Saturday, February 13, 2010 8:30AM - 10:18AM –

Session A7 DNP GFB: Mini-Symposium on Electromagnetic Reactions Involving Light Nuclei

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8:30AM A7.00001 Electromagnetic Reactions Involving Light Nuclei

— The structure of light nuclei is of primary importance for microscopic approaches to understanding nuclei. Precise knowledge at low energies also provides a connection to issues in nuclear astrophysics and to chiral perturbation and effective field theories, low energy approaches to quantum chromodynamics. High energy studies test quark-model approaches to nuclear structure. I will review recent experimental developments that test our understanding of the deuteron and 4He systems through measurements of photo-disintegration, the Gerasimov Drell-Hearn sum rule, elastic electron scattering form factors, and quasifree (e,e') reactions. I will also describe some prospects for future work.

1This work was supported in part by the U.S. National Science Foundation Grant PHY 06-52713.

9:06AM A7.00002 A precision description of deuteron electromagnetic form factors at low Q^2.

DANIEL PHILLIPS

— I will discuss the use of chiral effective theory (χET) to compute the form factors G_C, G_Q, and G_M that are measured in elastic electron-deuteron scattering. I will show that NN potentials derived from χET, when used in concert with the χET current operators, give an accurate description of the ratio G_Q/G_C: for momentum transfers √Q^2 < 0.6 GeV. I will describe ongoing work to achieve similar precision for the magnetic form factor G_M. I will also show a prediction for the charge form factor G_C: that is based on a χET calculation at O(eP^2). Such a prediction should be accurate up to corrections of order 1–2% for momentum transfers ~ M^2. I will explain how this uncertainty grows with Q^2, and then close by showing the resulting χET prediction (including theoretical uncertainties) for A(Q) in the range √Q^2 < 0.7 GeV. This prediction can be compared to recent JLab data on A(Q), taken in the range 0.2 < √Q^2 < 0.7 GeV.

1Research supported by the US Department of Energy.

9:18AM A7.00003 ABSTRACT WITHDRAWN —

9:30AM A7.00004 Measurement of the tensor analyzing powers T_20 and T_21 in elastic electron-deuteron scattering with BLAST

M. KOHL, Hampton University, BLAST COLLABORATION — With the BLAST experiment at MIT-Bates, precision measurements of single and double polarization observables were carried out by scattering longitudinally polarized electrons from internal, isotopically pure and highly polarized hydrogen and deuterium targets in elastic and quasi-elastic kinematics. Analysis of elastic scattering data acquired with tensor-polarized deuterium has provided new results at low momentum transfer for the deuteron tensor analyzing powers T_20 and T_21 which will be presented.

1Supported by DOE and NSF.

9:42AM A7.00005 Measurement of the magnetic form factor of the neutron with quasielastic electron scattering from vector-polarized deuterium with BLAST

R. ALARCON, Arizona State University, BLAST COLLABORATION — With the BLAST experiment at MIT-Bates, precision measurements of single and double polarization observables were carried out by scattering longitudinally polarized electrons from internal, isotopically pure and highly polarized hydrogen and deuterium targets in elastic and quasi-elastic kinematics. Analysis of inclusive scattering data acquired with vector-polarized deuterium has provided new results at low momentum transfer for the neutron magnetic form factor G_{Mn} which will be presented.

1Supported by DOE and NSF.

9:54AM A7.00006 Large Q^2 Electrodisintegration of the Deuteron in Virtual Nucleon Approximation

M. SARGSIAN, Florida International University — Two-body break up of the deuteron is studied at high Q^2 kinematics, with main motivation to probe the deuteron at small internucleon distances. Such studies are associated with the probing of high momentum component of the deuteron wave function. For this, two main theoretical issues have been addressed such as electromagnetic interaction of virtual photon with the bound nucleon and the strong interaction of produced baryons at the final state of the break-up reaction. Within virtual nucleon approximation we developed a new prescription to account for the bound nucleon effects in electromagnetic interaction. The final state interaction at high Q^2 kinematics is calculated within generalized eikonal approximation (GEA). We studied the uncertainties involved in the calculation and performed comparisons with the first experimental data on deuteron electrodisintegration at large Q^2. We demonstrate that the experimental data confirm GEA’s early prediction that the rescattering is maximal at ~ 700 of recoil nucleon production with respect to the momentum of virtual photon. Comparisons also show that the forward recoil nucleon angles are best suited for studies of the electromagnetic interaction of bound nucleons and the high momentum structure of the deuteron.

