2008 APS April Meeting and HEDP/HEDLA Meeting

St. Louis, Missouri

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Monday, April 14, 2008 2:06PM - 3:30PM –

Session S18 SPS: Undergraduate Session I Hyatt Regency St. Louis Riverfront (formerly Adam039;s Mark Hotel), Director039;s Row 46

2:06PM S18.00001 SPS Outstanding Student Award for Undergraduate Research Talk: Lifetime Measurements and Deformation in 79Sr YUN KYOUNG RYU, ROBERT KAYE, S.R. ARORA, Ohio Wesleyan University, S.L. TABOR, Florida State University, J. DORING, Gesellschaft für Schwerionenforschung, Y. SUN, University of Notre Dame, T.D. BALDWIN, D.B. CAMPBELL, C. CHANDLER, M.W. COOPER, S.M. GERBICK, M. WIEDEKING , C.R. HOFFMAN, J. PAVAN, Florida State University, O. GRUBOR-UROSEVIC, Purdue University Calumet, L.A. RILEY, Earlham College — High-spin states in ^{79}Sr were produced following the ^{54}Fe(^{28}Si, 2*pn*) fusion-evaporation reaction using a beam kinetic energy of 90 MeV at the Florida State University (FSU) Tandem-Linac particle accelerator facility, and the resulting de-exciting γ rays were detected with the FSU array of 10 Compton-suppressed high-purity Ge detectors comprised of three Clover detectors and seven single-crystal detectors. The synthesized nuclei were stopped completely in the target, resulting in Doppler-shifted γ-ray line shapes that could be analyzed using the Doppler-shift attenuation method. The experimental line shapes were acquired at detection angles of 35° and 145°, and the resulting Doppler-shifted peaks were analyzed to extract the lifetime of their parent states. In all, 23 lifetimes were measured in three separate band structures using this method, and then used to infer transition quadrupole moments (Q_t) and quadrupole deformations (β_2) using the rotational model. The resulting Q_t values indicated a high degree of collectivity and deformation in all three observed sequences of excited states (bands) with only a modest decline in collectivity with increasing angular momentum. The results show good qualitative agreement with the predictions of both cranked Woods-Saxon (CWS) and projected shell model (PSM) calculations. In addition, the pattern of excited energy states and their de-exciting gamma-ray transitions (level scheme) was re-examined and compared to the most recent study of ^{79}Sr using $\gamma - \gamma$ coincidence measurements, intensity measurements, and directional correlation of oriented nuclei (DCO) ratios in addition to the lifetime measurements. Overall, the level scheme was verified, with the exception of the re-arrangement of one transition. The band based on the intrinsic $d_{5/2}$ single-particle orbital from the shell model, was found to have the largest average deformation (β_2,ave = 0.41) among the three observed bands, in agreement with the CWS and PSM theoretical predictions

2:30PM S18.00002 Search for QCD Hawking Radiation in Heavy Ion Collisions , LAURA STILES, MICHAEL MURRAY, University of Kansas — A wide variety of measurements at RHIC, for example v_2 and energy loss, suggest that the partonic matter created in heavy collisions thermalizes early. One possible mechanism for this is the creation of the QCD analogue to gravitational black holes [1]. Such objects have no memory of their creation and radiate with a characteristic temperature, T, that can depend only on their energy, charge, and angular momentum. This hypothesis is consistent with the growth of multiplicity with $\sqrt{s}$ in e+e- collisions and thermal temperature observed at LEP. For central heavy ion collisions the angular momentum of the system is approximately zero and the model predicts a universal dependence of the chemical freezeout temperature on the ratios of charge to transverse energy. To test this prediction against BRAHMS data, We have fitted data on π, K, p and $\bar{p}$ from central Au + Au collisions at several rapidities and energies, using the THERMUS code. The experimental dependence of the temperature on the ratio of charge to transverse energy will be compared to the Hawking radiation predictions. By comparing data sets at different energy, centrality and rapidity we can select systems with the same ratio of baryon number to energy but different rapidities. This may allow us to test for any effect of angular momentum on temperature. [1] P. Castorina, D. Kharzeev and H. Satz, Eur. Phys. J. C 52, 187 (2007)

