.00004 Vlasov Equation for Quantized Meson Fields, MAMORU MATSUO1, TETSUO MATSUIT, Inst. Physics, Univ. Tokyo — In order to describe the final stage of space-time evolution of dense matter created by ultrarelativistic nuclear collisions, we formulate a kinetic theory of mesons starting from the Heisenberg equation of motion of self-interacting quantized fields. As a dense hadronic matter formed by ultrarelativistic nuclear collision is diluted by the expansion, we expect that the system undergoes a phase transition associated with the spontaneous breakdown of the chiral symmetry which is restored temporarily after the collision by the formation of a quark-gluon plasma. As the quark-gluon plasma hadronizes and turns into the confining phase, the system would expand under the influence of the growing chiral condensate. This physical situation is very similar to what happens when some of the magnetically trapped atoms condense into the lowest single particle level forming a Bose-Einstein condensate. The dynamics of such a system is described by the coupled equations of motion in the form of the Boltzmann-Vlasov equations. We will show that a similar set of equations can be derived for a system of interacting mesons described by the relativistic quantum field theory and discuss on the dispersion relations of the collective mesonic excitations at finite temperatures using these kinetic equations.

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10:00AM JK.00005 3-D Unrestricted TDHF - Studies with full Skyrme interaction, SAIT UMAR, VOLKER OBERACKER, Vanderbilt University — We present time-dependent Hartree-Fock (TDHF) studies without any spatial symmetry restrictions as well as no time-reversal invariance for the Skyrme force. The code uses the basis-spline collocation method for lattice representation. We will discuss the general nature of these unrestricted calculations and in particular the effects of no time-reversal invariance. This introduces many additional terms into the Skyrme energy functional, including spin-currents and tensors. We study a number of systems to understand the effects of time-odd parts of the interaction on heavy-ion fusion using some of the more recent parameterizations of the Skyrme force. The results of applying this code to study heavy-ion fusion for deformed nuclei will be discussed in another talk. Ref: A.S. Umar and V.E. Oberacker, Eur. Phys. J. A 24 (2005).

10:15AM JK.00006 TDHF fusion studies including dynamic alignment due to Coulomb excitation1, VOLKER OBERACKER, SAIT UMAR, VOLKER OBERACKER, Vanderbilt University — We utilize the Time-Dependent Hartree-Fock (TDHF) method to calculate heavy-ion fusion cross sections for systems involving a spherical projectile and a deformed target nucleus. The calculations involve modern Skyrme forces and are carried out on a large 3-D Cartesian lattice using the Basis-Spline collocation method. The computations involve two separate steps: first, a TDHF calculation for a given initial orientation of the deformed nucleus, and secondly a semiclassical time-dependent Coulomb excitation calculation to determine the relative orientation probability of the deformed nucleus near the distance of closest approach. In this paper, we focus on the second aspect of the theory. Specific results will be presented for the light system (\(^{16}\text{O} + ^{22}\text{Ne}\)) and for the heavy system \(^{64}\text{Ni} + ^{162}\text{Dy}\). We demonstrate that in heavier systems the alignment due to multiple E2 and E4 Coulomb excitation is substantial and must be taken into account when calculating the fusion cross section with TDHF. Ref: A.S. Umar and V.E. Oberacker, Eur. Phys. J. A 24 (2005)

1Supported by U.S. Department of Energy grant DE-FG02-96ER40963 and by National Energy Research Scientific Computing Center

10:30AM JK.00007 Application of the coherent state formalism to multiply excited states, M.A. CAPRIO, Yale University — Results are obtained allowing the coherent state formalism for algebraic models to be applied to states possessing an arbitrarily large number of intrinsic excitation quanta. A general procedure is presented for evaluation of the matrix element of an arbitrary \(n\)-body operator between coherent states constructed from multiple orthogonal coherent boson creation operators. The results may be applied to a variety of algebraic models. Supported by the US DOE under grant DE-FG02-91ER40068.

Thursday, September 22, 2005 9:00AM - 11:45AM — Session JL DNP JPS: Applications of Nuclear Physics Ritz-Carlton Hotel Oahu
9:00AM JL.00001 Examples for low energy nuclear physics simulations using GEANT4. L. ERIKSON, K. CHIPS, U. GREEFE, F. SARAZIN, Colorado School of Mines, Golden, CO, USA, J. BLACKMON, Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN, USA — General purpose software libraries such as the latest version of the Geometry and Tracking toolkit (GEANT4) continue to gain favor in the physics community. The advancements offered in GEANT4 are considerable but utilization isn’t trivial. One possible approach is to extend GEANT4 with a flexible software package designed to simulate and analyze commonly used detectors in this field. Such a package could be used with a number of projects allowing for greater focus on physics and software development. This talk describes the use of such a library to study a variety of applications, including: a cosmic ray veto, experiments with radioactive nuclear beams, and a neutrino detector.

9:15AM JL.00002 Geant4-based Simulation of Cosmic Ray Shower Development in the Earth’s Atmosphere. XIAOCHUN HE, HAKMANA SANJEEWA, CHRISTOPHER CLEVEN, Georgia State University — Geant simulation package has been widely used for decades in high energy nuclear and particle physics experiment for studying detector performance. The newest version of this simulation toolkit, Geant4, is constructed with object oriented technology and implemented in C++. Its application areas now extend to medical, accelerator and space physics studies. We report here our implementation of Geant4 simulation for studying cosmic ray shower development in the atmosphere with a realistic geomagnetic field and air density distribution. This study will provide significant detailed information about secondary cosmic ray shower particles and their distributions as a function of the altitude, the geomagnetic locations and the air density variations. The simulated results are important for understanding the measurement of primary cosmic ray spectra.

9:30AM JL.00003 Initial search for triggered energy release from $^{177m}$Lu. JAMES CARROLL, Youngstown State University — Nuclear isomers like $^{178m}$Hf and $^{180m}$Ta store large energy densities for long times and most often release that energy via beta, gamma or electron capture decay. These qualities have led to suggestions that isomers could serve in a wide variety of applications and, of course, such metastable states provide a fertile basis for studies of nuclear-reactor mechanisms. The demonstration that real photons could induce, or trigger, the depopulation of $^{180m}$Ta has provided a first step in understanding the underlying physics. Likewise, the failed search for low-energy triggering of $^{178m}$Hf has emphasized the need to connect the body of level data to investigations of energy-release mechanisms. This talk will discuss, in this context, initial tests of triggering of the 160-day isomer of $^{177m}$Lu by real photons.

9:45AM JL.00004 The Effect of X-Rays on the Strategic Defense Initiative (SDI) and the Resulting Government Changes. THOMAS A. BOSTER, American Physical Society — Strong and intense monochromatic x-ray emission lines were found experimentally in the mid to late 1970’s. 1-4 These findings resulted in the theoretical search for an x-ray laser system. These proposed systems for a “Star Wars” approach were made known to the highest levels of the United States Government. 5 Details will be discussed and examples given.

5 Personal communication from Dr. Edward Teller.

10:00AM JL.00005 Real-time Measurements of Carbon Partitioning in Plants Using $^{11}$CO$_2$. M.R. KISER, C.R. HOWELL, A.S. CROWELL, Duke University Physics Department and TUNL, C.D. REID, Duke University Biology Department — Understanding the effects that increased levels of atmospheric carbon dioxide (CO$_2$) can have on plants is of global importance. Of particular concern is the effect on crop yield and plant growth, as well as the potential of long-term carbon sequestration via natural processes. To better understand plant response to increased CO$_2$ levels, we use a short half-life radioisotope labelling process to trace the dynamics of carbon allocation and translocation within the plant. Using the positron-emitter carbon-11, which is produced at Triangle Universities Nuclear Laboratory via the reaction $^{14}$N(p, $\alpha$) $^{11}$C, we are able to introduce $^{11}$CO$_2$ to plants grown at current and projected CO$_2$ concentrations at the Duke University Phytotron. Positron emission imaging techniques are then used to trace the transport and distribution of carbon throughout the plant. Results from collimated, single-detector measurements and a low spatial resolution (~1cm) planar positron emission imager will be presented, as well as plans for $^{15}$N studies and the construction of a high spatial resolution (~3mm) planar imager.

10:15AM JL.00006 Modeling neutron reactions on actinides. MARK CHADWICK, PHILIP YOUNG, ROBERT MACFARLANE, TOSHIHIKO KAWANO, PATRICK TALOU, LOS ALAMOS NATIONAL LABORATORY TEAM — I will describe statistical model calculations of neutron reactions on isotopes of uranium, plutonium, and americium. This work uses Hauser-Feshbach, direct, preequilibrium, and fission theories to calculate neutron cross sections from 1 keV to 20 MeV. A particular challenge is the prediction of cross sections such as fission, capture, and (n,2n) for unstable target nuclei few measurements have been made. I will describe how systematical properties of reactions on isotope chains helps constrain predictions for such nuclei. I will also describe integral simulation comparisons to measurements made at LANL critical assembly facility, that provide an important validation of these results. The new cross sections are the basis of a new ENDF/B-VII cross section library that will be released by the US nuclear data community at the end of 2005. These data are valuable for use in radiation transport simulations in a number of applications, including stockpile stewardship, advanced fuel cycles, and nonproliferation.

10:30AM JL.00007 High Resolution Measurement of Atmospheric Radiation During Thunderstorms. MIHO ISHIKAGI, MARK GREENFIELD, MIKE KUBO, International Christian University, KAZUHISA KUMORA, Kanazawa University, PHYSICS-CHEMISTRY-ICU COLLABORATION, LLRL TATSUNOKUCHI COLLABORATION — Atmospheric $\gamma$ radiation was continuously observed in Utsunomiya and Shishiku highland, Japan, both of which have frequent seasonal lightning. Using a Ge detector, this observation ranging from 100 keV to 3000 keV was aimed at examining the characteristic $\gamma$ rays from atmospheric radioisotopes and 511 keV annihilation $\gamma$ rays with higher resolution during thunderstorms. Previous work proposed that excess $\gamma$ rays might be from radioisotopes such as $^{39}$Cl or $^{38}$Cl produced via nuclear reactions on atmospheric elements from bombardment of energetic protons or photons inside thunderclouds. Although these gamma ray energies have not yet been observed, the number of 511 keV annihilation $\gamma$ rays was slightly more than that observed during storms without lightning. Anomalous increases in the ratio of $^{214}$Bi to $^{214}$Pb (radon progeny) had also been observed during thunderstorms. Studies using an air filter near the Ge detector, increasing the observable volume of air exposed during thunderstorms, are in progress in order to elucidate the cause of this lightning enhanced radiation.

10:45AM JL.00008 Atmospheric γ Radiation Associated with Lightning1, MARK GREENFIELD, MIHO ISHIKAKI, MIKE KUBO, International Christian University, KAZUHISA KOMURA, Kanazawa University, GEOFF AUSTIN, DAVID KROFCHUCK, Univ. of Auckland, MARGARET PEACE, PAUL BARKER, University of Auckland, PAUL RUSHER, WILLIAM COTTRILL, Florida State University — Increases in atmospheric γ ray rates, GRR, during thunderstorms have been observed in Mitaka, Utsunomiya and Sishiku, Japan. Increased GRR associated with lightning persisted for a few hours and subsequently decayed with τ1/2=50 min. In the summer of 2003 a Ge detector with 2 keV resolution positioned near the rocket launch site at the lightning research center in Starke, Fla, USA was used to observe increases in integrated GRR following five rocket triggers up to five times per-trigrer background which subsequently decayed with about τ1/2=50 min. Recent data from Japan presented in the previous paper as well as data from Auckland, New Zealand, using high resolution Ge detectors, verify the previously observed correlations of GRR with precipitation, but additional gamma rays following lightning strikes, with energies other than those from anomalous increases in radon progeny and positrons, have yet to be observed.

1Supported by the NNSA under the Stewardship Science Academic Alliances Program through DOE Research grant #DE-FG03-02NA00057.E

11:00AM JL.00009 Neutron-Induced Partial Gamma-Ray Cross-Section Measurements on Uranium Using a Monoenergetic and Pulsed Beam at TUNL1, A. HUTCHESON, A.S. CROWELL, B. FALLIN, C.R. HOWELL, J. KELLEY, M. KISER, A.P. TONCHEV, W. TORNOW, TUNL, R.S. PEDRONI, NC A&T State University, G.J. WEISSEL, Penn State Altoona, J.A. BECKER, D. DASHDOR, R.A. MACRI, LLNL, N. FOTIADES, R.O. NELSON,LANL — An experimental program is being carried out at TUNL to study (n,2n) excitation functions on actinide nuclci using monoenergetic neutrons with the goal of improving the partial cross-section data for the NNSA Stockpile Stewardship Program. Measurements have been performed on 235,238U targets in the TUNL shielded neutron source area using a pulsed neutron beam with incident neutron energies between 5 and 18 MeV. The resultant emitted gamma rays are measured using different types of HPGe detectors. More than thirty (n,n’) and (n,2n) partial cross-sections have been measured in this energy range, and experimental results will be compared with the Hauser-Feshbach model. A more in-depth explanation of the experimental techniques and analysis will be presented.

1Supported by the NNSA under the Stewardship Science Academic Alliances Program through DOE Research grant #DE-FG03-02NA00057.E

11:15AM JL.00010 Nuclear Interaction Cross Sections for NASA’s New Vision, RAM TRIPATHI, NASA Langley Research Center, J. W. WILSON, NASA Langley Research Center — NASA has a new vision for space exploration in the 21st Century encompassing a broad range of human and robotic missions including missions to Moon, Mars and beyond. As a result, there is a focus on long duration space missions. Protection from the hazards of severe space radiation in deep space long duration is of paramount importance for the new vision. Accurate risk assessments critically depend on the accuracy of the input nuclear cross sections of the interaction of ions with materials, electronics and tissues. A huge amount of essential experimental information for all the ions in space, across the periodic table, for a wide range of energies of several (up to a Trillion) orders of magnitude are needed for the radiation protection engineering for space missions that is simply not available (due to the high costs) and probably never will be. Therefore, there is a compelling need to develop reliable accurate models of nuclear reactions and structures that form the basic input ingredients. State-of-the-art nuclear cross sections models have been developed at the NASA Langley Research Center. However a considerable number of interaction methodologies need to be developed to alleviate the situation.

11:30AM JL.00011 An Outreach Initiative to Improve High School Physics1, NOUREDINE ZETTILI, Department of Physical & Earth Science, Jacksonville State University, Jacksonville, AL 36265 — We want to discuss our outreach initiative at Jacksonville State University designed to help improve the teaching of physics at a number of high schools in Northeast Alabama. This initiative is part of Project IMPACTSEED (Improving Physics And Chemistry Teaching in Secondary Education), a No-Child Left Behind grant funded by the Alabama Commission on Higher Education. This project is motivated by a major pressing local need: A large number of high school physics teachers teach out of field. IMPACTSEED is designed to achieve a double aim: (a) to make physics and chemistry understandable and fun for hands-on, inquiry-based setting; (b) to overcome the fear-factor for physics and chemistry among students. Through a two-week long summer institute, a series of weekend workshops designed to help bring technology into physics classrooms, and onsite support, we have been providing year-round support to the physics/chemistry teachers in this area. IMPACTSEED aims at providing our students with a physics/chemistry education that enjoys a great deal of continuity and consistency from high school to college.

1Supported by the Alabama Commission on Higher Education.

Thursday, September 22, 2005 2:00PM - 5:00PM — Session KA DNP JPS: QCD Beyond Three Quarks Ritz-Carlton Hotel Salon 4

2:00PM KA.00001 Experimental status of the pentaquark searches, TAKASHI NAKANO, RCNP, Osaka University — Since the LEPS at SPring-8 collaboration reported the first evidence for the G+ which has a quark configuration of wudd, extensive experimental efforts have been made to confirm the existence of the G+ and other pentaquarks. In my talk, I will report on the experimental evidences and counter evidences for the pentaquarks. Results from recent dedicated experiments will be extensively covered.

2:45PM KA.00002 Determination of nuclear parton distribution functions and their uncertainties, SHUNZO KUMANO, KEK — Data of nuclear structure function F2 and Drell-Yan cross-section ratios are analyzed for obtaining nuclear parton distribution functions, and their uncertainties are estimated by the Hessian method. Valence-quark distributions are determined well by the F2 data in the large-x region. Their small-x behavior is constrained by baryon-number and charge conservations. Antiquark distributions are determined in the small-x region (x<0.01) by the F2 data and in the region x>0.1 by the Drell-Yan data; however, their nuclear modifications are not obvious in the large-x region. Current data are not enough to determine nucleon gluon distribution because they have large uncertainties in the whole-x region. A useful code could be obtained from our web site for calculating nuclear parton distribution functions.