1Supported by the U.S. DOE Grant DE-FG02-01ER41172.

10:06AM A7.00007 Experiment E06-009, “ROSEN07” – Measurement of R = F_L/F_T on Deuterium in the Nucleon Resonance Region

I. ALBAYRAK, Hampton University — This experiment ran in Hall C at Jefferson Lab to measure L/T separated structure functions from deuterium from the quasilaelastic region through the nucleon resonance region and beyond (up to W^2 = 4.5 GeV^2), spanning the four-momentum transfer range 1 < 4.5(GeV/c)^2. Rosenbluth separation technique is used to extract separated structure functions F_1, F_2, F_L and R. The measurement of these fundamental quantities allows a variety of physics issues to be addressed including: an evaluation of QCD moments of the deuteron and neutron structure functions (experimentally determining both the proton and neutron moments provide a direct confrontation with recent and future calculations from lattice QCD of the nucleon non-singlet moments), and quark-hadron duality in protons and neutrons. This experiment was completed in July 2007 at Jefferson Lab using the equipment: the High Momentum Spectrometer (HMS) to detect electrons and 4 cm cryogenic deuterium target. The current status of the data analysis and preliminary results such as nearly finalized cross sections, L/T separation results on deuterium, preliminary moments and duality studies will be presented.
10:45AM H6.00001 Universal Three-Body Bound States of Ultracold Fermionic Atoms. KENNETH O'HARA, The Pennsylvania State University — In the early 1970’s, Vitaly Efimov predicted that three-body systems with resonant two-body interactions admit an infinite sequence of arbitrarily shallow three-body bound states. The binding energy of these so-called Efimov trimers has a geometric spectrum with an accumulation point at the three-particle scattering threshold. The existence of these universal Efimov trimers is independent of the detailed structure of the two-body interactions and subsequent trimer states in the spectrum exhibit a discrete scaling symmetry with a universal scale factor $\approx 22.7$. I will present experimental evidence for the existence of the ground- and first-excited states of this infinite sequence in a system of ultracold fermionic atoms. Near resonant two-body interactions in our system of ultracold $^6$Li atoms are realized by making use of three overlapping, magneto-tun able Feshbach scattering resonances. I will describe how our observations of three-body recombination in the ultracold gas allows us to determine the spectrum of the Efimov trimers as well as their lifetime.

11:21AM H6.00002 Universal interactions in atomic and low-energy few-nucleon systems\(^1\). IONEL STETCU, University of Washington — Atomic systems with large two-body scattering lengths present remarkable similarities with nuclear systems at low energies. In both cases, the system properties are universal, depending mainly on the scattering length, which is much larger than the interparticle separation, and not on the details of the interaction. Therefore, the few-body methods developed to test one system, can be readily applicable to the other system. The study of the atomic systems characterized by large scattering lengths provide an excellent testing ground for few- and many-body methods that can be further applied, with little or no changes, to the description of nuclear systems at low energies. In this talk, I will present an effective-field theory approach to constructing two-body effective interactions in no-core shell model (a method developed for describing nuclear systems) finite spaces, with direct applications to the description of cold atom gases in harmonic traps. In particular, results up to next-to-next-to-leading order for the spectrum of the three-fermion system at unitarity will be presented and shown to agree with known results. Next, I will present the extension to finite values of the scattering length, as well as finite albeit small finite range, of interest for nuclear physics. Finally, I will discuss further application of such an approach to the description of atomic nuclei.

\(^1\)Partially supported by DOE under contract number DE-FG02-07ER41457 (ScIDAC-UNEDF).