2:42PM S18.00003 Measuring the transverse position of forward neutrons at the Large Hadron Collider[1] , NAVID TERHANI, ARADALAN DEHDASHT, University of Kansas, CMS COLLABORATION — One way to study the quark-gluon matter produced in heavy ion collisions is to measure the deflection of very forward neutrons. In CMS this can be achieved with the Zero Degree Calorimeters, ZDCs, if we add a hodoscope of cerenkov or silicon detectors. The ideal position for such a detector is at shower maximum, i.e. the point where the number of secondary particles produced by the incoming neutrons is greatest. Fortunately for us this point is between the electromagnetic and hadronic parts of the ZDCs. Such an upgrade must be very compact and robust. I will describe a possible design for such a detector based on an 8*8 grid of 1cm tiles and a multi-anode PMT. I will present a model of such a detector and give estimates of its performance.

[1]DOE Office of Science and National Science Foundation.

2:54PM S18.00004 Neutron Flow at the Large Hadron Collidor[1] , JESSICA SNYDER, University of Kansas, CMS COLLABORATION — One of the most exciting recent results in high-energy nuclear physics is the discovery that nucleus-nucleus collisions at the Relativistic Heavy Ion Collider, RHIC, produce an almost perfect fluid of quarks and gluons. This state was identified thanks to the strong collective "flow" of particles observed. In 2009 the Large Hadron Collider, LHC, will study lead-lead colllisions at an energy 28 times larger. At such high energies, it is possible that the collective properties of the produced matter resemble more that of a weakly interacting quark-gluon gas rather than the liquid-like state observed at RHIC. This would result in a different flow strength. Flow measurements at the LHC can be carried out by measuring the pattern of spectator neutrons emitted along the beam axis, using two detectors inserted between the electromagnetic and hadronic sections of the CMS Zero Degree Calorimeters (ZDCs). I will present results of GEANT simulations of such a detector, including estimates of its capabilities to measure neutron flow.

[1]DOE Office of Science and National Science Foundation.

3:06PM S18.00005 Accurate Energy Calibrations from Cosmic Ray Measurements[1] , AMY DELINE, JOSEPH FINCK, Central Michigan University, ARTEMIS SPYROU, MICHAEL THOENNESSEN, MSU/NSCL, PAUL DEYOUNG, Hope College, THE MONA COLLABORATION — The Modular Neutron Array, located at the NSCL at Michigan State University, is used in conjunction with the MSU/FSU Sweeper Magnet to study the breakup of neutron-rich nuclei. Fragmentation reactions create particle-unstable nuclei near the neutron dripline which spontaneously breakup by the decay of one or two neutrons with energies that reflect the nuclear structure of unbound excited and ground states. The neutrons continue forward into MoNA where their position and time are recorded, and the charged fragments' position and energy are measured by the array of detectors following the Sweeper Magnet. In such experiments it is important to be able to identify one-and two-neutron events hitting MoNA. For this reason an accurate energy calibration of the MoNA bars is crucial. The present work focuses on performing an energy calibration from cosmic ray measurements. The application of different gates on the cosmic ray spectra allowed the selection of events that correspond to different energy depositions in a MoNA bar, at energies between 18 and 32 MeV.

[1]NSF PHY0555439, PHY0606007, PHY0354920

3:18PM S18.00006 CDMS Veto Stability Study and Calibration[1] , GABRIEL CACERES, Augustana College — Most experiments searching for dark matter particles have been led deep underground to minimize the background produced by cosmic rays. The Cryogenic Dark Matter Search (CDMS) lies $1/2$ mile underground in the Soudan Mine in Minnesota. Even though the muon rate is lowered by a factor of $\sim 10^5$, the rate is still high enough to produce background signals. To solve this problem, scintillator panels have been placed around the detector to veto cosmic induced events. This work studies the behavior over time of the scintillator veto panels. By analyzing and tracking the response to a LED pulser system, the stability was determined to be within 3%. The absolute energy scale of the spectrum was then calibrated using radioactive sources, as well as the muon distribution. Knowing the absolute energy scale and where the veto trigger threshold lies provides useful information for calculating the amount of background that can be rejected.