3:30PM KA.00003 The Search for Color Transparency - A Color Coherence Effects in Nuclear Physics, DIPANGKAR DUTTA, Duke University/TUNL — Mapping the transition of the strong interaction from the hadronic degrees of freedom to the partonic degrees of freedom of quantum chromodynamics (QCD), is an important goal in intermediate energy nuclear and particle physics. The need for such a mapping arises from the fact that at low energies the nucleon-meson picture is very successful in describing the overall features of the strong interaction, while at high energies perturbative QCD (pQCD) with its quark-gluon degrees of freedom allows extremely precise description of the interaction. Unfortunately, there is no clear understanding of how these two regimes are connected. One of the popular approaches used to study the transition between these two regions involves searching for the onset of various phenomena which are naturally predicted in pQCD. One such phenomena is Color Transparency (CT), which refers to the suppression of final (and initial) state interactions of hadrons with the nuclear medium in exclusive processes at high momentum transfers. I will review the status of the experimental search for CT covering experiments spanning over a decade. I will also show preliminary results from a few recently completed experiments at Jefferson Lab (JLab) and talk about future experiments being planned at JLab following the proposed upgrade to 12 GeV. This work is supported by the U.S. Department of Energy under contract number DE-FG02-03ER41231.
4:15PM KA.00004 Hadronization within the Nuclear Environment, EDWARD R. KINNEY*1, University of Colorado at Boulder — Details of the hadronization process remain difficult to probe. Experimentally one can only detect the fully formed hadron. Studies of parton fragmentation from high energy collisions are explained by semi-empirical models, but are typically insensitive to details of the formation process. By studying the fragmentation process within the nuclear medium, one can hope to explore the time-development of the hadronic state, that is, the dynamics of confinement. Recent high-energy experiments at RHIC have provided new measurements of fragmentation within both cold and hot partonic matter. Since the properties of the hot matter produced in these collisions may reflect the underlying nuclear structure, the modification of hadronization in cold nuclear matter, and at the same time, the B-factors are determining the basic fragmentation functions to an unprecedented precision. Semi-inclusive deep inelastic scattering of leptons from nuclei provides a unique window on the hadronization process in cold nuclear matter since the momentum of the initially struck parton is experimentally determined; in addition, initial state hadronic effects are largely suppressed. The influence of the nuclear medium on the production of hadrons has been recently studied in the Hermes experiment at DESY in semi-inclusive deep-inelastic scattering of 27.6 GeV positrons off deuterium, helium, neon, nitrogen and krypton targets. Differential multiplicities for the heavier nuclei relative to deuterium have been determined for $\pi^+$, $\pi^0$, $K^+$, $K^-$, $p$ and $\bar{p}$, as a function of the virtual photon energy $\nu$, the fraction $z$ of the energy transferred to the hadron, the hadron transverse momentum squared, $p_T^2$, and the four-momentum squared of the virtual photon, $-Q^2$. New measurements of two-hadron attenuation will also be presented. Strong nuclear effects are seen, which depend also on hadron identity and nuclear size. Results will be compared to predictions of theoretical models which seek to explain hadron formation within the nuclear medium, and compared with recent results from RHIC.

*1Supported in part by US Dept. of Energy Contract DE-FG02-04ER41301.

Thursday, September 22, 2005 2:00PM - 5:00PM – Session KB DNP JPS: Mini-symposium on Low Energy Tests of the Standard Model and Low Energy Searches for New Physics III Ritz-Carlton Hotel Salon 3

2:00PM KB.00001 Weak Interaction Parameters from Superallowed Beta Decay, J.C. HARDY, Texas A&M University — A critical survey of world data on superallowed beta decay, which closed in late 2004, has confirmed two tenets of the Conserved Vector Current hypothesis with improved precision: a) $G_{V}$ is demonstrated to be constant to three parts in $10^4$; and b) the induced scalar current is limited to $f_{S} < 0.0013$ in electron rest-mass units. An improved value is also obtained for the up-down quark-mixing element, $V_{ud}$, of the Cabibbo-Kobayashi-Maskawa (CKM) matrix. This is a key result for testing CKM unitarity and probing the possible existence of right-hand currents. The precision obtained for the parameters extracted from superallowed decays is currently limited by the small theoretical correction terms applied to the data. One can test the terms that are nuclear-structure dependent experimentally by determining their detailed effectiveness in removing the nucleus-to-nucleus variations in the measured $ft$ values. This is the focus of modern experiments, which aim to improve the precision of known $ft$ values or to extend measurements to new cases with large predicted corrections. The results included in the survey strongly support the calculated corrections terms but a new measurement of the $46^\circ$ decay energy by Savard et al. (Phys. Rev. Lett., to be published) does raise some interesting questions. In collaboration with I.S. Towner, Cyclotron Institute, Texas A&M University, WINTER, Physics Department, University of California, Berkeley and the Lawrence Berkeley National Laboratory, S.J. ASZTALOS, J.T. BURKE, Lawrence Livermore National Laboratory, J.P. GREENE, N.D. SCIELZO, Argonne National Laboratory — We report a new measurement of the strength of the superallowed Fermi branch in $1^+$ -decay of $^{10}$C. The experiment was done at the LBNL 88-inch cyclotron using eighty-three GAMMASPHERE germanium detectors. This measurement is similar to an earlier experiment performed at GAMMASPHERE but with a significantly higher statistical precision. Precise knowledge of this branching ratio is necessary to compute the superallowed Fermi $ft$-value which in turn gives the weak vector coupling constant and the u to d element of the Cabibbo-Kobayashi-Maskawa quark mixing matrix.

2:30PM KB.00002 Progress towards Precision Measurement of the Neutron Lifetime using Magnetically Trapped Ultracold Neutrons (UCN), L. YANG, J.M. DOYLE, Harvard University, F.H. DUBOSE, E. ROBBKINA, R. GOLUM, C.M. O’SHAUGHNESSY, G.L. PALMOUST, P.-N. SEO, P.R. HUFFMAN, North Carolina State University, K.J. COAKLEY, H.P. MUMM, A.K. THOMPSON, G.L. YANG, NIST, S.K. LAMOREAUX, LANL — Measuring the neutron lifetime using magnetically trapped ultracold neutrons promises to improve the current experimental limit at least by an order of magnitude. Such a trap can be loaded through inelastic scattering of 0.89 nm neutrons with phonons in superfluid Helium-4. Trapped neutrons are detected when they beta decay; energetic decay electrons ionize helium atoms in the superfluid with losses. Our recent measurement is limited by statistics to 40 seconds. We are currently upgrading our experiment with a larger and deeper magnetic trap. The new apparatus will trap 20 times more neutrons than the previous one, making it possible to reduce the statistical error to below 1 s. Recent experimental data, corrections. The results included in the survey strongly support the calculated corrections terms but a new measurement of the $46^\circ$ decay energy by Savard et al. (Phys. Rev. Lett., to be published) does raise some interesting questions. In collaboration with I.S. Towner, Cyclotron Institute, Texas A&M University, WINTER, Physics Department, University of California, Berkeley and the Lawrence Berkeley National Laboratory, S.J. ASZTALOS, J.T. BURKE, Lawrence Livermore National Laboratory, J.P. GREENE, N.D. SCIELZO, Argonne National Laboratory — We report a new measurement of the strength of the superallowed Fermi branch in $1^+$ -decay of $^{10}$C. The experiment was done at the LBNL 88-inch cyclotron using eighty-three GAMMASPHERE germanium detectors. This measurement is similar to an earlier experiment performed at GAMMASPHERE but with a significantly higher statistical precision. Precise knowledge of this branching ratio is necessary to compute the superallowed Fermi $ft$-value which in turn gives the weak vector coupling constant and the u to d element of the Cabibbo-Kobayashi-Maskawa quark mixing matrix.

2:45PM KB.00003 A New Measurement of the Strength of the Superalloowed Fermi Branch in the Beta Decay of $^{10}$C with GAMMASPHERE!, B.K. FUJIKAWA, T.I. BANKS, S.J. FREEDMAN, P.A. VETTER, W.T. WINTER, Physics Department, University of California, Berkeley and the Lawrence Berkeley National Laboratory, S.J. ASZTALOS, J.T. BURKE, Lawrence Livermore National Laboratory, J.P. GREENE, N.D. SCIELZO, Argonne National Laboratory — We report a new measurement of the strength of the superallowed $0^+ \rightarrow 0^+$ transition in the $\beta$-decay of $^{10}$C. The experiment was done at the LBNL 88-inch cyclotron using eighty-three GAMMASPHERE germanium detectors. This measurement is similar to an earlier experiment performed at GAMMASPHERE but with a significantly higher statistical precision. Precise knowledge of this branching ratio is necessary to compute the superallowed Fermi $ft$-value which in turn gives the weak vector coupling constant and the u to d element of the Cabibbo-Kobayashi-Maskawa quark mixing matrix.


3:00PM KB.00004 Beta decays in mass 8 system and test of conserved vector current hypothesis, T. SUMIKAMA, RIKEN, T. NAGATOMO, M. OGURA, T. IWAKOSHI, Y. NAKASHIMA, H. FUJIIWARA, K. MATSUTA, Osaka University, T. MINAMISONO, Fukui University of Technology, M. FUKUDA, M. MIHARA, Osaka University, K. MINAMISONO, Michigan State University, T. YAMAGUCHI, Saitama University — We observed the alignment correlation terms in the $\beta$-ray angular distribution for $^{6}$Li and $^{8}$B. The alignment correlation terms are useful probes to test the conserved vector current (CVC) hypothesis or the G-parity conservation in the $\beta$-decay process. The experiment was performed using the Van de Graaff accelerator at Osaka University. The pure nuclear-spin alignments were successfully produced by applying the $\beta$-NMR techniques and the alignment correlation terms were extracted from the $\beta$-ray angular distribution as a function of the $\beta$-ray energy. Under the assumption of the G-parity conservation, not only the weak magnetism (WM) but also the second-forbidden matrix element ($M_{2}$) of the vector current was obtained both from the present alignment correlation terms and the previous $\beta$-n angular correlation terms. The WM and $M_{2}$ are related by the CVC hypothesis to the M1 and E2 analog $\gamma$-decays from the isobaric analog state of $^{8}$Be. It is found that the $M_{2}$ is inconsistent with the previously observed $\gamma$-decay.
3:15PM KB.00005 \(\gamma\)-rays following the \(\beta\)-decay of \(^{62}\)Ga and the strength of the superallowed transition. J.R. LESLIE, I.S. TOWNER, Queen’s University, C. ANDREOU, P.E. GARRETT, B.H. HYLAND, A.A. PHILLIPS, M.A. SCHUMAKER, C.E. SVENSSON, J.J. VALIENTE-DOBIN, University of Guelph, A. ANDREYEV, G.C. BALL, P. BricaULT, M. DOMBSKY, G. HACKMAN, D. MELCONIAN, A.C. MORTON, C.J. PEARSON, TRIUMF, D. CROSS, Simon Fraser University, J.A. BECKER, LLNL — As part of an ongoing study of superallowed \(\beta\)-decay at TRIUMF, we have measured the intensity and energy of \(\gamma\) rays following the \(\beta\)-decay of \(^{62}\)Ga. During a beam on period of 10 s., a total of approximately \(3 \times 10^{15}\) atoms of \(^{62}\)Ga, from the Resonant Laser Ionisation Source at the ISAC facility, was implanted into a collector tape at the centre of the SCEPTAR/8\(\pi\) arrays. Before and after the beam on period, 2 s. of data were taken to assess backgrounds and the build up of long-lived activities. After each counting cycle the tape was moved in order to transport the implanted atoms to a shielded location. Substantial reduction in the Bremstrahlung induced background were achieved by vetoing events in which the \(\beta\)-rays and \(\gamma\)-rays were observed in corresponding detectors. Singles \(\beta\) and coincident \(\beta-\gamma\) events were recorded. The intensities of \(\beta\)-rays feeding of low lying states in \(^{62}\)Zn and a \(\gamma\)-decay scheme of \(^{62}\)Zn are proposed. The data are compared to shell model predictions of energies and transition strengths. Predictions of charge dependent effects are tested against the deduced superallowed transition probability.

3:30PM KB.00006 Precise Half Life Measurement for the Superallowed \(\beta^+\) Emitter \(^{34}\)Ar. V.E. IACOB, J.C. HARDY, C.A. GAGLIARDI, V.E. MAYS, N. NICA, G. TABACARU, L. TRACHE, R.E. TRIBBLE, Cyclotron Institute, Texas A&M University, College Station, TX 77843 — The half-life of the superallowed \(\beta^+\) emitter \(^{34}\)Ar was measured as part of our program to test the Standard Model via the unitarity of the CKM matrix, which requires 0.1% precision or better. A 25-1 MeV \(^{35}\)Cl beam from the Texas A&M cyclotron initiated the \(^{1}\)H\(^{(35}\)Cl, \(p\)\(^{34}\)Ar\) reaction, with recoils then passing through the MARS recoil separator. After being degraded, \(^{34}\)Ar ions were implanted as a 99.7% pure source in the tape of a fast transport system. After a short collect time (0.7 s or 1.0 s), the beam was turned off and the implanted source moved in 175 ms to the center of a shielded 4\(\pi\) proportional gas counter. Decay positrons were then multi-scaled for 12 s. The cycle was repeated until more than half a billion combined \(^{34}\)Ar and \(^{34}\)Cl decay events had been recorded. Critical detection parameters were changed periodically to expose any possible systematic effects; none were found. The extraction of a precise half-life for \(^{34}\)Ar presents a special challenge as its daughter \(^{34}\)Cl is itself \(\beta^+\) unstable with a half-life only 1.8-times longer. This result in an observed spectrum that is almost indistinguishable from pure \(^{34}\)Cl decay. A special method was developed to extract a precise half-life for the shorter-lived component in such a decay curve. Our preliminary result for the half-life of \(^{34}\)Ar is 843.8(7) ms.

3:45PM KB.00007 Neutrinoless double beta decay and lepton flavor violation. VINCENZO CIRIGLIANO, ANDRIY KURYLOV, MICHAEL RAMSEY-MUSOLF, PETR VOGEL, California Institute of Technology — We point out that extensions of the Standard Model with low scale (\(\sim\) TeV) lepton number violation (LNV) generally lead to a pattern of lepton flavor violation (LFV) experimentally distinguishable from the one implied by models with GUT scale LNV. As a consequence, muon LFV processes provide a powerful diagnostic tool to determine whether or not the effective neutrino mass can be deduced from the rate of neutrinoless double beta decay. We discuss the role of \(\mu \rightarrow e\gamma\) and \(\mu \rightarrow e\) conversion in nuclei, which will be studied with high sensitivity in forthcoming experiments.

4:00PM KB.00008 Double beta decay of \(^{48}\)Ca in CANDLES III - Construction and first run - . KAYOKO ICHIHARA, Graduate School of Science, Osaka University, TADAFUMI KISHIMOTO, IZUMI OGAWA, RYUTA HAZAMA, SEI YOSHIDA, SAIRO UMEMURA, YOSHIYUKI HIRANO, CANDLES COLLABORATION — Experiments of neutrino oscillation show that neutrinos have mass. The absolute mass scale and Majorana nature of neutrino are of current interests. The measurement of neutrino-less double beta decay can establish the Majorana nature of neutrino and is the realistic experiment to measure the effective mass in the range of meV, so far. We have been studying double beta decay of \(^{48}\)Ca. The highest Q-value of \(^{48}\)Ca among double beta decay nuclei makes it possible to realize background free measurement. CANDLES (CAlium fluoride for the study of Neutrino and Dark matter by Low Energy Spectrometer) system was proposed, in order to achieve the sensitivity of order of meV neutrino mass. In this system, CaF\(_2\) crystals are immersed in liquid scintillator. We started studying of neutrino-less double beta decay by using CANDLES III that consists of 60 undoped CaF\(_2\) crystals with total mass of 191kg. The present status of construction and performance of CANDLES III in the first run will be reported.