11:57AM H6.00003 Large Scattering Lengths, Universality, Correlations and Few-Nucleon Systems\(^1\). HARALD W. GRIESSHAMMER, George Washington U. — In a plethora of processes pivotal e.g. for Big-Bang Nucleo-synthesis BBN, the typical energy scale lies below 10 MeV. Since the scattering lengths between two nucleons are much larger than the typical range of the nucleon-nucleon interaction, Nuclear Physics at these energies is described by the Effective Field Theory of Point-Like Interactions, EFT(PLI), a model-independent theory with systematically improvable, reliable theoretical uncertainties. It helps to provide the bridge from the deceptive simplicity of high-energy QCD, the microscopic theory of strong interactions, to the richness and complexity of few-nucleon physics, and to explain in turn how universal aspects emerge from that complexity. In contradistinction to atomic systems, effective-range contributions have often to be accounted for, as they provide sizable corrections of up to 30%. EFT(PLI) is an excellent tool to check data consistencies, to extract nucleon properties by uniquely subtracting nuclear binding effects, and to model-independently predict processes which are experimentally hard to access, e.g. for BBN and interactions between neutrinos and the lightest nuclei. Furthermore, its model-independent assessment of few-body interactions explains correlations between e.g. binding energies and scattering lengths, and thus allows to differentiate between observables which are dominated by large scattering lengths from those which are sensitive to the details of the nuclear force. The same concepts apply to halo-nuclei, i.e. systems which are much larger than its constituents, namely a small core orbited by nucleons. Some of these systems exhibit e.g. Borromean binding or an Efimov-spectrum. While the nucleon-nucleon scattering lengths cannot be tuned experimentally, there are indications that they are infinite when the pion has about 3 times its physical mass. EFT(PLI) explores which impact varying fundamental parameters of QCD has on the nuclear spectrum, and in particular on BBN. This contribution will illustrate the above points, focusing on concrete examples of general relevance.

\(^1\)Supported in part by NSF CAREER and DOE.

3:30PM K7.00001 An overview of the research program at the High Intensity Gamma-Ray Source (HIGS) to study light nuclei\(^1\). MOHAMMAD AHMED, Duke University/TUNL — A program is underway at the HIGS facility to study the response of nucleons and light nuclei, namely the deuteron and 3He, to gamma rays having energies between photodisintegration threshold and 100 MeV. Major components of this program are: 1) the spin response of polarized deuterium and polarized 3He to circularly polarized gamma rays to study the Gerasimov-Drell-Hearn (GDH) sum rule; 2) Compton scattering from protons and deuterons to extract the static electromagnetic polarizabilities of the nucleons; 3) A first measurement of the proton spin-polarizabilities; and 4) measurement of total and differential cross sections of the deuteron and 3He at energies relevant to Big-Bang Nucleosynthesis (BBN). An overview of these programs and initial results will be presented.

\(^1\)Work supported by DOE grant DE-FG02-07ER41033.

4:06PM K7.00002 The Near-Threshold Pion Photoproduction Program at MAX-lab. GRANT O’RIELLY, University of Massachusetts Dartmouth, MAX-TAGG COLLABORATION — One of the important questions in nuclear science is to describe the properties of the nucleon in terms of the framework provided by QCD. In the low-energy nuclear region the QCD calculations are impossible to do using standard techniques, so it is necessary to use alternative approaches to solve them. One process where these other techniques are both valid and useful is pion photoproduction near threshold. Since this process involves a rearrangement of the quarks in the nucleon it is directly accessing the underlying quark structure. Measurements of this fundamental process can be used to test the predictions from chiral effective-field theories, dispersion theory approaches and other quark-based models of the nucleon. The new Photon Tagging Facility at MAX-lab in Lund, Sweden is uniquely suited to perform measurements of pion photoproduction at energies between threshold and the $\Delta$-resonance. A comprehensive program to investigate pion photoproduction is currently underway at MAX-lab. These measurements will provide important new information on the $p$-wave contributions to charged pion photoproduction, resolve questions regarding the threshold $\Gamma_{\pi N}^p\equiv \Gamma_{\pi^+ n}$ amplitude, and will be the first measurement of neutral pion production from the neutron. A brief overview of the program at MAX-lab, together with preliminary results from measurements already performed will be presented.
4:18PM K7.00003 Program of Compton Scattering Studies on the Deuteron at HIGS. GERALD FELDMAN, George Washington University. COMPTON@HIGS COLLABORATION — The High Intensity Gamma Source (HIGS) at Duke University will deliver intense mono-energetic photon beams with high degrees of linear or circular polarization by backscattering of free-electron laser (FEL) photons. To exploit the unique capabilities of this facility, a program of Compton scattering studies on light nuclei (\( p, d, ^3\text{He} \)) is planned. Experiments using deuterium targets will elucidate the electromagnetic polarizabilities of the neutron (\( \alpha_n \) and \( \beta_n \)) and provide high precision data at low energies \( (E_\gamma = 30-50 \text{ MeV}) \) for comparison with chiral Effective Field Theory (EFT) calculations. Absolute cross sections for elastic Compton scattering on deuterium will be measured for the first time in this energy region, and with the advent of polarized deuterium targets at HIGS, additional constraints on \( \alpha_n \) and \( \beta_n \) can be imposed. Furthermore, the prospect of measuring double polarization observables with circularly polarized photons in Compton scattering at higher energies \( (E_\gamma = 100-120 \text{ MeV}) \) will enable the spin polarizabilities \( (\gamma_1, \gamma_2, \gamma_3, \gamma_4) \) of the neutron to be determined for the first time and will complement parallel studies on the proton. The plans for Compton scattering experiments on deuterium will be outlined and the impact on the neutron electromagnetic and spin polarizabilities will be discussed.