[1]Fermilab Summer Internships in Science and Technology

Monday, April 14, 2008 2:06PM - 3:18PM –

Session S19 SPS: Undergraduate Session II Hyatt Regency St. Louis Riverfront (formerly Adam039;s Mark Hotel), Director039;s Row 47

2:06PM S19.00001 Optimization of CESR-c Optics for High Time-Integrated Luminosity[1] , MACKENZIE VAN CAMP, Lawrence University, JAMES CRITTENDEN, Laboratory for Elementary-Particle Physics, Cornell University, CESR OPERATIONS GROUP TEAM — The Cornell Electron Storage Ring (CESR) operates at world-record production rates for bound states of charm quarks, enabling unprecedented statistical precision in the study of their decays. Its success depends on maximizing the time-integrated collision rate between the counter-circulating e-/e+ beams in CESR, which is limited by a combination of stored beam current and beam lifetime. These are in turn constrained by the requirements of operating counter-circulating particle beams of opposite charge in a single beampipe, including managing the attraction between the beams as they collide and the repulsion between the beams as they pass each other in their orbits. Two strategies for regulating these interactions are adjusting the beam current, which can sacrifice luminosity, and adjusting the separation between the beams, which is limited by the size of the beampipe and the strength of the repulsion between the beams. We describe a modeling algorithm which optimizes operating currents and orbit separations. The algorithm successfully finds values for the beam current and orbit separation which are likely to increase the time-integrated collision rate, making it a useful new tool for optimizing CESR's optics.

[1]Supported by NSF REU grant PHY-0552386 and research co-operative agreement PHY-0202078.

2:18PM S19.00002 ABSTRACT WITHDRAWN –

2:30PM S19.00003 Bio-Photons of Various Cellular Cultures and Tissues , PATRICK HANN, ERNST KNOESEL, MARIA GARZON, SAMUEL LOFLAND, ERIK PFIEFFER, Rowan University — Since it is non-invasive, there has been increased research in the field of bio-optics. Many biological systems display an unusual phenomenon, delayed luminescence, produced by what is known as bio-photons. We present an apparatus and procedure for the detection of these ultra-weak photonic emissions using a single photon detection device. The results of bread yeast, saccramyces, and algae will be presented and compared to other reports in the literature.

2:42PM S19.00004 Whispering-Gallery-Mode Resonances in FLourescent Microspheres[1] , MARY WILLIAMS, D. BRIAN THOMPSON, University of North Alabama — We are collecting emission spectra from fluorescent microspheres, aligned to form coupled cavities. A single fluorescent microsphere can act as a Fabry-Perot resonance cavity, so that it will exhibit morphology-dependent resonances (MDRs), also known as whispering gallery mode (WGM) resonances, as intense narrow peaks superimposed upon the free-space fluorescence emission background. Two or more microspheres in close proximity may form a coupled cavity, where the coupling arises from evanescent fields between the microspheres. The coupling strength then should be a strong function of separation distance between spheres. We use an optical tweezers to position the microspheres, to guide the excitation light, and to collect the emission from the microspheres for spectral analysis. The goal of these measurements is to examine the behavior of MDRs in the emission spectra of two coupled microspheres as separation distances are varied. However, at this stage in our work, we are examining how various dye-staining methods impact the spectra we collect.

[1]Cottrell College Science Award from Research Corporation and Faculty Research Grants from the University of North Alabama

2:54PM S19.00005 Probing the Unusual Thresholds of AlH+/AlD+ formation by Molecular Dynamic Simulations on MRCI Potential Energy Surfaces , NATHAN BREWER, Sigma Pi Sigma/SPS- Union University — In an experiment performed by P. Armentrout (Int. Rev. Phys. Chem. **1990**, 9, 115), the Al^+ cation was accelerated into the various isotopic combinations of H_2 to form AlH^+ and AlD^+. It was found that the product-forming reactions proceed very inefficiently. The experiments also showed a reduction of ∼29% in the threshold for the formation of AlD^+ from the HD reactant whereas all other AlH^+ and AlD^+ products formed at the same energetic threshold. Four previous theoretical attempts at capturing this unusual phenomenon have not been successful. The lowest energy singlet surfaces for the reaction of Al^+ with H_2 have been calculated at the multi-reference configuration interaction (MRCI) level of theory. The real/imaginary boundary of the symmetry-breaking b_2 vibrational mode was examined in three dimensions using Hessian matrices computed at a multi-configurational self-consistent field (MCSCF) level of theory. Molecular dynamic simulations numbering on the order of 10^7 were performed, sampling initial conditions reflective of the experiments. The simulations were run until they reached the location where the b_2 vibrational mode became unbound. A dissociation model was applied at these greatly compressed geometries to model the dissociation into AlH^+ and AlD^+ products.