4:15PM KB.00009 Double beta decay of \(^{48}\)Ca in CANDLES III - development of the calibration system- . YOSHIYUKI HIRANO, Graduate School of Science, Osaka University, TADAFUMI KISHIMOTO, IZUMI OGAWA, RYUTA HAZAMA, SEI YOSHIDA, SAIRO UMEMURA, KAYOKO ICHIHARA, CANDLES COLLABORATION — We have been studying double beta decay of \(^{48}\)Ca. The observation of neutrino-less double beta decay is important since it establishes lepton number non-conservation and the Majorana nature of neutrinos. The detector system CANDLES were developed for the study of neutrino-less double beta decay. We are now constructing CANDLES III, which consists of 40 large PMTs and 60 undoped CaF\(_2\) crystals immersed in a liquid scintillator acts as an active veto. And the detector has to be in low background environment because double beta decay is quite rare event. The Q-value (4.27MeV) of \(^{48}\)Ca is the highest among the double beta nuclei. Therefore, the least background rate is expected because the Q-value is higher than the natural gamma ray energy. With regarding to the energy calibration, there are no commercially available sources with gamma ray energy around the Q-value. Consequently, we use sum energy (4.11MeV) of 1.36 MeV and 2.75 MeV emitted from \(^{226}\)Ra, which is activated by neutron source. According to a simulation, it is applicable for CANDLES by making use of the 4 pi active shield. I will report CANDLES and it’s calibration system.

4:30PM KB.00010 Studies of radon nuclear polarization and relaxation1. SARAH NUSS-WARREN, ERIC TARDIFF, CASEY SCHNIEDER-MIZELL, TIM CHUPP, University of Michigan FOCUS Center, JOHN BEHR, MATTHEW PEARSON, TRIUMF, NORBERT PIETRALLA, GEORGI RAINOVSKI, GENE SPROUSE, Nuclear Structure Lab, SUNY Stony Brook — In preparation for electric dipole moment (EDM) measurements with octupole deformed \(^{225}\)Rn, a radon source has been developed at the Stony Brook Nuclear Structure Lab, and studies of radon polarization and relaxation are underway. The \(^{209}\)Rn (29 m) is produced from the decay of \(^{209}\)Fr (50 s) produced by \(^{197}\)Au\(^{(16}\)O,4n) at about 100 MeV beam energy. The \(^{209}\)Fr ionizes at the surface of the heated gold target, is accelerated to 5 keV and implanted in a zirconium foil. To release the radon, the foil is heated. The radon is frozen into a valved measurement cell to which\(N_2\) buffer gas is added. The radon is polarized by spin exchange with optically pumped Rb vapor and nuclear orientation is detected by observing anisotopy of \(^{209}\)At gamma rays populated by beta-decay/electron capture. The EDM measurements require free precession with coherence times of order 100 seconds, which are expected to be limited by wall relaxation in the measurement cell. Spin exchange parameters and wall relaxation will be studied with varying temperatures, wall coatings, and buffer gas compositions.

1Supported by DOE, NSF, UM FOCUS Center, NSERC
II. Final results for Super-Kamiokande—I as well as preliminary results for Super-Kamiokande—II are presented and perspectives for Super-Kamiokande—III

It is found that several SME parameter combinations that reproduce the LSND signal, including combinations with and without sidereal variations. Using the maximum likelihood method, coupled SME parameter values are extracted and the scale of Lorentz and CPT violation for LSND is determined to be of order $10^{-22}$GeV. A maximal mixing of the MSW within the stellar medium results in higher energy electron neutrinos ($E > 1$ GeV) that are detectable by a lead based detector.

1 This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. W-31-109-ENG-38.
4:00PM KC.00008 KamLAND: Studying Neutrino Oscillation with Reactors , MICHAL PATRICK DECOWSKI, UC Berkeley, KAMLAND COLLABORATION — Since the 1950's physicists have been using nuclear reactors to study the properties of anti-neutrinos. In 1956, one of the first such experiments, at the Savannah River Reactor Plant, proved the existence of anti-neutrinos. The original experiment was located only a few meters away from the reactor core, the source of the anti-neutrinos. In the years since, reactor neutrino experiments have steadily increased their baselines, with the goal to test and ultimately establish neutrino disappearance. That goal was reached in 2002, when KamLAND, a one kiloton liquid scintillator detector phase II, reported evidence for neutrino disappearance. The Kamioka monitoring collaboration (KAMLAND) has been an active member of the reactor antineutrino experiments since 1993. KamLAND's experimental goal is to provide a high-precision measurement of the reactor antineutrino flux and the associated power output, which are relevant to many energy and environmental applications. In this talk, I will present the status of the SNO Collaboration for the SNO Collaboration. 

4:15PM KC.00009 Solar Neutrino Measurements from the Sudbury Neutrino Observatory , AKSEL HALLIN1, Queen’s University, SUDBURY NEUTRONIQUO OBSERVATORY COLLABORATION — The Sudbury Neutrino Observatory (SNO) is a heavy water Cerenkov detector, designed to measure both the electron and total active neutrino flux coming from the sun. The experiment has three phases, which differ in the technique by which neutrinos generated by the neutrino-deuterium reactions in the Earth’s interior are captured. Earth composition models assume 16 TW radiogenic power from the decay of 238U and 232Th, approximately half of the total measured heat generation rate from the Earth, and that this can be directly verified by the detector at the Earth’s surface. The measurement of radiogenic contribution is incomplete without precise understanding of neutrino oscillation from decades of neutrino oscillation experiments, including the KamLAND reactor neutrino observation. In this talk, the results from a search for geoneutrinos are shown.

4:30PM KC.00010 MiniBooNE Neutrino Oscillations Search , ION STANCU, University of Alabama, Tuscaloosa — The MiniBooNE experiment at the Fermi National Accelerator Laboratory has been designed to confirm or dismiss the LSND neutrino oscillations result. The experiment has been taking data since August 2000 and has collected 5.5e+20 protons on target to date. This talk will focus on the current status of the neutrino oscillations search.

4:45PM KC.00011 Geoneutrino Detection in KamLAND , ITARU SHIMIZU, Tohoku University, for the KamLAND Collaboration — KamLAND has the sensitivity enough to measure geologically produced antineutrinos. That gives us new tools to investigate the Earth’s interior. Earth composition models assume 16 TW radiogenic power from the decay of 238U and 232Th, approximately half of the total measured heat generation rate from the Earth, and that this can be directly verified by the detector at the Earth’s surface. The measurement of radiogenic contribution is incomplete without precise understanding of neutrino oscillation from decades of neutrino oscillation experiments, including the KamLAND reactor neutrino observation. In this talk, the results from a search for geoneutrinos are shown.

Thursday, September 22, 2005 2:00PM - 5:00PM –
Session KD DNP JPS: Mini-symposium on New Technology in Gamma Ray Detection Ritz-Carlton Hotel Salon 1

2:00PM KD.00001 Overview of gamma ray tracking , I-YANG LEE, Lawrence Berkeley National Laboratory — Gamma ray energy tracking is a new concept for a detector array with unprecedented capabilities. In this type of detector, the position and energy of individual interactions of all the gamma rays are identified, and the scattering sequences of the gamma rays are reconstructed. Such an array will give high peak efficiency, peak-to-background ratio, and position resolution. A number tracking detector projects have been started recently in US, Japan, Canada and Europe. In this talk I will present physics opportunities provided by tracking detectors, and review the recent progress of the construction projects, including the production and testing of segmented detector, the use of digital electronics for signal processing, results from an in-beam experiments, and design efforts for various subsystems.

2:30PM KD.00002 A digital signal decomposition algorithm for GRETINA1 , DAVID RADFORD, Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA — Energy-tracking arrays such as GRETINA and AGATA will be the next generation of detector systems for in-beam gamma-ray spectroscopy. They depend on digital pulse processing to extract the positions and energies of multiple interactions in segmented high-purity Ge detectors. This processing makes use of digitized signals both from the hit segments themselves, and the induced image charges in neighboring segments. The complex algorithms involved make this process the major computational bottleneck for these detectors, requiring a computer farm at least of the order of 100 high-speed processors. For GRETINA, candidate algorithms for signal decomposition include Adaptive Grid Search, Singular Value Decomposition, and Sequential Quadratic Programming. Current work on the development of the algorithm, and verification of its efficacy and resolution, will be described.

2:45PM KD.00003 Gamma-Ray detector Array with Position and Energy sensitivity (GRAPE) , E. IDEGUCHI, S. SHIMOURA, M. NIKIURA, M. TAMAKI, H. IWASAKI, H. SAKAI, CNS, The University of Tokyo, T. FUKUCHI, Rikkyo University, H. BABA, M. KUROKAWA, S. MICHIIMA, RIKEN, S. OTA, Kyoto University — We have constructed a Ge detector array, GRAPE, for high-resolution in-beam gamma-ray spectroscopy using RI beams. In order to correct for the Doppler broadening effect from the moving gamma-ray emitters, the array was designed to have position sensitivities in the Ge crystal. The total array consists of 18 detectors and each of which contains two Ge planar crystals with effective radius of 3 cm and thickness of 2 cm. One side of crystal has 3 x 3 segmented electrodes. The planar structure and the segmented electrodes enable us to extract the position information based on a pulse-shape analysis. The resolution of less than 1% for v/c = 0.3 can be achieved after Doppler shift correction. Total efficiency of 5% for 1 MeV gamma ray is expected. First-phase electronics using conventional analog techniques for pulse shape analysis has been completed. Overall performance of the system with the first-phase electronics was evaluated in the physics experiments using RI beams. As a second phase data acquisition, a system for pulse shape sampling using flash ADC was tested. R&D of pulse shape analysis based on an artificial neural network algorithm was initiated by using the digital pulse-shape data. We will present current status of GRAPE.

3:00PM KD.00004 Sub-segment position measurement in 32-fold segmented high-purity germanium detectors , D.-C. DINCA, C.M. CAMPBELL, J.M. COOK, T. GLASMACHER, Department of Physics and Astronomy and National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824, USA — Sub-segment position resolution of gamma-ray interactions has been demonstrated for the cylindrically-symmetric 32-fold segmented HPGe detectors of the NSCL/MSU Segmented Germanium Array (§CfA) using digital electronics. Flash ADCs sampled waveforms at 100 MHz to measure both real and induced charges from the outer contact segments of a §CfA detector. To bypass issues with computation and bandwidth, integral quantities based on short (1-2 μsec) waveform samples were used. Analysis of induced charges on segments neighboring those with real charge deposition allowed for sub-segment position resolution along both the crystal’s linear axis and the azimuthal angle. Multiple measures of the real charge signal’s rise time allowed for determination of the radial position.
3:15 PM KD.00005 Progress and Physics with planar germanium strip detectors (HpGeDSSDs) — C.J. (Kim) LISTER, Physics Division, Argonne National Laboratory — Large area position-sensitive planar germanium wafers potentially offer great promise in many areas of science, including, excellent imaging capability, medical and biological imaging, and Cerenkov imaging for high-energy astronomy and homeland security. However, implementation of large, efficient, robust and high resolution counters has proven difficult and progress has been slow. I will report on several projects which have demonstrated the practical applications of these devices, including performing excellent Doppler correction, measuring linear polarizations, and the construction of a digital Compton camera. I will also review the considerable technical improvements being undertaken that will lead to improved devices in the future which will be more useful for widespread use.

3:30 PM KD.00006 TIGRESS—The TRIUMF-ISAC Gamma-Ray Escape-Suppressed Spectrometer — PAUL GARRETT, C. ANDREOU, D. BANDYOPADHYAY, P. FINLAY, G.F. GRINIER, B. HYLAND, A.A. PHILLIPS, M.A. SCHUMAKER, E.C. SVENSSON, University of Guelph, A.A. ANDREYEV, G.C. BALL, R.S. CHAKRAWARTHY, H. COWAN, G. HACKMAN, A.C. MORTON, C.J. PEARSON, M.B. SMITH, TRIUMF, R.A.E. AUSTIN, Saint Mary’s University, A.J. BOSTON, H.C. CRAGGS, University of Liverpool, T.E. DRAKE, University of Toronto, J.P. MARTIN, Université de Montréal, F. SARAZIN, Colorado School of Mines, J.C. WADDINGTON, L.M. WATTERS, McMaster University — TIGRESS is a next generation γ-ray spectrometer designed to be used at the TRIUMF radioactive beam facilities ISAC and ISAC-II. It will consist of 12 Clover-geometry HPGe detectors that are supported by BGO-CsI anticoincidence shields. The outer contacts of each crystal is 8-fold segmented, including 2 longitudinal segments. The γ-ray interaction location is determined through analysis of pulse waveforms from the 32 outer contacts. Detailed coincidence scans of the prototype detector deduced a mean position sensitivity of 0.44 mm for single-interactions. Delivery of the production modules, with a slightly modified segmentation scheme, has commenced, and an in-beam test of the detector performance is currently scheduled for late July. Results of the characterization of the new production modules, including a preliminary analysis of the ability to determine interaction locations in-beam, along with the performance of the suppression shield, will be presented.

3:45 PM KD.00007 Tests of the GREITNA triple cluster prototype detector1 — A.O. MACCHIAVELLI, R.M. CLARK, M. CROMAZ, M.A. DELEPLANQUE, M. DESCROISY, S. ETTENAUER, P. FALLOON, I.Y. LEE, E. RODRIGUEZ-VIEITEZ, F.S. STEPHENS, D. WARD, M. WIEDEKING, Lawrence Berkeley National Laboratory — The GREITNA prototype detector consists of a cluster of 3 tapered regular hexagonal HPGe crystals in a common cryostat. The Ge crystals have 36 segments (6 longitudinal x 6 transverse) and a central contact for a total of 111 contacts, each instrumented with a cold FET stage. A number of tests have been performed and will be the subject of this presentation. Acceptance tests include: mechanical dimensions, liquid nitrogen holding time, and energy resolution. Characterization tests, which are of importance for the performance in tracking arrays, were carried out and include “singles” and “coincident” scans for pulse shape analysis (Cs source). Preliminary results of an in-beam experiment using the reaction 12C(82Se,4n)39Zr at 285MeV establish a position resolution (RMS) of ∼ 2 µm.

1Supported by DOE under contract DOE-AC03-76SF00098

4:00 PM KD.00008 Development and demonstration of gamma-ray tracking based Compton imaging instruments1 — KAI VETTER, Glen T. Seaborg Institute, Lawrence Livermore National Laboratory — Recent developments in the manufacture of large and two-dimensionally segmented, high-resolution Si and Ge detectors along with advances in digital signal processing enable the implementation of compact and highly sensitive Compton imaging spectrometers. A hybrid system of low-Z material such as Si and a higher Z material such as Ge promises a high Compton imaging sensitivity between 100keV and several MeV, which is an energy range of significant interest for applications in homeland security, astrophysics, and nuclear medicine. The excellent energy resolution of the low-temperature detectors being used provide isotope identification and spectroscopic background suppression as well as excellent imaging capabilities. The imaging capability of a Compton camera not only enables to localize and image radioactive sources but also enables to potentially increase the sensitivity in finding weak or hidden gamma-ray sources by increasing the signal-to-background ratio in the image.

1The work was performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

4:15 PM KD.00009 Development of Position Sensitive Germanium Detector, TOMONORI FUKUCHI, Rikkyo University, SUSUMU SHIMOURA, Center for Nuclear Study (CNS), University of Tokyo, EIJI IDEGUCHI, CNS, MEIKO KUKOWA, HIDETADA BABA, RIKEN, SHINSUKE OTA, Kyoto University, MITSURO TAMAKI, MEGUMI NIIKURA, CNS — We have been developing the Gamma-Ray detector Array with Position and Energy sensitivity (GRAPE) which is mainly used for detecting γ-rays from fast moving nucleons. The GRAPE consists of 18 high-purity Germanium (Ge) detectors. All detectors have two planar-type Ge crystals (60 mm in diameter and 20 mm thickness). The electrode of Ge crystal is segmented in 3 × 3. The pulse shape analysis enables three-dimensional position determination. We applied an artificial neural network (ANN) algorithm for pulse shape analysis. An advantage of the ANN technique is rapid pattern recognition with an appropriate training in advance. We aim to extract the interacting position of γ-rays online using the ANN algorithm. In order to make a supervisory data set for training the ANN, the pulse shape sampling was performed using the flashADCs with a sampling rate of 100 MHz. However, the pulse shape sampling takes long time, therefore a fast sampling method using the Compton scattering kinematics was proposed. This method cope with the individual character of each detector and the change of a detector response as years go by.

4:30 PM KD.00010 Multitracer imaging by strip germanium telescope — SHINJI MOTOMURA, SHUICHIC ENOMOTO, HIROMITSU HABA, YASUYUKI GONO, YASUSHIGE YANO, Accelerator Research Program, RIKEN, Saitama 351-0198, Japan — In multitracer method, a tracer reagent that contains multiple nuclides (multitracer) is injected into samples such as plants or small animals. In order to examine the possibility of nondestructive imaging of the multitracer, we have fabricated a Compton camera including two double-sided strip germanium detectors. For image reconstruction, we are currently trying a linear model between the real image and an intermediate image referred to as a simple back-projection (SBP) image. When the number of the detected events is sufficiently large, the SBP image is regarded as being constructed by convoluting a blur and the real image. If we assume that the blur is invariant anywhere in the real image space, the real image can be reconstructed analytically. However, the blur varies depending on the position in the real image space. Therefore, the analytical method is relevant only in a restricted region. Thus we have implemented an iterative method in which the variation in the blur can be incorporated. In this talk the imaging performance of the current model of the Compton camera will be presented.