4:30PM K7.00004 Interaction current in \( pp \rightarrow pp\gamma \). K. NAKAYAMA1, Department of Physics and Astronomy, University of Georgia, Athens, GA 30602. H. HABERZETTL2, Center for Nuclear Studies, Department of Physics, The George Washington University, Washington, DC 20052 — The nucleon-nucleon bremsstrahlung reaction is investigated based on a fully gauge-invariant relativistic meson-exchange model approach. In order to account consistently for the complicated part of the interaction current (which at present is too demanding to be calculated explicitly), a generalized contact current is introduced following the approach of Haberzettl, Nakayama, and Krewald [PRC 74, 045202 (2006)]. The contact interaction current is constructed phenomenologically such that the resulting full bremsstrahlung amplitude satisfies the generalized Ward-Takahashi identity. The formalism is applied to describe the high-precision proton-proton bremsstrahlung data at 190 MeV obtained at KVI [PRC 65, 031001 (R) (2002)]. The present results show good agreement with the data, thus removing the longstanding discrepancy between the theoretical predictions and experimental data. The present investigation, therefore, points to the importance of properly taking into account the interaction current for this reaction.

4:42PM K7.00005 First Study of Three-body Photo-disintegration of \( ^3\text{He} \) with Double Polarizations1, W. CHEN, X. ZONG, M.W. AHMED, H. GAO, S. HENSHAW, B.A. PERDUE, X. QIAN, P. SEO, S. STAVE, H.R. WELLER, Q. YE, W. ZHENG, X. ZHU, M. BUSCH, J. LI, S.F. MIKHAILOV, C. SUN, Y.K. WU, TUNL/Duke, R. LU, Institute of Modern Physics, CAS — The study of the three-nucleon system has long been of fundamental importance to nuclear physics. We report on a first study of three-body photo-disintegration of polarized \(^3\text{He}\) with a circularly polarized \( \gamma \)-ray beam at an incident energy of 11.4 MeV. This experiment was carried out at the High Intensity \( \gamma \)-Ray Source (HiγS) facility located at the Duke University Free Electron Laboratory. A high-pressure polarized \(^3\text{He}\) target based on spin-exchange optical pumping of hybrid alkali was used in the experiment. Both differential cross sections and asymmetries were extracted from the experiment. The results are compared to the three-body calculations using both CD Bonn and AV18 potentials and are in agreement within experimental uncertainties.

4:54PM K7.00006 Photodisintegration of Lithium Isotopes, R.E. PYWELL, University of Saskatchewan, W.A. WURTZ, U. of Saskatchewan, B. NORUM, S. KUCUCKER, U. of Virginia, B.D. SAWATZKY, Temple U./Jefferson Lab, H.R. WELLER, M.A. AHMED, S. STAVE, Duke U. — The study of the three-nucleon system has long been of fundamental importance to nuclear physics. We report on a first study of three-body photo-disintegration of polarized \(^3\text{He}\) with a circularly polarized \( \gamma \)-ray beam at an incident energy of 11.4 MeV. This experiment was carried out at the High Intensity \( \gamma \)-Ray Source (HiγS) at Duke University in Durham, NC, USA. The Blowfish Neutron Detector Array, a segmented neutron detector array with good angular resolution that covers \( 1/3 \) of \( 4\pi \) steradians, was used to detect photoneutrons. Clear separation of various reaction channels is possible which allows detector efficiencies to be accurately modeled using a GEANT4 simulation. Several methods for obtaining the incident photon flux are available so precision cross sections between 8 and 35 MeV can be obtained.