3:06PM S19.00006 The late–time tails in the Reissner–Nordström space-time revisited[1] , CARL J. BLAKSLEY, LIOR M. BURKO, University of Alabama in Huntsville — We propose that the late-time tail problem in the Reissner-Nordström (RN) spacetime is dual to a tail problem in the Schwarzschild spacetime with a different initial data set: at a fixed observation point the asymptotic decay rate of the fields are equal. This duality is used to find the decay rate for tails in RN. This decay rate is exactly as in Schwarzschild, including the case of the extremely-charged RN spacetime (ERN). The only case where any deviation from the Schwarzschild decay rate is found is the case of the tails along the event horizon of an ERN spacetime, where the decay rate is the same as at future null infinity. As observed at a fixed location, the decay rate in ERN is the same as in Schwarzschild. We verify these expectations with numerical simulations.

[1]CJB was supported by Research Experiences for Undergraduates in Science and Engineering sponsored by the ASGC under Contract NNG05GE80H and by the UAH President's Office. LMB was supported by NASA/GSFC NCC5–580 and NASA/Stennis NNX07AL52A grants.

Monday, April 14, 2008 2:06PM - 3:18PM –

Session S20 SPS: Undergraduate Session III Hyatt Regency St. Louis Riverfront (formerly Adam039;s Mark Hotel), Director039;s Row 48

2:06PM S20.00001 3D Quantitative Nanoscale Imaging via Coherent X-Rays[1] , KEVIN RAINES, CHANGYONG SONG, HUAIDONG JIANG, ADRIAN MANCUSCO, RUI XU, JIANWEI MIAO, Department of Physics and Astronomy, University of California, Los Angeles, CA 90095, CHIEN-CHUN CHEN, TING-KUO LEE, Institute of Physics, Academia Sinica, Nankang, Taipei, 11529, Taiwan, TETSUYA ISHIKAWA, RIKEN SPring-8 Center, 1-1-1, Kouto, Sayo, Hyogo 679-5148, Japan — Coherent x-ray diffraction microscopy (CXDM) promises to become an important imaging technique, particularly with the development of FELs. Indeed, recently there has been much interest in harnessing CXDM to quantitatively image in 3D such biological samples as single cells, organelles, and eventually macromolecules. Such images are obtained by rotating a specimen about an axis, resulting in its 3D diffraction pattern in cylindrical coordinates. Thus interpolating the data accurately onto a Cartesian grid is an essential step to 3D image reconstruction. I have developed a gridding-based interpolation scheme that yields a superior reconstruction from a limited and incomplete set of diffraction patterns. This interpolation algorithm is generalizable to a variety of imaging and interpolation applications. The effect of various degrees of angular under-sampling and the missing wedge upon resolution in each dimension will also be discussed.

[1]Supported by NSF, DOE, and RIKEN.

2:18PM S20.00002 Using a Large Ring Laser Gyroscope (RLG) to Understand the Torsional Components of Near-Field Seismic Events[1] , ADAM JACOBS, Hendrix SPS Chapter — Seismographs are able to accurately measure translational components of seismic events, i.e. the North-South, East-West, and Up-Down (z) components. However, there has recently been a renewed interest in measuring the torsional components of such events. Preliminary results from a triangular, large ring laser (measuring 17 meters on a side) suggest that RLGs could be a vital tool in opening up this relatively unexplored aspect of seismology. The ring laser has produced data similar to that of seismographs in response to three near-field earthquakes in Tennessee, the Gulf of Mexico, and Mexico. In addition to this, Fourier analysis of voltage variations caused by perturbations of the ring laser during these near-field events has yielded several interesting results not given by traditional seismographs. These results include the increased effectiveness of RLGs for near-field measurements versus far-field, the torsional resonances excited by the detected earthquakes, and perhaps the mechanism which generates torsion in an earthquake. The ring laser's results, their implications, and a potential model will be presented.