4:45 PM KD.00011 R&D of a low background cosmic hard X-ray Imager with a Position Sensitive PMT and an Active Coded Mask — SHINYA HIRAKURI, MOTOHIDE KOKUBUN, TAKESHI ITOH, TAKAYUKI YANAGIDA, RYOHEI MIYAWAKI, University of Tokyo, KAZUO MAKISHIMA, University of Tokyo / RIKEN, SHIN KUBO, Clear-Pulse Co., Ltd, TSUNEIO HONDA, Ohyo Koken Kogyo Co., Ltd — A new low background cosmic hard X-ray imager has been developed, based on the Hard X-Ray Detector (HXD-II) which is one of the scientific payloads on board the 5th Japanese cosmic X-ray satellite Astro-E2 (scheduled for launch in June 2005). The imager incorporates one of the basic design concepts of the HXD-II, namely tight well-shaped active shields. Furthermore, it has an imaging capability (unlike the HXD-II), using a coded mask and a position-sensitive main detector. In order to reduce the background, the mask is made of active elements. First we made a prototype model, of which the main detector consists of a 64ch flat panel position sensitive photomultiplier (FP-PMT:HAMAMATU H8500) and an 8 × 8 array of CsI scintillator cubes of 5 mm in dimension each. Reading out its 64 anode outputs by 8 of resister chains, we achieved a spatial resolution of about 5 mm (digitized). To improve the spatial resolution, we have adopted 256cch FP-PMT (HAMAMATU H9500) and are developing a readout unit which can acquire its 256 anode outputs, pixel by pixel, using analog LSI chips (ideas VA32 TA32).
2:00PM KE.00001 Systematic analyses on Hydrogen isotopes by using an extended AMD approach, SHIGEYOSHI AOYAMA, Niigata University — It is a very challenging problem to make an extremely neutron-excess system which corresponds to the neutron star. Very recently, an experimental evidence of $^1$H was reported as an enhancement of the cross section above the $t+n+n+n+n$ threshold [1]. Its neutron ratio to the proton is the largest value of six. It is very interesting to investigate pair correlations between the nucleons and the cluster-like correlation of triton in such an almost neutron matter like nuclei only with one proton. Recently, we propose a new extended AMD approach [2]. In this approach, AMD combined with the generator coordinate method is extended with the idea of the stochastic variational method (SVM). We call this new approach AMD triple-S (Superposition of Selected Snapshots) [2]. By using AMD triple-S, we will give the calculated results and discussions for H-isotopes with the core-nucleus plus the valence neutrons model, and discuss the nucleon correlations in the extremely neutron-rich nuclei. Work done in collaboration with Naoyuki Itagaki, Niigata University.


2:30PM KE.00002 0+ states of the $^{12}$C nucleus: Faddeev calculation in configurations space. BRANISLAV VLAHOVIC, IGOR FILIKHIN, VLADIMIR SUSLOV, North Carolina Central University, Durham, NC 27707, US — The a-cluster model and Faddeev equations in configuration space are applied to study the $^{12}$C nucleus. The model includes the Ali-Bodmer nuclear potential [1], attractive three-body potential, and takes into account the Coulomb interaction. An s-wave model [2] is adapted and parameters of the three-body potential are chosen to describe the first two 0+, 11/2- levels of $^{12}$C. The value of the range parameter of the potential is adjusted to reproduce the position of diffraction minimum for the elastic form factor of 12C. The model assumes a strong distortion of the charge density of a clusters inside the $^{12}$C nucleus. It was found that the most probable configuration of the a-clusters in the 0+ state corresponds to an equilateral triangle with sides as large as 3.5 fm and in the 11/2- state to a linear chain with the values of 2.9 fm and 13.1 fm for each link. Having calculated low-lying levels of $^{12}$C, we found that the contributions of higher partial waves of nuclear interaction to the energy of 3α-system are unnaturally large and some states turn to be overbound. Upon applying the method [3] based on the Padé approximation we got satisfactory description for the 0+ and 11/2- states [4]. Additional 0+ broad resonance obtained in [3] was not found. 1. S. Ali, A. R. Bodmer, Nucl. Phys. 80, 99 (1966). 2. Z. Papp, et al. Few-Body Systems 30, 31 (2001). 3. C. Kurokawa and K. Kato, Phys. Rev. C76, 021301-1 (2005). 4. http://www.tunl.duke.edu/nucldata/.

4:25PM KE.00003 Formation and Dissolution of the $^{16}$O Cluster Core and their relation to the Motion of the Valance Neutrons in Ne Isotopes. MASAKI KIMURA — Focusing on the a clustering, the level structure of Ne isotopes will be discussed. The theoretical framework of the antisymmetrized molecular dynamics (AMD) plus generator coordinate method with the Gogny D1S interaction. The formation and dissolution of $^{16}$O cluster core which strongly depend on the motion of the valence neutrons are discussed. The presence of the molecular-orbital bands in $^{20}$Ne and $^{22}$Ne which have an $^{16}$O cluster core surrounded by valence neutrons occupying the molecular-orbitals are presented. The $^{16}$O molecular bands of $^{22}$Ne is also discussed. The presence of the molecule-like structure which has an a+$^{16}$O cluster core plus valence neutrons are suggested throughout the Ne isotopes and their properties and dependence on the neutron number will be discussed.

3:00PM KE.00004 Staying probability of valence neutron around each clusters. TOORU YOSHIDA, NABUKI ITAGAKI, University of Tokyo, TAKAHARU OTSUKA, University of Tokyo, CNS, RIKEN — It has been shown that there are many states in light nuclei which have alpha cluster components, for example in Be isotopes and in C isotopes. If we calculate larger system like Ne isotopes, shell model configuration also become more important. Therefore we need to superpose many Antisymmetrized Molecular Dynamics (AMD) basis to describe such nuclei. The AMD Triple-S is such kind of method. Based on this method we confirm existence of alpha correlation. We take variety of configuration of the core, for example very developed cluster structure. We see to what extent these configurations are realized. Afterward we restrict the distance between clusters and show the change of single-particle motion of valence neutrons as a function of the distance. Here we take notice of staying probability of valence neutrons around each clusters of the core. We define the probability properly, and we can see that the behavior is quite different between in positive parity states and in negative parity states.

3:15PM KE.00005 Coexistence of Cluster Structure and Mean-field-type Structure in Medium-weight Nuclei. YASUTAKA TANIGUCHI, Department of Physics, Kyoto University, Japan, MASAAKI KIMURA, Yukawa Institute for Theoretical Physics, Kyoto University, Japan, HISASHI HORIZUCHI, Department of Physics, Kyoto University, Japan — We have studied the coexistence of cluster structure and mean-field-type structure in $^{40}$Ca using Antisymmetrized Molecular Dynamics (AMD) with a new type of constraint of clustering for AMD, which we proposed. The constraint is for the distance between the centers of masses of groups of nucleons corresponded to clusters. By energy variation with the constraint and quadrupole deformation constraint, we calculated wave functions of many kinds of cluster structure, for example $^{40}$Ar-$^{16}$O cluster core which strongly depend on the motion of the valence neutrons. We also discuss negative parity states of $^{40}$Ca.

3:30PM KE.00006 A new stochastic method superposing multiple Slater determinants. KAZUHIRO YABANA, SATOSHI SHINOHARA, HIROFUMI OHTA, TAKASHI NAKATSUKASA, Institute of Physics, Univ. of Tsukuba — In light nuclei, there appear various excited states with different correlation structures. We propose a new stochastic method of superposing multiple Slater determinants which we wish to describe these excited states in a unified way. Our method starts with preparing a lot of Slater determinants whose single-particle orbitals are randomly distributed Gaussian wave packets. They are cooled towards a mean-field solution by the imaginary-time method. In the course of cooling, a lot of shoulder states as well as local minima appear. They exhibit various correlation structures with clustering, deformations, and so on. We store these configurations and then make a configuration mixing calculation with projections with respect to the parity and the angular momentum. To examine usefulness and feasibility of the method, we made a calculation for an $^{16}$O nucleus employing a simple BKN interaction. We find that our method provides convergent solutions for a few excited states for each spin and parity.

3:45PM KE.00007 Projected Skyrme Hartree-Fock approach to structure of Mg isotopes. HIROFUMI OHTA, Institute of Physics, University of Tsukuba, TAKASHI NAKATSUKASA, KAZUHIRO YABANA. Center for Computational Sciences, University of Tsukuba — Skyrme-Hartree-Fock (SHF) calculations using the Cartesian mesh representation have been successful to describe ground-state properties of nuclei for a wide mass region. We extend the method so as to describe odd-parity excited configurations in the variation after parity projection (H. Ohta, K. Yabana, and T. Nakatsukasa, Phys. Rev. C 70 (2004) 014301). The angular momentum projection in the full three-dimensional Euler angles has been performed for the first time in realistic calculations. Now the method is being applied to Mg isotopes. The ground-state correlation energies, excitation spectra, transition amplitudes, etc. are calculated. The calculation shows an importance of symmetry restoration.
4:00PM KE.00008 Cluster structure and excitation strengths in $^{11}$B , T. KAWABATA, Center for Nuclear Study, University of Tokyo, H. AKIMUNE, Department of Physics, Konan University, Y. FUJITA, Department of Physics, Osaka University, H. FUJITA, M. FUJIIWARA, K. HARA, K. HATANAKA, M. ITOH, K. NAKANISHI, Y. SHIMBARA, A. TAMII, M. UCHIDA, H.P. YOSHIDA, M. YOSOI, Research Center for Nuclear Physics, Osaka University, Y. KANADA-E'NYO, Yukawa Institute for Theoretical Physics, Kyoto University, S. KISHI, H. SAKAGUCHI, S. TERASHIMA, Y. YASUDA, Department of Physics, Kyoto University, T. WAKASA, Department of Physics, Kyushu University — The $^{11}$B($^3$He,$t$), $^{11}$B($d,d'$) and $^{11}$B($p,p'$) reactions were measured at forward scattering including zero degrees. Combining the experimental results from the three reactions, the isoscalar and isovector spin-flip M1 strengths were successfully determined for the low-lying states in $^{11}$B. The proton and neutron quadrupole excitation strengths were also deduced from the $^{11}$B($d,d'$) results and previously measured $\gamma$ decay widths. The obtained excitation strengths were compared with the shell model and antisymmetrized molecular dynamics calculations. It was found that the $3/2^+$ state in $^{11}$B has a cluster structure. This state is considered to be an analog state of the $0^+_2$ state in $^{12}$C which is a well-known $3\alpha$ cluster state. For the $5/2^+$ state, both the shell-model-like and cluster-like structures were observed.

4:15PM KE.00009 Cluster structure in A=6 nuclei above particle decay threshold , HIDETOSHI AKIMUNE, TAMIO YAMAGATA, MAKI KINOSHITA, MASHAISHA OHTA, AYAKO SHIKAIWA, HIROAKI UTSONOMIYA, Department of Physics, Konan University, KAOORU HARA, Japan Nuclear-Cycle Development Institute, SHINTARO NAKAYAMA, KENICHI FUSHIMI, KAYOKO ICHIHARA, YUKO MATSU, MAMORU FUJWARA, NAONOBU HASHIMOTO, KEIGO KAWASE, KOUSUKE NAKANISHI, MASARU YOSOI, MASAYOSHI TANAKA, Koke Tokiwa College, MARK GREENFIELD, International Christian University, KEIGO HARA, KEK — The di-trinucleon clustering-resonance of $^3$He+$^5$Be in $^9$Be and $t$-$t$ in $^9$He were studied via the $^6$Li($^3$He,$t$) and $^6$Li($^3$He,$^3$He) reactions at the incident energies of 150 MeV/A and 65 MeV/A. A new resonance in $^6$Be and $^6$He was found at around $E_x=18$ MeV in the binary decay channel of $^3$He+$^5$Be and $t$-$t$. The angular correlations measured for $^3$He and $t$ particles in the binary decay show a dominant contribution from the multipolarity of an $L=1$.

Department of Physics, Konan University

2RCNP, Osaka University

4:30PM KE.00010 Alpha Condensed Structure of Resonance States of $^{12}$C , YASURO FUNAKI, Dept. of Phys., Kyoto Univ., AKIHIRO TOHSAKI, Suzuki Corporation, HISASHI HIRUCHI, Dept. of Phys., Kyoto Univ., PETER SCHUCK, IPN, Orsay, GERO ROEPKE, FB Phys., Rostock University — The states with $J^P=0^+\, 2^+, 3^+$ and $4^+$ of $^{12}$C with excitation energies less than about 15 MeV are investigated with the alpha-condensed model — a combination of $\alpha$-gas and $\alpha$-cluster with spatial deformation and by comparing the method of ACCC (an approximate calculation of the condensation constant) which is necessary for a proper treatment of resonance states. The calculated energy and width of the recently observed $2^+_3$ state are found to be well reproduced. The obtained $2^+_3$ wave function has a large overlap with a single condensate wave function of $3\alpha$ gas-like structure. The density distribution is shown to be almost the same as that of the $0^+_2$ state that is regarded as a $3\alpha$ Bose- condensed state, if the energy of the $2^+_3$ state is scaled down to the same value as the one of the $0^+_2$ state. Furthermore, the kinetic energy, nuclear interaction energy, and Coulomb interaction energy of the calculated $2^+_3$ state are shown to be very similar to those of the $0^+_2$ state. It is also shown that the $2^+_3$ state is obtained by promoting just one alpha cluster out of the condensate of the $0^+_2$ state into a $D$-wave. We conclude that the $2^+_3$ state has a structure similar to the $0^+_2$ state of Bose-condensate character with a dilute $3\alpha$ gas-like structure.[1]


Thursday, September 22, 2005 2:00PM - 4:15PM — Session Kyoto JPS: Nuclear Density and Excitations Ritz-Carlton Hotel Plantation 3

2:00PM KE.00001 Neutron density distributions in $^{40,42,44,46}$Ca observed via polarized proton elastic scattering at 300 MeV , JUZO ZENIHIRO, HARUTAKA SAKAGUCHI, TETSUYA MURAKAMI, YUUSUKE YASUDA, SATORU TERAISHIMA, YOHEI NAKATSUGAWA, Department of Physics, Kyoto University, TOSHIYU SUDA, HIROYUKI TAKEDA, TETSUYA OHNISHI, The Institute of Physical and Chemical Research (RIKEN), MASARU YOSOI, Research Center for Nuclear Physics (RCNP), Osaka University, MASATOSHI ITOH, Department of Physics, Tohoku University, MAKOTO UCHIDA, Department of Physics, Tohoku University, TAKATOSHI YOSHIDA, Research and Development Center for Higher Education, Kyoto University — Systematic behaviors of neutron densities in $^{40,42,44,46}$Ca have been deduced via proton elastic scattering at $E_p = 300$ MeV. For the deduction we used RIA with medium modified $NN$ interaction and realistic point proton density distributions unfolded from charge distributions. In this work we have taken into account the effect of intrinsic charge distribution inside neutron as well as that of proton, which makes the proton distributions more gradual and the RMS radius larger than the case only proton charge assumed. We have observed that the isotope shift of neutron density distributions due to the occupation of the 1$f_{7/2}$ neutron orbit is seen around 3 fm and $^{40}$Ca has a large neutron skin of ~0.2 fm compared with the other three Ca isotopes.

2:15PM KE.00002 Systematic change of neutron density distribution in tin isotopes deduced from elastic proton scattering at 295 MeV , SATORU TERAISHIMA, HARUTAKA SAKAGUCHI, YUUSUKE YASUDA, Kyoto University, HIROYUKI TAKEDA, RIKEN, MASARU YOSOI, Research Center for Nuclear Physics, Osaka University, TAKATSUGU ISHIKAWA, Laboratory of Nuclear Science, Tohoku University, MASATOSHI ITOH, Tohoku University, TAKATOSHI KAWABATA, Center for Nuclear Study, University of Tokyo, MAKOTO UCHIDA, Tokyo Institute of Technology, TESUO NORO, HIDETOMO YOSHIDA, TAKASHI ISHIDA, SHUN ASAJI, TAKAHISA YONEMURA, Kyushu University — Cross sections and analyzing powers of proton elastic scattering off $^{116,118,120,122,124}$Sn at 295 MeV have been measured up to about 3.5 fm$^{-1}$ in momentum transfer to deduce a systematic change of neutron density distribution. We have used effective interaction to explain proton elastic scattering off $^{12}$N nuclei whose density distribution are well known. For the analysis, we have used the relativistic impulse approximation with relativistic Love-Franey interaction which was tuned by using medium effect. Then, we have applied the elastic proton scattering to deduce the neutron density distribution of tin isotopes. The result of our analysis shows a clear systematic behavior which shows a gradual filling in the $3s_{1/2}$ neutron single particle orbit.