5:06PM K7.00007 A New Measurement of the Total Cross Section for the Photodisintegration of \(^9\text{Be}\) Near Threshold1, C.W. ARNOLD, T.B. CLEGG, H.J. KARWOWSKI, G.C. RICH, J.R. TOMPKINS, UNC Chapel Hill, TUNL, C.R. HOWELL, Duke University, TUNL — The hot and neutron rich dense matter in Type II supernovae is a plausible environment where r-process nucleosynthesis takes place. The reaction \( \alpha(\alpha,\gamma)^9\text{Be}(\alpha,n)^{12}\text{C} \) is the favored reaction chain for synthesizing carbon in this explosive environment. Nucleosynthesis network models indicate that the ratio of neutrons to seed nuclei at the onset of the r-process is highly sensitive to the rate of the \( \alpha(\alpha,\gamma)^9\text{Be}(\alpha,n)^{12}\text{C} \) reaction relative to the \( \alpha(\alpha,\gamma)^{12}\text{C} \) reaction. The rate of the \( \alpha(\alpha,\gamma)^{12}\text{C} \) reaction is derived from the measured cross section for photodisintegration of \(^9\text{Be}\). New cross section measurements for this reaction have been made from threshold to 5 MeV using the High Intensity Gamma-ray Source (HiγS) at TUNL. The low energy spread (as low as 1%) of the beam at HiγS enabled high precision measurements at the reaction threshold energy and of the narrow resonance at 2.43 MeV. Experimental techniques and results will be presented and astrophysical consequences will be discussed.

1This work is supported by the U.S. Department of Energy under contract number DE-FG02-03ER41231 and the school of Arts & Science at Duke University.

5:18PM K7.00008 Measuring the Neutron Lifetime. JEFF NICO, NIST — Precision measurements of neutron beta decay parameters address basic questions in nuclear and particle physics, astrophysics, and cosmology. As a basic semileptonic decay system, the free neutron plays an important role in understanding the physics of the weak interaction, and improving the precision of the neutron lifetime is fundamental to testing the validity of the theory. Currently, there are two main strategies for measuring the lifetime. Experiments using confined, ultracold neutrons determine the lifetime by counting neutrons that remain after some elapsed time; experiments using cold neutrons measure the absolute specific activity of a beam by counting decay protons and the neutron flux simultaneously. The status of the recent lifetime measurements using these methods is discussed along with prospects for future experiments using new techniques.
2:06PM Q2.0002 Results from a Search for the Permanent Electric Dipole Moment (EDM) of $^{195}$Hg$^1$. BLAYNE HECKEL, University of Washington — Observation of a nonzero EDM would imply CP violation beyond the Standard Model. Additional sources of CP violation are expected to help explain the matter-antimatter asymmetry observed in our universe and naturally arise in extensions to the standard model such as supersymmetry. Our group has recently reported a new upper limit: $|d_{\text{Hg}}| < 3.1 \times 10^{-20}$ e-cm for the EDM of $^{195}$Hg. The experiment compared the spin precession frequencies in four spin-polarized Hg vapor cells: two cells lie in parallel magnetic and anti-parallel electric fields, resulting in EDM-sensitive spin precession while the remaining two cells, at zero electric field, serve to cancel noise generated by magnetic field gradients and test for systematic errors. A frequency shift, linear in the applied electric field, due to the Stark mixing of atomic states has been identified and measured. A description of the EDM experiment and measurements that led to our recent result will be presented.