[1]Gracious acknowledgement is due to the National Science Foundation and the Arkansas Space Grant Consortium.

2:30PM S20.00003 Chaos in the Relativistic Three-Body Problem , MIRIAM CONDE, J.J. CAMPBELL, DAVID TANNER, DAVID NEILSEN, Brigham Young University — We investigate chaos in general relativity by studying three-body interactions using the post-Newtonian formalism. The initial data consist of a binary pair (with equal or unequal masses) that scatters a third object that comes from infinity, and these data are parametrized by the orbital phase of the binary pair and the initial impact parameter of the third body. The final state of the system is characterized by quantities measurable at infinity, and we examine the sensitivity of these quantities on the initial parameters. Finally, we calculate Lyapunov exponents directly from the simulations to quantify the chaotic behavior.

2:42PM S20.00004 Relativistic Corrections and Chaos in the Three-Body Problem , J.J. CAMPBELL, DAVID NEILSEN, MIRIAM NEUBAUER, DAVID TANNER, Brigham Young University — In classical Newtonian gravity, the three-body problem is known to be chaotic for general initial data. We investigate the existence of chaos for the three-body problem in general relativity using the first and second post-Newtonian approximations. Our initial data consists of a third object scattering from a binary pair and are parameterized by an impact parameter and phase angle. The Hamiltonian equations of motion are integrated using geometric methods and we extract gauge-independent quantities at infinity. We present results that characterize chaos in general relativity.

2:54PM S20.00005 Six degree-of-freedom thrust sensor for hybrid rocket. , JOSHUA WILSON, Hendrix College — Thrust is the reactive force experienced by a rocket due to the ejection of high velocity matter. The Hybrid Rocket Facility at the University of Arkansas at Little Rock (UALR) uses strain gauges mounted to an s-beam to measure axial direction thrust of the rocket. A new six degree of freedom thrust sensor has been built for the UALR Hybrid Rocket Facility. The six degrees of freedom are the thrust force components in the three spacial directions (F_x, F_y, F_z) plus the three moments (roll, pitch, yaw). Even though the majority of the rocket's thrust is in the axial direction, the components in the other directions are non-zero, and must be measured to account for the total work done by the rocket motor. The sensor design and fabrication are now complete. Calibration of the load cells on each of the six uni-axial legs of the sensor and any preliminary data available will be presented.

3:06PM S20.00006 Synthesis, Structural, and Electrochemical Stability Studies of Nanocrystalline 5V Lithiated Oxides for Asymmetric Supercapacitor , WILLIAM PARKER[1], Southern University and A&M College, HUIMING WU, Southern University, RAMBABU BOBBA[2], Southern University and A&M College — For the development of asymmetric (hybrid) supercapacitor, we have synthesized nanoscale double substituted $LiNi_YCo_{1-2Y}Mn_{1+Y}O_4$ (Y=0.05, 0.1, 0.25 and 0.45) spinels using mechanochemical, hydrothermal, microwave assisted combustion aided procedures. The samples have been characterized by XRD, TEM, and XAFS. Lattice parameter of the spinels increased with nickel content, and decreased from 400 to 600 °C, at which temperature the particle size is ≈20nm. The sample with composition $LiNi_{0.45}Co_{0.1}Mn_{1.45}O_4$ has shown the best electrochemical performance, with redox potential of 4.6V, capacity of 129.6mAhg^{-1}, cyclability of 99.6% per cycle, and retained the capacity up to 1 C rate. The XANES of Mn and M as a function of x showed that the high voltage (∼5 V) in the cathode materials of an Li secondary battery is due to the oxidation of M^{3+} to M^{4+} (M=Co) and M^{2+} to M^{4+} (in the case of M=Ni). The EXAFS analysis revealed that Ni^{2+} is oxidized to Ni^{4+} via the Ni^{3+} state with a Jahn–Teller distorted Ni^{3+}–O octahedron. A hybrid device employing nanostructured $LiNi_YCo_{1-2Y}Mn_{1+Y}O_4$ /polymer electrolyte/nanoporous carbon black (NCB) powders was assembled. grant # W911NF-07-1-0426

[1]UG Physics
[2]Faculty Advisor