2:30PM KE.00003 Nuclear Structure Physics at HI-β: Parity Assignments to Levels in $^{138}$Ba , A. TONCHEV, W. TORNOW, Duke U. and TUNL, C. ANGELL, M. BOSWELL, H. KAROWOSKI, UNC and TUNL, J. KELLEY, NCSU and TUNL, J. LI, S. MIKHAILOV, Y. WU, Duke U. and DFELL, N. TSONEV, U. of Giessen — Nuclear resonance fluorescence measurements have been performed on the $^{138}$Ba nucleus using polarized $\gamma$-ray beams at the High-Intensity $\gamma$ Source (HI-β). Taking advantage of the monenergetic and pulsed HI-β beams, negative parity assignment were made to seven $J=1$ states in the energy region of 1 MeV below the neutron separation threshold. These low-lying dipole excitations have been related to the so-called pygmy dipole resonance. Further analysis will determine the branching ratio of these E1 dipole states and their partial cross sections. In addition to the decays to the ground states, we have observed for the first time strong gamma transitions from the first three $2^+$ states in $^{138}$Ba to the ground state.

This work was supported in part by USDOE Grants No. DE-FG02-97ER41033, DE-FG02-97ER41041 and DE-FG02-97ER41042.
3:15PM KF.00006 Nuclear Resonances at Zero and Finite Temperatures. NGUYEN DINH DANG, Cyclotron Center RIKEN 2-1 Hiroswa - Wakyo city - 351-0198 Saitama, Japan — The theoretical description of nuclear resonances at zero and finite temperatures is discussed, which includes 1 – giant dipole resonances (GDR) in highly excited nuclei, including both low and high regions of temperature; 2 – multiple-phonon resonances in relativistic Coulomb excitations; 3 – pygmy dipole resonances in neutron rich nuclei within the framework of the phonon-damping model [1]. The theoretical predictions are put in direct comparison with the most recent experimental data. In particular, in (1) the role of thermal pairing in the description of the GDR widths at low temperature T=1 MeV in the latest experiment using O-17 scattered inelastically on Sn-120 will be discussed in detail [2]. In (2) the emphasis will be put on the double GDR in Xe-136 and Pb-208, where a large enhancement is seen as compared to the prediction by the independent phonon picture; in (3) the effect of pairing and coupling of GDR to complicated configurations on the pygmy dipole resonances is also analyzed.

References:

3:30PM KF.00007 Giant resonance study by $^6$Li scattering. X. CHEN, Y.-W. LUI, H.L. CLARK, Y. TOKIMOTO, D.H. YOUNGBLOOD, Texas A&M University — The compressibility of nuclear matter $K_{nm}$ can be related to the energies of the isoscalar giant monopole resonance (ISGMR). Essentially all of the precise data on the ISGMR energies have been obtained with inelastic $\alpha$ scattering. Dennenert et al [1] have successfully studied the ISGMR in $^{28}$Mg with $^6$Li scattering, and we have chosen to study $^6$Li scattering as an alternate means of obtaining these energies. A $^6$Li target might also be viable for studying the ISGMR in unstable nuclei. A beam of 240 MeV $^6$Li ions from the Texas A&M University K500 superconducting cyclotron bombarded self-supporting target foils of $^{28}$Mg, $^{29}$Si, $^{116}$Sn in the target chamber of the multipole-dipole-multipole (MDM) spectrometer. Elastic scattering from $^{29}$Si $\sim 350$ and inelastic scattering from $^{116}$Sn $\sim 60$ deg were measured. Both Woods-Saxon phenomenological potentials and N-N effective M3Y interaction folded potentials have been used to fit the elastic scattering data from $^{116}$Sn. $^6$Li inelastic scattering to low-lying states and the giant resonance region of $^{116}$Sn was analyzed by both the deformed potential model and folded potential model [1]. H. Dennenert et al, Phys. Rev. C 52, 3195 (1995).

4:00PM KF.00009 The energy and multiplicity correlation of resonances in $^{151,152}$Eu(n,\gamma) reaction$^1$. U. AGVAANULSAN, J. BECKER, R. MACRI, W. PARKER, P. WILK, C.V. WU, R. CLEMENT, L. LUNL, T. BREDEWEG, E. ESCH, J. O'DONNELL, R. REIFARTH, R. RUNDBERG, J. SCHWANTE, J. WOUTERS, J. ULLMANN, D. VIEIRA, J. WILHELMY, LANL, S. SHEETS, D. DASHDORJ, G. MITCHELL, H. NITSCHKE, UC Berkeley, A. ALPRIZAR-VICENTE, R. HATARIK, CO School of Mines — Highly granulated with 160 BaF$_2$ crystals and a 4\pi solid-angle coverage, the state-of-the-art DANCE array at LANSE offers an opportunity to study detailed statistical properties of atomic nuclei. The neutron capture for neutron energies $<1$eV up to 100 keV has been measured for $^{151,152}$Eu targets. Stable Eu isotopes on Be backings were used in this presentation. The resonances in $^{151,152}$Eu are considered. The parameters characterizing most of the resonances were previously known. For each resonance the gamma-ray multiplicity and energy distribution are deduced. The variation from resonance to resonance is investigated. In addition, radiative cascades following the neutron capture are simulated and compared with the experimental results shedding light on the nearly unknown subject of transitions between highly excited states in the compound nucleus.

$^1$Supported by DOE under UC contracts W-7405ENG48 and W-7405-Eng36, and NNSA Academy Alliances grants DE-FG03-03NA00076 and DE-FG03-03NA00075, and DOE grant DE-FG02-97ER414042.
2:00PM KG.00001 PHENIX Measurement of Particle Yields at High pT with Respect to Reaction Plane in Au+Au collisions at \( \sqrt{s} = 200 \text{ GeV} \), DAVID WINTER, Columbia University — One of the most intriguing puzzles in RHIC physics is the origin of the azimuthal anisotropy of particle yields at high pT (> 5 GeV/c). Traditional flow and parton energy loss pictures have failed to describe the magnitude of this anisotropy. Measurement of the azimuthal asymmetry v2 at high pT will shed light on the contributions from flow, recombination, and energy loss, as well as the transition from soft to hard production mechanisms. The PHENIX Run4 dataset provides a powerful opportunity for exploring the angular anisotropy of identified particle yields at high pT. Complementing traditional v2 measurements, we present pi0 and eta yields as a function of angle with reaction plane, up to pT of at least 10 GeV/c. The centrality dependence of the angular anisotropy allows us to probe the density and path-length dependence of the energy loss of hard-scattered partons. We will discuss various mechanisms for particle production in this high pT region.

2:15PM KG.00002 Transverse momentum distributions and string percolation study in p+p, d+Au, and Au+Au at 200 GeV, TERENCE TARNOWSKY, BRIJESH SRIVASTAVA, Purdue University, STAR COLLABORATION — Multiparticle production at high energies is described in terms of color strings stretched between the projectile and target. These color strings hadronize, producing the observed particles. As string density increases, overlap among the strings leads to cluster formation. At some critical density a macroscopic cluster appears, spanning the entire system. This marks the percolation phase transition. Data from pp, d+Au and Au+Au at 200 GeV has been analyzed to experimentally determine the percolation density parameter, \( \rho \). This value is obtained by parameterization of 200 GeV pp data. The resultant particle pt spectrum from pp collisions was fit with a power law. Values of the fit parameters are used in d+Au and Au+Au analysis. For 200 GeV Au+Au collisions, the value of \( \rho \) is determined to lie above the critical percolation threshold. While for 200 GeV d+Au collisions it is below the critical value. This supports the idea of string percolation, which at high enough string density is a possible mechanism to explore the hadronic phase transition to a quark-gluon plasma (QGP).

2:30PM KG.00003 Measurement of D* in Au+Au collisions at \( \sqrt{s} = 200 \text{ GeV} \), AN TAI, UCLA, STAR COLLABORATION — We present the status of the D* analysis in Au+Au collisions at \( \sqrt{s} = 200 \text{ GeV} \). Comparisons with open charm production in d+Au collisions will be made. Implications on nuclear dependence of the charm quark yield and the nuclear modification factor of open charm production at intermediate pT will be discussed.

2:45PM KG.00004 \( R_{CP} \) measurement at forward rapidities with muons from light meson decays in Au+Au collisions at \( \sqrt{s_{NN}} = 200 \text{ GeV} \) in the PHENIX experiment at RHIC, WOOJIN PARK, Korea University, PHENIX COLLABORATION — We study high pT light meson production at forward rapidity as a function of centrality in Au-Au collisions. It is expected that the energy and parton density of the fireball created in Au-Au collisions would be smaller at a larger rapidity, thus reducing the jet quenching effects observed at central rapidity for light mesons. On the other hand, gluon saturation models predict a suppression of particle yields at small x, or at a large rapidity, for a given pT. We perform a quantitative analysis of the nuclear modification factor \( R_{CP} \) for high pT light mesons at forward rapidities in Au+Au collisions at \( \sqrt{s_{NN}} = 200 \text{ GeV} \). Light meson yields are measured in the PHENIX muon spectrometers through their decay muons. The latest results from this analysis will be presented.

3:00PM KG.00005 \( \phi \rightarrow K^+K^- \) meson measurements in d+Au and Au+Au collisions at \( \sqrt{s_{NN}} = 200 \text{ GeV} \), DIPALI PAL, Vanderbilt University, PHENIX COLLABORATION — The \( \phi \) meson is an important probe for studying both medium effects and strangeness production in high energy heavy ion collisions. In order to distinguish between cold and hot nuclear matter effects we compare the \( \phi \) meson yields and line shapes in d+Au and Au+Au collisions at RHIC. The PHENIX experiment has measured the \( \phi \) mesons in the \( K^+K^- \) channel in both Au+Au and d+Au collisions at \( \sqrt{s_{NN}} = 200 \text{ GeV} \) including the data from recent high statistics (~1.5 \times 10^5 events) in the RHIC 2003-4 run. The latest results on the \( \phi \) meson line shapes and yields at different centralities will be discussed.

3:15PM KG.00006 Photoproduction of \( \rho \) mesons in Au+Au Ultra-Peripheral Collisions of \( \sqrt{s_{NN}} = 200 \text{ GeV} \) from STAR, B.A. HAAG, UC Davis, STAR COLLABORATION — Photoproduction between Au+Au ions in Ultra Peripheral Collisions (UPCs) at RHIC generates vector mesons including the \( \rho \) meson. This occurs when a photon from one nucleus fluctuates into a quark-antiquark pair and scatters off the second nucleus which produces a vector meson. The t = pT^2 spectrum for \( \rho \) production, where t is the 4 momentum transfer squared, is sensitive to interference between the two possible production channels: the first nucleus emits a photon which scatters from the second nucleus, or vice versa. In this talk, we will present \( dN/dt \) for \( \rho \) production from the STAR detector at RHIC. Correlations between the degree of interference and the features of the spectrum will be discussed.

3:30PM KG.00007 Measurement of the low mass dielectron continuum in \( \sqrt{s_{NN}} = 200 \text{ GeV} \) Au+Au collisions in the PHENIX Experiment at RHIC, RALF AVERBECK, Stony Brook University, PHENIX COLLABORATION — Electromagnetic probes are ideally suited to investigate hot and dense matter produced in high energy heavy ion collisions. They do not undergo strong interactions and thus probe the full time evolution of the collision. The dielectron continuum is rich in physics. Dalitz decays of light hadrons and direct decays of vector mesons, which might be modified in the medium, and correlated charm decays contribute to the spectrum. Furthermore, exotic states, e.g. quasi-particles predicted to exist in the medium only beyond the phase transition, might leave their footprint in the continuum. Although correlated e^+e^- pairs are rare, the 0.24 nb^{-1} collected by PHENIX for Au+Au collisions at \( \sqrt{s_{NN}} = 200 \text{ GeV} \) in 2004 provides a significant sample to investigate the dilepton continuum. The continuum and its resonances are separated from the combinatorial background via an event mixing technique. Mass spectra are presented and compared with the expectations from decays of hadronic sources.

3:45PM KG.00008 PHENIX Measurement of Azimuthally Sensitive Hanbury Brown-Twiss Interferometry in Au+Au Collisions at \( \sqrt{s_{NN}} = 200 \text{ GeV} \), JASON NEWBY, Lawrence Livermore National Laboratory, PHENIX COLLABORATION — The initial spatial anisotropy of relativistic heavy-ion collisions with finite impact parameter has proven critical in understanding collision medium properties and system evolution. Nevertheless, our theoretical understanding remains incomplete and present hydrodynamic calculations are unable to simultaneously describe the experimentally observed elliptic flow and HBT radii. The Au+Au collisions recorded by the PHENIX experiment during the RHIC year 4 run provide a high statistics dataset to study observable trends in transverse momentum and collision geometry. We present an azimuthally sensitive measurement of the emitting source using Bose-Einstein correlations of identical charged pions. The excellent PHENIX particle identification provides sensitivity of extracted Bertsch-Pratt parameters across a broad range of pair transverse momentum essential for comprehensive evaluation of hydrodynamic calculations. Finally, we discuss promising experimental measurements of Bose-Einstein correlations with respect to the jet axis now possible at RHIC energies.
4:00PM KG.00009 PHENIX Measurement of Charged Kaon Interferometry in Au+Au Collisions at $\sqrt{s_{NN}} = 200$GeV, AKITOMO ENOKIZONO, Lawrence Livermore National Laboratory, PHENIX COLLABORATION — Detailed measurements of the Bose-Einstein correlations (HBT) of charged pions have revealed a fact that at RHIC energies the extents of source size and emission duration of charged pions were unexpectedly small and less changed from AGS energies. One of unresolved problems at RHIC is that such results are hard to be described by hydrodynamics calculations in conjunction with results of the single spectrum and elliptic flow of charged pions. Meanwhile, detailed studies of source sizes and emission durations of different particles are expected to give more insights in the freeze-out dynamics at RHIC. We present a HBT measurement of charged kaons by PHENIX in Au+Au collisions at $\sqrt{s_{NN}} = 200$GeV. A high statistics data set taken during the Year-4 allows us to study the charged kaon source in several pair momentum and centrality regions. Both the recently developed imaging and a traditional HBT analysis schemes are applied to get detailed information of source functions and to compare with those of charged pions. Lastly, we discuss the possibility of measuring the space-time evolution of the source from photon correlations.

4:15PM KG.00010 Methodology and Systematics for electron-hadron Correlations with the PHENIX Experiment at RHIC, JENNIFER KLAY, Lawrence Livermore National Laboratory, PHENIX COLLABORATION — High $p_T$ electron-hadron correlations offer a way to study heavy flavor production in the complicated environment of relativistic heavy ion collisions. Near angle correlations can result from the semi-leptonic decays of D and B mesons whereas the correlation of an electron with an opposite side hadron is sensitive to the back-to-back jet signature of hard-scattered c and b quarks. To extract information about particles containing c- and b-quarks requires corrections for detector systematics as well as detailed understanding of background correlations arising from the anisotropic source, photon conversions and other hadronic decays. This talk will focus on the techniques used to evaluate these contributions to the electron-hadron correlation signals measured by the PHENIX experiment in p+p, d+Au and Au+Au collisions at $\sqrt{s_{NN}}=200$GeV. Prospects for measuring e-h correlations with respect to the reaction plane will also be discussed.

4:30PM KG.00011 PHENIX measurements on High $p_T$ photon-hadron and $\pi^0$-hadron Azimuthal Correlations in $\sqrt{s_{NN}} = 200$ GeV Au+Au Collisions, JIAMIN JIN, Columbia University, PHENIX COLLABORATION — PHENIX has measured direct photon production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Due to the suppression of high-$p_T$ pion production, a large photon excess over meson decay background is seen in central Au+Au collisions at $p_T > 6$GeV/c. This large direct photon signal allows us to use jets tagged by direct photons to probe the dense medium created in ultra-relativistic heavy-ion collisions at RHIC. Since photons interact with the medium much more weakly than hadrons, they will carry roughly the same amount of energy as the scattered quarks, thus providing a better measurement of the energy and direction of the away side jets. We will present the PHENIX results on the measurements of photon-hadron and $n^{l=1}$-hadron azimuthal correlations with the photon or $\pi^0$ momentum above 5 GeV/c. The results will be shown as a function of centrality and associated hadron $p_T$. By comparing the photon-hadron and $n^{l=1}$-hadron correlations, we will discuss the use of these two measurements to perform the first extraction of a direct photon-hadron correlation measurement at RHIC.

4:45PM KG.00012 Strangelet Search at RHIC, AIHONG TANG, STAR Collaboration, AIHONG TANG COLLABORATION — It is demonstrated that strangelet production could be enhanced at forward region due to Pomeron cuttings[1]. We report the results of a strangelet search using a triggered data-set that sampled 60 million central (4%) Au+Au collisions at the top RHIC energy of $\sqrt{s_{NN}} = 200$ GeV in the very forward rapidity region at the STAR detector. Two position sensitive Shower Maximum Detector (SMDs) were installed in the Zero-Degree Calorimeters (ZDCs) at STAR prior to run 2004. The calorimeters are located on both sides of the interaction point along the beam axis downstream of strong magnetic fields which sweep away particles with low rigidity. The ZDC-SMDs provide energy deposition as a function of transverse position in ZDCs. The strangelets, which have very large rigidities reflecting their large mass-to-charge ratios, are expected to produce an energy profile significantly different from neutrons. This is the first effort of strangelet search at RHIC, and also the first search at forward region. [1]M. Bleicher et al., Phys. Rev. Lett. 92 072301 (2004)

5:00PM KG.00013 Preliminary Results on Direct Photon-Photon HBT Measurements in $\sqrt{s_{NN}}=200$ GeV Au+Au Collisions at RHIC, GUOJI LIN, ALEXEI CHIKANIAN, EVAN FINCH, JACK SANDWEISS, HAIBIN ZHANG — Direct photons emitted from the early hot phase of relativistic heavy ion collisions and their HBT correlations are an important signature of the quark gluon plasma and its properties. Despite the large number of decay photons, direct photon HBT correlations were observed at SPS energies[1]. Monte Carlo simulations at RHIC energies also show promising possibilities. In this presentation, we will report the current status on the direct photon HBT measurements in Au+Au collisions at $\sqrt{s_{NN}}=200$ GeV at STAR. Photons have been reconstructed using conversions via $\gamma \rightarrow e^+e^-$ in the STAR Time Projection Chamber (TPC) and energy deposited by photons in the STAR Barrel Electromagnetic Calorimeter (BEMC). Correlations have been extracted using one photon reconstructed from conversions and the other measured with the BEMC. Preliminary results of the two-photon correlation function distributions will be presented. Possible solutions to some difficulties we currently face and future plans will be addressed. [1]M.M Aggarwal et al.,Phys. Rev. Lett. 93.022301(2004).

Thursday, September 22, 2005 2:00PM - 4:15PM
Session KH DNP JPS: Relativistic Heavy Ions: Theory

Ritz-Carlton Hotel Plantation 1

2:00PM KH.00001 From Hard Scattering to Classical Color Fields to Quark Gluon Plasma, JOSEPH KAPISTA, University of Minnesota, RAINER FRIES, YANG LI — We present a new approach to determine the energy-momentum tensor density between two colliding nuclei at very high energies shortly after the collision. Perturbative QCD is used to calculate the first hard scattering between partons in the colliding nuclei. The resulting fluctuation in the local color charge is used as a source for solving the classical equations of motion for the gluon field. This classical field decays into quark gluon plasma. Coherence arguments and energy-momentum conservation, including the decelerating nuclei, lead to constraints on the local energy density and pressure of the plasma phase. Our results can serve as initial conditions for a subsequent hydrodynamic evolution of the system.

2:15PM KH.00002 Charge Transport in High-Energy Hadron Collisions, PAUL STANKUS, Oak Ridge National Laboratory — Precise measurement of net electrical charge density can reveal the transport of quarks in high-energy $p+p$ or $A+A$ collisions. Such measurements could shed interesting light on the “baryon anomaly” observed at RHIC, on the existence of baryon junctions, and on the general questions of initial stopping and transport in hadronic collisions. We will examine what constraints can be placed on charge transport from existing RHIC and ISR data, and discuss possible future high-precision measurements.

2:30PM KH.00003 Quark production in high-energy pA collisions in the Color Glass Condensate framework, HIROTOSUJI FUJIJI, U Tokyo, Komaba, FRANCOIS GELIS, CEA/DSM/SPhT, RAJU VENUGOPALAN, BNL — We present quantitative estimates of heavy flavor production in pA reactions at collider energies in the framework of the color glass condensate. We first quantify the breaking of $k_T$-factorization as a function of the saturation scale, the quark mass and the transverse momentum. Next we evaluate the open charm/bottom cross sections numerically, and study their sensitivity to physical parameters. Our results are compared to the RHIC data for charm production and predictions are made charm and bottom production for the LHC. Finally, we apply our formalism (which includes re-scatterings of the produced quark pairs) to quarkonium production at RHIC and LHC.
2:45PM KH.00004 Proton-Nucleus Scattering in the Color Glass Condensate, KAZUNORI ITAKURA, Institute of Particle and Nuclear Studies, KEK — We present an alternative description of the proton-nucleus collision within the framework of the Color Glass Condensate (CGC). This is based on the eikonal approximation for three valence quarks in a projectile proton which propagate in the strong gauge field created by the target nucleus treated as the CGC. The similar construction was recently done for the C-odd Odderon exchange. This description directly allows us to compute the evolution of the scattering amplitude between a 3-quark state and the CGC. We show the evolution equations in the weak and strong field regimes, and discuss the effects of gluon saturation.

3:00PM KH.00005 Confinement-Deconfinement Phase Transition at nonzero Chemical Potential, ARIEL ZHITNITSKY, UBC — We present arguments suggesting that large size overlapping instantons are the driving mechanism of the confinement-deconfinement phase transition at nonzero chemical potential \( \mu \). The arguments are based on the picture that instantons at very large chemical potential in the weak coupling regime are localized configurations with finite size \( r \sim \mu^{-1} \). At the same time, the same instantons at smaller chemical potential in the strong coupling regime are well represented by the so-called instanton-quarks with fractional topological charge \( 1/N_c \). We estimate the critical chemical potential \( \mu_c(T) \) where this phase transition takes place as a function of temperature in the domain where our approach is justified. In this picture, the long standing problem of the "accidental" coincidence of the chiral and deconfinement phase transitions at nonzero temperature (observed in lattice simulations) is naturally resolved. We also derive results at nonzero isospin chemical potential \( \mu_I \) where direct lattice calculations are possible, and our predictions can be explicitly tested.\(^1\)

3:15PM KH.00006 Quarkonium Spectral Functions at zero and finite temperature, PETER PERTECZKY, BNL, SAUMEN DATTA TEAM, FRITHJOF KARŠCH TEAM, ANTAL JAKOVAC TEAM, KOSTYA PETROV TEAM, ALEXANDER VELYTSKY TEAM — I present calculations of quarkonium spectral functions at zero and finite temperature in lattice QCD. Calculations are performed in quenched approximation using both isotropic and anisotropic lattices. Lattice artifacts and systematic uncertainties are investigated in the zero temperature limit in detailed studies where many data points in the time direction are available. Then finite temperature spectral functions for charmonia and bottomonia spectral functions are presented. It has been found that 1S state charmonia (\( J/\psi \), \( \eta_c \)) can survive in the plasma up to temperatures \( 1.5T_c \) with little in-medium modification, while 1S bottomonia states (\( Y \) and \( \eta_b \)) exist in the plasma up to temperatures \( 4.5T_c \). The 1P states (\( \chi_{c0} \), \( \chi_{b0} \)), on the other hand, dissolve at temperatures of about \( 1.1T_c \).

3:30PM KH.00007 Diquark fragmentation model of baryon production in ultrarelativistic nucleus-nucleus collisions, KOSUKE TERASAKI, TETSUO MATSUI, Institute of Physics, University of Tokyo — Quark recombination model has been proposed to explain anomalous production of baryons with transverse momenta of a few GeV/c observed in Au+Au collisions at RHIC. The model explains the observed enhancement of baryon/meson ratio as well as the quark-number scaling of elliptic flow associated with baryons. The recent RHIC data shows, however, jet-like correlations of associated hadron production, the feature which may be more naturally explained by the quark fragmentation model. In this work, we study a new hybrid mechanism of baryon production which involves (color anti-triplet) di-quark formation by recombination of a pair of thermal quarks and its subsequent fragmentation into a baryon. This model, which we call "diquark fragmentation model," incorporates two desirable features of the recombination model and the quark fragmentation model. Our results show, however, that there is a significant reduction of baryon momentum from that of its parent diquark at the time of the diquark fragmentation, and this leads to a suppression of baryon production at relevant momentum range. We found about 10 - 20% of baryons are still produced at RHIC compared to usual recombination model at the transverse momentum of 2.5 - 4 GeV.

3:45PM KH.00008 Proposal for a High Energy Nuclear Database, DAVID BROWN, Lawrence Livermore National Lab, RAMONA VOGT, Lawrence Berkeley National Lab — We propose to develop a high-energy heavy-ion experimental database and make it accessible to the scientific community through an on-line interface. The database will be searchable and cross-indexed with relevant publications, including published detector descriptions. It should eventually contain all published data from the Bevalac, AGS, SPS and FNAL fixed-target programs to the RHIC and LHC colliders; proton-proton, proton-nucleus to nucleus-nucleus collisions as well as other relevant systems; and all measured observables. Such a database would have tremendous scientific payoff as it makes systematic studies easier and allows simpler benchmarking of theoretical models to a broad range of experiments. Furthermore, there is a growing need for compilations of high-energy nuclear data for applications including stockpile stewardship, technology development for inertial confinement fusion and target and source development for upcoming facilities such as the Next Linear Collider. To enhance the utility of the database, we propose periodic data evaluations and topical reviews.

4:00PM KH.00009 Form-factor dependence of \( B \) absorption cross sections by nucleons, M.A.K. LODHI, RIAN MARSHALL, Texas Tech University, DEPARTMENT OF PHYSICS, TEXAS TECH UNIVERSITY, LUBBOCK TX 79409 TEAM — The cross sections for \( B \) absorption by nucleons are examined using a gauged SU5 hadronic Lagrangian as a meson-baryonic exchange model. Only the charm exchange processes are examined with the assumption that lighter exchange processes dominate. Results are obtained without and with monopole form-factors to account for the hadron structure. Results with form-factors tend towards a range of about 1 to 7 mb near threshold energies.

Thursday, September 22, 2005 2:00PM - 4:30PM — Session KJ DNP JPS: Nuclear Reactions: Heavy Ion Induced Ritz-Carlton Hotel Hawaii

2:00PM KJ.00001 Isovector Quadrupole Resonance observed in the \( ^{60}\text{Ni}(^{13}\text{C},^{13}\text{N})^{60}\text{Co} \) reaction at \( E/A = 100 \) MeV, TAKASHI ICHIHARA, RIKEN, MASAYASU ISHIHARA, RIKEN, HAJIME OHNUMA, Chiba Institute of Technology, TAKASHI NIIZEKI, Tokyo Kasei University, YOSHITERU SATOU, Tokyo Institute of Technology, HIROYUKI OKAMURA, Cyclotron Radio-Isotope Center, Tohoku University, SHIGERU KUBONO, CNS, University of Tokyo, MASAHIKO TANAKA, High Energy Accelerator Research Organization (KEK), YOSHISHI FUCHI, High Energy Accelerator Research Organization (KEK) — The charge-exchange reaction \( ^{60}\text{Ni}(^{13}\text{C},^{13}\text{N})^{60}\text{Co} \) at \( E/A = 100 \) MeV has been studied to locate isovector (\( 2^+ \)) non-spin-flip (\( 2^+ \)) giant resonances. Besides the giant dipole resonance at \( E_x = 8.7 \) MeV, another resonance has been observed at \( E_x = 20 \) MeV with a width of 9 MeV. DWBA analysis on the angular distribution clearly indicated the \( L = 2 \) multipolarity, attributing the \( E_x = 20 \) MeV state to the giant isovector quadrupole resonance. The present analysis further indicates that the observed peak exhausts approximately 50% strength of the isovector \( L=2 \) classical energy-weighted sum rule. The same \( (^{13}\text{C},^{13}\text{N}) \) reactions at \( E/A = 100 \) MeV for other target nuclei will be also presented and discussed. A part of this result can be found at the reference of T. Ichihara et al., Phys. Rev. Lett. 89, 142501 (2002).
2:15PM KJ.00002 α-stripping reactions with light exotic nuclei: \(^{12}\text{C}(^{7}\text{Be}, ^{3}\text{He})^{16}\text{O})\). H. AMRO, F.D. BECCHETTI, H. JIANG, H. GRIFFIN, Y. CHEN, University of Michigan, J.J. KOLATA, B. SKORODUMOV, University of Notre Dame, J.D. HINNEFELD, Indiana University South Bend, G. PEASLEE, Hope College — Considerable experimental and theoretical efforts have been devoted to examine the importance of α-particle clustering in \(p\)-shell and \(sd\)-shell nuclei which is essential for the analysis of the helium- and silicon-burning processes in nuclear astrophysics. α-stripping reactions such as \((^{6}\text{Li}, d)\) and \((^{7}\text{Li}, t)\) were used to probe the α structure of \(^{16}\text{O}\). These studies showed that the \((^{7}\text{Li}, t)\) reaction is significantly more selective than \((^{6}\text{Li}, d)\) reaction. New reaction, \((^{7}\text{Be}, ^{3}\text{He})\) has been studied at \(E(^{7}\text{Be})=34\text{ MeV}\) using the University of Michigan-University of Notre Dame radiactive nuclear beam facility. Angular distributions have been measured for several states in \(^{16}\text{O}\). At this energy, this reaction exhibits a high selectivity for populating α-cluster states in \(^{16}\text{O}\). Furthermore, \(^{7}\text{Be}\)-stripping reaction \((^{7}\text{Be}, \alpha)\) populating several states in \(^{15}\text{O}\), never been reported before for \((^{7}\text{Li}, t)\) or \((^{6}\text{Li}, d)\) reactions, was observed in our data. Experimental and theoretical analysis of this data will be presented.

2:30PM KJ.00003 Production of Very Neutron-rich Nuclei with Low Energy Beam. MASAHIRO NOTANI, K. BAILEY, J. GREENE, D. HENDERSON, R.J. HOLT, R.V.F. JANSSENS, C.L. JIANG, Z.-T. LU, P. MUELLER, T.P. O’CONNOR, R.C. PARDO, K.E. REHM, J.P. SCHIFFER, X. TANG, A.M. PAUL, Hebrew Univ., G.W.F. DRAKE, Univ. of Windsor, L.-B. WANG, Univ. of Illinois — The production cross section of very neutron-rich nuclei, \(^{8}\text{Be}\), has been investigated using multi-nucleon transfer reaction with a \(^{9}\text{Be}\) beam at 14 MeV/nucleon. The cross section data will be used to optimize the produced neutron-rich nuclei beam for the study of nuclear structure. The experiment was performed at ATLAS facility at Argonne, where the \(^{8}\text{Be}\) beam bombarded production targets of \(\text{Be}, \text{BN}, \text{C}\), and \(U\). Particle identification of reaction products was carried out by means of the magnetic split-pole-spectrograph with a focal plane detector that consists of PPAcs and ion chambers. The momentum distribution of \(^{8}\text{Be}\) yield was measured by varying the magnetic field. The angular distribution was measured at \(1\) and \(5\) degrees. The cross section of \(^{8}\text{Be}\) was obtained for integration of the observed yield for each target. The production cross section of the \(^{8}\text{Be}\) \((^{8}\text{Be}, ^{6}\text{He})\) \(X\) reaction is smaller than that of the \(^{238}\text{U}(^{8}\text{Be}, ^{6}\text{He})\) \(X\) by one order of magnitude. In the present talk, we will report details of the experiment and discuss the production mechanism of neutron-rich nuclei with low energy beams.

2:45PM KJ.00004 Scaling of projectile residue yields from peripheral heavy-ion collisions below the Fermi energy. C.A. SOULIOTIS, D.V. SHETTY, A. KEKSIS, M. JANDEL, M. VESELSKY, S.J. YENNELLO, Cyclotron Institute, Texas A&M University — The scaling properties of the yields of isotopically resolved projectile residues from very peripheral collisions of \(^{64}\text{Kr}(25\text{MeV}/\text{nucleon})\) and \(^{64}\text{Ni}(25\text{MeV}/\text{nucleon})\) on \(^{16}\text{O}\) and \(^{124,125}\text{Sn}\) target pairs are investigated. The reactions of \(^{86}\text{Kr}\) were studied with the MARS recoil separator. Their yields and isoscaling properties have already been discussed [1,2]. The reactions of \(^{64}\text{Ni}\) were studied with the Superconducting Solenoid (BigSol) Line. In the present study, special attention is given to neutron-rich projectile fragments produced in peripheral collisions. For these fragments, isoscaling in the usual sense is not observed: e.g. the yield ratios of the isotopes of a given element do not follow an exponential dependence on neutron number. Comparison of the measured yield ratios with model calculations using either a deep-inelastic transfer code (DIT) [3] code or a BNV transport code [4] followed by a deexcitation code seem to reproduce the observed behavior of the measured yield ratios. These comparisons may offer the possibility to extract information on the nuclear symmetry energy (and its density dependence) from the process of peripheral nuclear exchange. [1] G.A. SOULIOTIS et al., Phys. Rev. C 68, 024605 (2003). [2] G.A. SOULIOTIS et al., Phys. Rev. Lett. 91, 022701 (2003). [3] L. Tassan-Got et al., Nucl. Phys. A524, 121 (1991). [4] V. Baran et al., Nucl. Phys. A 730, 329 (2004).

3:00PM KJ.00005 Target effect of fragmentation reactions at intermediate energy. SADAO MOMOTA, YOICHI NOJIRI, Kochi University of Technology, MITSUTAKI KANAZAWA, ATSUSHI KITAGAWA, MITSURU SUDA, MAKOTO SAŠAKI, SHINJI SATO, NIRS — To investigate the production mechanism of projectile-like fragments (PLF’s) at intermediate energies, the momentum distributions of PLF’s produced from \(\text{Ar}\) beam at intermediate energy were measured. The production cross sections were derived by integrating observed momentum distributions. The present result is useful to design experiments, which will be done at new RIB facilities. The measurements were performed by using HIMAC facility at NIRS. The longitudinal and transverse momentum distributions of PLF’s produced in the reactions with \(Z_{P}=18, Z_{T}=6-79\) at \(E/A=290\text{ MeV}\) were measured. In the reaction with heavier targets, the transverse momentum distribution was broader than that measured with lighter targets. This broadening effect is remarkable for heavier PLF’s (\(A>F\)) and negligible for lighter ones. This result implies that the effect of the Coulomb force shrinks caused by the nuclear force in the case of lighter PLF’s. The target effect was found in the production cross sections of PLF’s derived from observed momentum distributions as well. The production mechanism of PLF’s will be discussed based on the present results by comparing with the theoretical results.

3:15PM KJ.00006 Study of Fusion enhancement/hindrance with \(^{132}\text{Sn}\). A.M. VINODKUMAR, W. LOVELAND, D. PETERSON, P. SPRUNGER, Oregon State University, J.F. LIANG, D. SHAPIRA, R.L. VARNER, C.J. GROSS, Oak Ridge National Laboratory, J.J. KOLATA, University of Notre Dame, L. WESTERBERG, Upsala University — One of the interesting aspects of the study of nuclear reactions induced by radioactive ion beams is the possibility of using neutron rich projectiles to synthesize new, neutron rich heavy nuclei. Also, large fusion cross section enhancement has been predicted for fusion reactions with massive neutron rich radioactive nuclei by different authors. This is due to the lowering of the fusion barrier, excitation of the soft dipole modes and lowering of reaction Q values. However, previous experimental data with stable beams indicates fusion hindrance in the case of massive projectiles near the Coulomb barrier. The present study was carried out on ORNL. The coincident fission fragments were detected using 4 Si strip detectors. The time of flight of the beam was measured. The coincidence fission cross section was obtained for integration of the observed yield for each target. The production cross section of the \(^{86}\text{Kr}\) \((^{86}\text{Kr}, ^{92}\text{Zr})\) \(X\) reaction is smaller than that of the \(^{238}\text{U}(^{86}\text{Kr}, ^{92}\text{Zr})\) \(X\) by one order of magnitude. In the present talk, we will report details of the experiment and discuss the production mechanism of neutron-rich nuclei with low energy beams.

3:30PM KJ.00007 Decrease of Coulomb Barrier Height due to Charge Polarization for Cold Fusion Reactions. AKIRA IWAMOTO, TAKATOSHI ICHIKAWA, Japan Atomic Energy Research Institute — We estimate the decrease of Coulomb-barrier height between colliding partners due to static charge polarization in the entrance channel of cold-fusion reactions [1]. Charge displacement between protons and neutrons is modeled as the sum of two components, one is surface-type and the other is volume-type. The strength of both types of polarization is determined by the energy-balance between the decrease of mutual Coulomb energy and the increase of self-energies for both target and projectile. It is shown that the surface-type dominant polarization for light nuclei changes gradually toward comparable surface-and-volume polarization for heavy nuclei, which feature is similar to what was obtained in the study of giant dipole resonance [2]. Although the strength of the induced polarization is not large, the decrease of the Coulomb barrier height amounts to 1 to 2 MeV for typical cold-fusion reactions, which is not negligible in fine tuning of the most-favorable incident energies to synthesize super-heavy elements. [1] Takatoshi Ichikawa and Akira Iwamoto, Phy. Rev. C, in press. [2] W.D. Myers, W.J. Swiatecki, T. Kodama, E.J. El-Jaick and E.R. Hils, Phys. Rev. C 15, 2032 (1977).

3:45PM KJ.00008 Probing fusion barrier distributions with large-angle quasielastic scattering of \(^{48}\text{Ti}, ^{56}\text{Fe}\) and \(^{64}\text{Ni}\) on \(^{208}\text{Pb}\). SHINICHI MITSUOKA, HIROSHI IKEZOE, KATSUHISA NISHIO, KAOORU TSURUTA, Japan Atomic Energy Research Institute, SUN-CHAN JEONG, YUTAKA WATANABE, High Energy Accelerator Research Organization — As a new procedure to extract representations of fusion barrier distributions, it has been proposed to take the first derivative of the ratio of the quasielastic cross section to the Rutherford cross section with respect to the center-of-mass energy. We measured the excitation functions of quasielastic scattering at large-backward angles of 162°, 168° and 172° from \(^{208}\text{Pb}\) target bombarded with heavy-ions of \(^{48}\text{Ti}\), \(^{56}\text{Fe}\) and \(^{64}\text{Ni}\) from the JAERI Tandem-booster accelerator at energies near the Coulomb barrier. The result for quasielastic barrier distributions will be discussed by comparing with couple-channel calculations and data of fusion barrier distribution in the \(^{208}\text{Pb}\) based cold fusion reactions for superheavy element synthesis.
4:00PM KJ.00009 Attempt to confirm superheavy element production in the $^{48}\text{Ca} + ^{238}\text{U}$ reaction, W. LOVELAND, Oregon State University, K.E. GREGORICH, Lawrence Berkeley National Laboratory, D. PETERSON, Argonne National Laboratory, P.M. ZIELINSKI, S.L. NELSON, CH. E. DUELLMANN, C.M. FOLDEN III, D.C. HOFFMAN, G.K. PANG, R. SUDOWE, R.E. WILSON, H. NITSCH, Lawrence Berkeley National Laboratory, Y.H. CHUNG, Hallym University, K. ALEKLETT, Uppsala University, R. EICHLER, S. SOVERNA, Paul Scherrer Institut, J.P. OMTVEDT, University of Oslo, P. SPRUNGER, Oregon State University, J.M. SCHWANTES, Los Alamos National Laboratory — An attempt to confirm production of superheavy elements in the reaction of $^{48}\text{Ca}$ beams with actinide targets has been performed using the $^{238}\text{U}(^{48}\text{Ca},3n)^{283}\text{U}$ reaction. Two $^{48}\text{Ca}$ projectile energies were used, that spanned the energy range where the largest cross sections have been reported for this reaction. No spontaneous fission events were observed. No alpha decay chains consistent with either reported or theoretically predicted element 112 decay properties were observed. The cross section limits reached are significantly smaller than the recently reported cross sections.

4:15PM KJ.00010 Entrance Channel in Heavy-ion Reactions for Superheavy Element Production, TAKATOSHI ICHIKAWA, AKIRA IWAMOTO, Japan Atomic Energy Research Institute, PETER MÖLLER, ARNOLD J. SIERK, Los Alamos National Laboratory — We discuss both cold fusion reactions of the type that lead to the formation of elements with proton number $Z$ from 107 to 113 and hot fusion, that is reactions with deformed actinide targets [1]. In cold fusion with Pb-like targets we show that for reactions eading to the heavier evaporation residues deformation and shell effects lead to a fusion barrier that is more than 10 MeV lower that what is obtained in a standard spherical macroscopic liquid-drop model. Inside touching we calculate the macroscopic-microscopic potential energies of the composite system in a five-dimensional deformation space consisting of about 4 million nuclear shapes. We find that the composite system exhibits a well-established fusion channel in which the initial composite shape closely matches the shape-polarized shapes just outside touching. In hot-fusion reactions that target is deformed and experimental and theoretical considerations indicate that “equatorial” collision are the most likely to lead to evaporation residue formation. Also in this case we show that shape polarization leads to a significant decrease of the equatorial fusion barrier. [1] T. Ichikawa, A. Iwamoto, P. Möller, A. J. Sierk, Phys. Rev. C 71, 044608 (2005).

Thursday, September 22, 2005 2:00PM - 4:00PM – Session KK DNP JPS: Nuclear Theory III Ritz-Carlton Hotel Maui

2:00PM KK.00001 Critical Point Symmetry in A Fermion Monopole and Quadrupole Pairing Model, JOSEPH N. GINOCCHIO, Los Alamos National Laboratory — Recent interest in symmetries at a critical point of phase transitions in nuclei prompts a revisit to the fermion monopole and quadrupole pairing model [1]. This model has an exactly solvable symmetry limit that is transitional between spherical nuclei and gamma unstable deformed nuclei. The eigenenergies, eigenfunctions, pairing strength and quadrupole transition rates in this limit are derived. Comparison with empirical quadrupole transition rates suggests that the Xenon isotopes may have this symmetry [2]. 1. Joseph N. Ginocchio, Ann. Phys. 126, 234 (1980). 2. Joseph N. Ginocchio, Phys. Rev. C (2005).

3Supported by DOE Contract W-7405-ENG-36

2:15PM KK.00002 All-order core polarization for shell-model effective interactions, JASON D. HOLT, JEREMY HOLT, T.T.S. KUO, G.E. BROWN, State University of New York at Stony Brook, SCOTT BOGNER, Ohio State University — Although core polarization, calculated to second-order in perturbation theory, has been successful in describing a range of nuclear observables, the effect of high-order diagrams has been a long-standing issue. In this talk we present an all-order summation of a large class of core polarization diagrams using the low-momentum NN interaction $V_{low-k}$. Our calculation, based on the elegant formalism of Kirson and Babu-Brown, involves solving a set of coupled non-linear equations in which the vertex functions are generated self-consistently. By using $V_{low-k}$, which is energy independent, and true Green functions in the particle-particle and particle-hole channels, we can simplify the solution and include a class of diagrams whose calculation has been previously intractable. We apply this procedure to the sd-shell effective interactions and find that the all-order calculation serves to mildly suppress the second order results, typically by less than 10%.

2:30PM KK.00003 Very-low Momentum Nucleon-Nucleon Interaction Based upon Chiral Perturbation Theory, RUPRECHT MACHELDEIT, University of Idaho, LUIGI CORaggio, University of Naples, DAVID ENTEM, University of Salamanca — Recently, several groups have constructed low-momentum nucleon-nucleon (NN) interactions that have become known as $V_{low-k}$. One starts from a conventional high-momentum NN potential and applies renormalization group techniques that preserve the (half)-on-shell T-matrix to obtain a new potential that is characterized by a low-momentum cutoff, typically around 2 fm$^{-1}$. The general justification for this procedure comes from low-energy effective field theory (EFT). This fact suggests that there may be a more efficient way to construct a $V_{low-k}$. Namely, instead of taking the detour through a high-momentum NN potential, one may as well construct a low-momentum potential from scratch—and this is what our contribution is about. We use chiral perturbation theory at next-to-next-to-next-to-leading order (N3LO) and apply a sharp cutoff at 2.1 fm$^{-1}$. This potential reproduces the NN phase shifts up to about 300 MeV lab energy and the deuteron properties. While the $V_{low-k}$ constructed in the past allow only for a rather cumbersome numerical representation, our low-momentum potential is given in analytic form. Moreover, the low-energy constants are explicitly known such that the chiral three-nucleon forces consistent with our NN potential can be properly defined.

2:45PM KK.00004 Fermi liquid theory and Kuo-Brown effective interactions, JEREMY W. HOLT, G.E. BROWN, J.D. HOLT, T.T.S. KUO, SUNY, Stony Brook, S.K. BÖGNER, The Ohio State University — We study the properties of nuclear matter using the low-momentum nucleon-nucleon interaction $V_{low-k}$ and Landau’s theory of normal Fermi liquids. The Landau $f$-function, which describes the quasiparticle-quasihole interaction at the Fermi surface, can be expanded in Legendre polynomials whose coefficients are directly related to the effective mass, symmetry energy, and compression modulus of nuclear matter. It is found that in the single-bubble approximation to the induced interaction of Babu and Brown, the compression modulus is much too repulsive compared with experiment. This is remedied by solving the Babu-Brown equation self-consistently using $V_{low-k}$ as the driving term. The result is a reasonable agreement with experiment, both for the compression modulus and the remaining Fermi liquid parameters. In addition, we discuss the effect of high-order direct and exchange terms in the quasiparticle scattering amplitude.
Both, the ground state band and the first deformed band, as well as the transition probabilities, compares favorably with the experimental data.

We discuss the exact solution of the isovector pairing (T=1) in nuclei within the SO(5) Richardson-Gaudin algebraic structures. For example, for a 3-particle system, we can form basis states $|12\rangle$ and $|13\rangle$, and expand the wave function as $|\Psi\rangle = \sum_{v} c_{v} |J_{v}J_{v}J_{v}\rangle |\Psi_{0}\rangle$. However, this involves an overcomplete set of principal cfp's. But for, say, $J = 9/2$, there are five $\Psi_{0}$'s, but only two independent wave functions, one with seniority 1 and one with seniority 3. We note that $|J_{v}J_{v}J_{v}\rangle |\Psi_{0}\rangle = 1/(3N[J_{0}])$. We are able then to obtain the following relation overcomplete pcfp's and complete orthonormal cfp's: $A = B = C$, where

$$A = \sum_{v}^{n} |J_{v}J_{v}J_{v}\rangle |\Psi_{0}\rangle |\Psi_{0}\rangle,$$

$$B = \sum_{v}^{n} |J_{v}J_{v}J_{v}\rangle |\Psi_{0}\rangle |\Psi_{0}\rangle,$$

$$C = \delta_{J_{0}J_{v}} \delta_{v_{0}v_{1}} + n(-1)^{J_{0}+J_{v}} \sqrt{(2J_{0}+1)(2J_{v}+1)} \sum_{\nu} J_{\nu}J_{\nu}J_{\nu}J_{\nu} \times |J_{\nu_{0}J_{v_{0}}}\rangle |J_{\nu_{0}J_{v_{0}}}\rangle |\Psi_{0}\rangle |\Psi_{0}\rangle.$$

Applications of RPA in the nuclear shell model. CALVIN JOHNSON, Dept of Physics, San Diego State University, IONEL STETCU, Dept. of Physics, University of Arizona — In recent work we have described a computational implementation of the random phase approximation (RPA) in the interacting shell model. Such an implementation is computationally much cheaper than full scale diagonalization, and provides a reasonable approximation, to binding energies and transitions, including charge-changing transitions. Here we discuss the latest applications of our computer code, SHERPA, with an emphasis on astrophysics.

Thursday, September 22, 2005 2:00PM - 5:15PM – Session KL DNP: Light Ion and EM Reactions Ritz-Carlton Hotel Oahu

2:00PM KL.00001 d-p Elastic Scattering Measurement at Internal Target Station of Nuclotron

TOMOHIRO UESAKA, Center for Nuclear Study, University of Tokyo, VLADIMIR P. LADYGIN, Joint Institute for Nuclear Research, KENJI SUDA, YUKIE MAEDA, Center for Nuclear Study, University of Tokyo, L.S. AZHGIREY, YU.V. GURCHIN, A.YU. ISUPOV, Joint Institute for Nuclear Research, KEISUKE ITOH, Saitama University, MARIAN JANKE, J.-T. KARACHUK, Joint Institute for Nuclear Research, TAKAHIRO KAWABATA, Center for Nuclear Study, University of Tokyo, A.N. KHRENOV, A.S. KISELEV, V. KIZKA, J. KLIMAN, VLADIMIR A. KRASNOV, A.N. LIVANOVA, ALEXANDRE I. MALAKHOV, S.G. REZNIKOV, Joint Institute for Nuclear Research, SATOSHI SASAMOTO, Center for Nuclear Study, University of Tokyo, HIDEYUKI SAKAI, University of Tokyo, YOSHIO SASAMOTO, Center for Nuclear Study, University of Tokyo, KIMIKO SEKIGUCHI, RIKEN, TARAS A. VASILIEV, Joint Institute for Nuclear Research, S. NEDEV — Measurement of analyzing powers for the d-p elastic scattering at energies of 300–2000 MeV will be carried out in June 2005, by use of a polarized deuteron beam from Nuclotron at Dubna. Aim of the measurement is twofold: 1) to investigate energy dependences of the observables for the purpose to clarify spin-dependences of 3N forces. 2) to establish the d-p elastic scattering as a deuteron polarimetry in the energy region considered. Results of the measurement together with details of the experimental setup will be reported.
2:15PM KL.00002 Bjorken scaling for hadron-nucleus scattering\textsuperscript{1}, R.J. PETERSON, University of Colorado — Electron scattering to the continuum for several nuclear samples at energy losses less than those for scattering on free nucleons ($x_B > 1$) has been shown to sense high nucleon momenta arising from hard collisions or correlations within nuclei, using ratios of cross sections\textsuperscript{2}. A similar analysis has been carried out for continuum hadron scattering at lower momentum transfers but including a very wide range of nuclei and several reactions, including proton scattering up to 19.2 GeV/c, proton charge exchange, and pion scattering. These data show the same trends as noted with electrons, but heavier nuclei show systematically enhanced contributions from high nucleon momenta. A wide range of data will be compared to the electron results.

\textsuperscript{1}Work supported in part by the USDOE.


2:30PM KL.00003 Photodisintegration of Deuteron and Coherent and Incoherent Photoproduction Processes off the Deuteron, WILLIAM BRISCOE, JESSICA GOHS, The George Washington University, EVIE DOWNIE, JOHN ANNAND, The University of Glasgow, CRYSTAL BALL AND TAPS AT MAMI COLLABORATION — The MAMI B photon beam with a maximum energy of 855 MeV is used with a liquid deuterium target and the Crystal Ball and TAPS to investigate photodisintegration and photoproduction processes. Among these are coherent $^3\text{He}$ production on the deuteron itself, $^3\text{He}$ production off the individual quasi-free nucleons, and the photodisintegration of the deuteron into a proton and a neutron. In addition to providing insight into the properties of the neutron, proton and nucleus, the photodisintegration data is also analyzed to calibrate the neutron efficiency of the Crystal Ball and TAPS detectors in their current configuration at MAMI. We will report on the preliminary physics and calibration results from measurements made with the deuterium target.

2:45PM KL.00004 Investigation of Short Range correlations in 3He(e,e'pp)n, HOVHANNES BAGHDASARYAN, LARRY WEINSTEIN, CLAS COLLABORATION — Nucleon-Nucleon (NN) Short Range Correlations (SRC) represent a valuable part of the nuclear wavefunction. The better knowledge of SRC will give us better understanding of nuclear matter and nuclear interactions in extreme conditions. A study of the effects of short-range correlations over the 3He(e,e'pp)n reaction measured at Jefferson Lab is presented. Looking at the reaction, we can extract the kinematic regions where the NN SRC is an almost non interacting spectator. We have measured the relative and total momentum distributions of spectator (pp) and (pn) pairs up to 600 MeV/c. We will compare results with various theories.

3:00PM KL.00005 Measuring the Spin Structure of $^3\text{He}$ and the Neutron at Low $Q^2$, TIMOTHY HOLMSTROM, College of William and Mary, JEFFERSON LAB HALL A COLLABORATION, E97-110 COLLABORATION — The spin structure of the nucleus has been of great interest over the past few decades. Sum rules, including the Gerasimov-Drell-Hearn (GDH), and moments of the nucleon spin structure functions are powerful tools for understanding nucleon structure. The goal of Jefferson Lab experiment E97-110 is to perform a precise measurement of the $Q^2$ dependence of the generalized GDH integral, an extension to finite $Q^2$ of the GDH sum rule, and the moments of the $^3\text{He}$ and neutron spin structure functions between 0.02 and 0.3 (GeV/c)^2. This $Q^2$ range will allow us to test the dynamics of Chiral Perturbation Theory, extrapolate to the real photon point for $^3\text{He}$ and the neutron, and will complement a previous experiment at higher $Q^2$. The measurement will also contribute to the understanding of nucleon resonances. The acquisition of data has been completed. Status and prospects will be discussed.

3:15PM KL.00006 Tensor Analyzing Powers in Elastic Electron Deuteron Scattering, CHI ZHANG, M.I.T., BLAST COLLABORATION — BLAST Collaboration recently completed its experimental program to measure the tensor analyzing powers in elastic electron deuteron scattering. The experiment was carried out at the South Hall Storage Ring of the MIT-Bates Linear Accelerator Facility with BLAST (Bates Large Acceptance Spectrometer Toroid) detector. An Atomic Beam source is used to inject vector and tensor polarized atomic deuterium gas into an internal target embedded in the electron storage ring. Unprecedented statistical precision is obtained across the $Q^2$ range of 0.1 to 0.8 (GeV/c)^2. Data in various kinematics and momentum transfer are collected simultaneously along with other reaction channels, including vector polarized observables in e-d elastic scattering. Combined with cross section world data, the new polarized measurement will shed light on the nucleon-nucleon bound state and nucleon-nucleon interaction. Preliminary results for $T_{20}$, $T_{21}$ and the deuteron form factors will be presented.

3:30PM KL.00007 Spectroscopy of $^{19}\text{Na}$ nucleus, B.B. SKORODUMOV, University of Notre Dame, IN 46556, G.V. ROGACHEV, Florida State University, Tallahassee, FL 32306, P. BOUTACHKOV, A. APRAHAMIAN, J.J. KOLATA, L.O. LAMM, M. QUINN, A. VOEHR — Studies of proton-rich nuclei can provide fundamental insights into the properties of nuclear structure and interactions that are not manifest in the valley of stability. Light exotic nuclei are the perfect proving ground for our understanding of the behavior of nuclear matter under extreme proton to neutron ratios. Availability of radioactive beams is needed to use simple reactions such as elastic scattering to populate states in exotic nuclei. I will present results on the spectroscopy of neutron deficient unbound isotope $^{19}\text{Na}$. Resonance elastic scattering of $^{18}\text{Ne}$ on protons was measured using inverse geometry and the very thick target technique\textsuperscript{1}. The experiment was carried out at the TwinSol radioactive nuclear beam facility of the University of Notre Dame\textsuperscript{2}. The beam of $^{18}\text{Ne}$ was produced via the $^{20}\text{Ne}(^{16}\text{O},^{18}\text{Ne})n$ reaction. The analysis of the excitation function of elastic scattering was carried out with the R-Matrix formalism and Potential model approach. The spectrum of $^{19}\text{Na}$ was measured up to excitation energy of 2.75 MeV. Results of this work will be compared with the F.de Oliveira et.al\textsuperscript{3} where excitation function was measured up to 6 MeV.


3:45PM KL.00008 Coherent Pion Production Measurement from the reaction $^{12}\text{C}(p,p\pi^+)^{12}\text{C}$, KUNIHIRO FUJITA, YASUHIRO SAKEMI, KICHIJI HATANAKA, ATSUSI TAMII, YOUHEI SHIMIZU, YUJI TAMESHIGE, HIROAKI MATSUBARA, RCNP, Osaka Univ., MASAHARU NOMACHI, HIDEHITO NAKAMURA, Osaka Univ., TETSUO NORO, TOMOTSUGU WAKASA, HIDE TOMO YOSHIDA, TAKASHI ISHIDA, SHUN ASAJI, YUJI NAGASUE, Kyusyu Univ. — The physics goal of our experiment is to measure the Coherent Pion Production (CPP) such as $^{12}\text{C}(p,p\pi^+)^{12}\text{C}$ (Ground State) and investigate the short range component of the nuclear interaction, which is sensitive to the critical density of pion condensation phase. We performed the test experiment in December, 2004 and May, 2005. Trigger counter for the pion is developed and procedure of coincidence with neutron was established. To identify the CPP event under enormous background, we need tracking detector with high position resolution and radiation tolerance. It can be achieved by Gas Electron Multiplier (GEM) Detector. Then, we developed the GEM detector and its readout electronics called Space Wire readout system for the charged pion measurement. The prototype of the detector is fabricated and basic detector specification is measured. We plan to measure the CPP cross section with full setup including GEM and neutron counter to get quantitative information about the short range component.

3:15PM KL.00007 Measurement of the Spin Structure of $^3\text{He}$ and the Neutron at Low $Q^2$, T. HOLMSTROM, College of William and Mary, Jefferson Lab Hall A Collaboration, E97-110 Collaboration — The spin structure of the nucleus has been of great interest over the past few decades. Sum rules, including the Gerasimov-Drell-Hearn (GDH), and moments of the nucleon spin structure functions are powerful tools for understanding nucleon structure. The goal of Jefferson Lab experiment E97-110 is to perform a precise measurement of the $Q^2$ dependence of the generalized GDH integral, an extension to finite $Q^2$ of the GDH sum rule, and the moments of the $^3\text{He}$ and neutron spin structure functions between 0.02 and 0.3 (GeV/c)^2. This $Q^2$ range will allow us to test the dynamics of Chiral Perturbation Theory, extrapolate to the real photon point for $^3\text{He}$ and the neutron, and will complement a previous experiment at higher $Q^2$. The measurement will also contribute to the understanding of nucleon resonances. The acquisition of data has been completed. Status and prospects will be discussed.
4:00PM KL.00009 Measurements of Gamow-Teller strength distributions via \((t,^3\text{He})\) and \((^3\text{He},t)\) reactions,\(^1\) , REMCO G.T. ZEGERS, National Superconducting Cyclotron Laboratory, The Joint Institute for Nuclear Astrophysics and the Department of Physics, Michigan State University, EXP. 96031 NSCL COLLABORATION, EXP. E219 RCNP COLLABORATION — The \((t,^3\text{He})\) and \((^3\text{He},t)\) reactions at beam energies exceeding 100 MeV/nucleon are important tools to study the spin-isospin response of nuclei. Of particular interest is the extraction of Gamow-Teller strengths \((B(GT))\), since these provide direct information about weak-interaction rates that serve as input for stellar evolution calculations. Accurate measurements provide a way to test shell-model codes that can then be used to make estimates for stellar conditions that cannot be achieved in the laboratory. The combined capability to perform high-resolution \((^3\text{He},t)\) and \((t,^3\text{He})\) experiments (at RCNP, Osaka) makes these probes especially suited to perform such studies. The linear relationship between cross section and \(B(GT)\) has to be validated experimentally. \((^3\text{He},t)\) and \((t,^3\text{He})\) data on a variety of targets will be presented that is used to test the method, focusing on results from \(^{26}\text{Mg}(^3\text{He},t)\) and \(^{26}\text{Mg}(t,^3\text{He})\) for which Gamow-Teller strengths have been extracted up to high excitation-energy ranges.

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4:15PM KL.00010 Studying the \((^7\text{Li},^5\text{Li})\) reaction using STARS, LEE BERNSTEIN, J.T. BURKE, J.A. CHURCH, K. MOODY, LLNL, L.W. PHAIR, P. FALLON, S. SINHA, M.A. MCMAHAN, M. WIEDEKING, R.M. CLARK, A.O. MACCHIAVELLI, Y.Y. LEE, LBNL, E. RODRIGUEZ-VIEITEZ, B. LYLES, S.G. PRUSSIN, Univ. of California, H.-C. AI, Yale Univ., C.W. BEAUSANG, Univ. of Richmond — The LLNL group has been pioneering an effort to determine \((n,x)\) cross sections on unstable nuclei via decay probability measurements of compound nuclei formed using light-ion induced “surrogate” reactions. To this end an experiment was performed at the 88-Inch cyclotron at LBNL using the STARS (Silicon Telescope Array for Reaction Studies) spectrometer coupled to LiBeRACE (Livermore-Berkeley Array for Collaborative Experiments) to study using the \(^{234,238}\text{U}(^7\text{Li},^5\text{Li})\) reactions to populate neutron-rich compound nuclei. Results from this experiment will be presented and its use for determining \((n,x)\) cross sections on neutron-rich nuclei will be discussed. This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48, Lawrence Berkeley National Laboratory under contract No. DE-AC03-76SF0098 (LBNL) and by the NNSA Stockpile Stewardship Academic Alliance program (Yale/Richmond).

4:30PM KL.00011 Deep hole state in \(^6\text{He}\) and its cluster structure, YOHEI NAKATSUGAWA, HARUTAKA SAKAGUCHI, YUUSUKE YASUDA, SATORU TERASHIMA, SATOSHI KISHI, JUZO ZENHIRO, Kyoto University, MASARU YOSOI, MAMORU FUJWARA, KOHSUKE NAKANISHI, KEIGO KAWASE, HISANOBU HASHIMOTO, SHUN OKUMURA, Research Center for Nuclear Physics, Osaka University, TAMIO YAMAGATA, HIDETOSHI AKIMUNE, MAKI KINOSHITA, Konan University, SHINTARO NAKAYAMA, KENICHI FUSHIMI, University of Tokushima, MASAYOSHI TANAKA, Kobe Tokiwa College, HIDENORI TOYOKAWA, Japan Synchrotron Radiation Research Institute, MASATOSHI ITOH, Tohoku University, HIDETOMO YOSHIDA, Kyushu University, MAKOTO UCHIDA, Tokyo Institute of Technology — The deep-hole state in \(^6\text{He}\) was investigated via the quasifree \(^{7}\text{Li}(p,2p)^{9}\text{He}\)\(^+\) reaction with decay coincidence measurements. In general, it is said that light nuclei are described not only by the shell model, but also by the cluster model. In order to investigate their structure, we have measured decay particles from deep-hole states in light nuclei because the direct decay process is dominant and its decay mode gives us information on the structure of deep-hole states. In this experiment, triton decay was found to be dominant for the so-called s-hole state in \(^6\text{He}\) contrary to the shell model calculation. This result implies the tri-nucleon cluster structure in \(^{9}\text{He}\)(s-hole), which is created by knocking out a proton from an \(\alpha\) in \(^7\text{Li}(gnd)\).

4:45PM KL.00012 Chiral Symmetry Breaking in Pion Double Charge Exchange, ROMAN KEZERASHVILI, City Tech, The City University of New York — We study the energy behavior of the forward pion double charge exchange reaction on atomic nuclei in the framework of meson exchange currents (MEC) mechanism. Different chiral symmetry breaking Lagrangians are used to describe pion–pion vertex and vertex corresponding to a seagull diagram. To investigate the energy dependence of meson exchange currents contribution we neglected pion distortion. Our analytical calculations show that matrix elements for a forward differential cross section do not depend on the energy of the incoming pion. However, the amplitudes of the MEC diagrams considered depend on the chiral symmetry breaking parameter. The comparison of the sequential and the meson exchange current mechanisms shows that both mechanisms have a comparable contribution to the differential cross section at zero degree at the high energy region.

5:00PM KL.00013 Double-Spin Asymmetry of \(J/\psi \rightarrow \mu^+ \mu^-\) in longitudinally polarized \(p + p\) collisions at \(\sqrt{s} = 200\) GeV, IMRAN YOUNUS, University of New Mexico, PHENIX COLLABORATION — Polarized DIS experiments have established that the spin carried by quarks and anti-quarks in the proton does not account for the total proton spin. The gluon polarization and orbital angular momentum of the partons are other possible contributors, but remain largely inaccessible through the virtual photon probes of DIS. Heavy-quark pair production, including \(J/\psi\) production in polarized \(p + p\) collisions at RHIC is dominated by gluon-gluon interactions and provide direct access to the gluon polarization in the proton. The muon spectrometers at the PHENIX experiment can measure \(J/\psi\) yields through the \(\mu^+ \mu^-\) decay mode at large rapidity \((1.2 < |y| < 2.2)\). In this talk we present the current status of the analysis of the double longitudinal spin asymmetry \(A_{LL}\) in the \(J/\psi\) yields in polarized \(p + p\) collisions at \(\sqrt{s} = 200\) GeV, using the data obtained in 2005. The integrated luminosity is expected to be \(~4\) pb\(^{-1}\) with average polarization of 50\%.