3:30PM S7.00001 Electromagnetic properties of hadrons from lattice QCD. BRIAN TIBURZI, University of Maryland, WILLIAM DETMOLD, ANDRE WALKER-LOUD, College of William and Mary — The response of hadrons to electromagnetic probes is highly constrained by chiral dynamics; but, in some cases, predictions have not compared well with experimental data. Electromagnetic properties of hadrons can be computed by lattice simulations of QCD in background fields. Focusing on calculations in background electric fields, we demonstrate new techniques to determine electric polarizabilities and magnetic moments. Results for the nucleon are presented. We argue that the lattice can be used to test the chiral electromagnetism of hadrons, and ultimately confront experiment.

3:42PM S7.00002 Hard Photodisintegration of a Proton Pair, DOUGLAS HIGINBOTHAM, Jefferson Lab, ISHAY POMERantz, Tel Aviv University, JEFFERSON LAB HALL A COLLABORATION — The energy dependence of the high energy 90 degree center of mass photodisintegration of proton-pairs in kinematics corresponding to the proton pair (and the spectator neutron) nearly at rest have been measured in Hall A at Jefferson Lab. Cross-section measurements were taken for eight photon energies in the range of 0.8 - 4.7 GeV. Scaling of the cross section by $s^{-1/2}$ was observed, in agreement with the constituent counting rule prediction, but commencing at $E_c$ ~ 2.2 GeV, rather than 1 GeV as in the deuteron (pn pair) breakup. The magnitude of the scaled cross section for pp pair breakup was found to be dramatically lower than for the breakup of pn pairs and theoretical predictions. At energies below the scaling region, the scaled cross section was found to present a strong energy-dependent structure not observed in the pn breakup. The data indicate a transition from three-nucleon hadronic photodisintegration processes at low energies to two-nucleon quark-dominated photodisintegration processes at high energies.

3:54PM S7.00003 Deeply Virtual Compton Scattering off $^4$He nucleus, AHMED EL ALAOUI — The recently developed formalism of generalized parton distributions (GPDs) provides a theoretical tool to reveal the internal structure of the nucleon. These objects can be obtained via Deeply Virtual Compton Scattering (DVCS) processes. They contain informations on the transverse spatial position and the longitudinal momentum of quarks inside the nucleon and they also give access to the contribution of the quark orbital angular momentum to the nucleon. In contrast to many DVCS experiments using a proton target, only few experiments are devoted to study GPDs in a nuclear target which is important because it allows to address medium modification of bound nucleon GPDs compared to free nucleon GPDs. One of the goals of the new EG6 experiment at Thomas Jefferson Laboratory is to extract the real and imaginary parts of the $^4$He Compton form factor ($\Pi_{A}(x_F, t)$) from measurement of beam spin asymmetries by scattering a polarized 6 GeV electron beam off a $^4$He pressurized gaz target. Details on the experiment will be presented here.

4:06PM S7.00004 Measurements of the Electric Form Factor of the Neutron at High Momentum Transfer, SEAMUS RIORDAN, University of Virginia, E02-013 COLLABORATION — The electromagnetic form factors of the nucleon provide experimental access to the underlying charge and magnetic moment distributions of quarks. These form factors provide excellent testing grounds for QCD and QCD-inspired models and are of fundamental importance in our understanding of non-perturbative QCD. Of the four nucleon form factors, the electric form factor of the neutron, $G_E^n$, has been measured in the smallest range of momentum transfer. We have measured the electric form factor of the neutron at four $Q^2$ points between 1.2 and 3.5 GeV$^2$ in Hall A at Jefferson Lab. This more than doubles the momentum transfer region for which this quantity has previously been measured, providing new information on the structure of the neutron. Final results for $G_E^n$ at three $Q^2$ points, 1.7, 2.5, and 3.5 GeV$^2$, will be presented and compared with QCD-based models and phenomenological approaches. Separated form factors for $u$ and $d$ quarks will also be presented.

4:18PM S7.00005 Understanding 3He(e,e’p) Reaction Asymmetry Dependence on Missing Momentum, GE JIN, University of Virginia, JEFFERSON LAB HALL A COLLABORATION — Two-body calculations using realistic wave-functions predicted that the (e,e’p) asymmetry would vary strongly as a function of missing momentum. This prediction has been tested in quasi-elastic (e,e’p) experiments in which people have observed the predicted sign change of the asymmetry as the missing momentum gets larger than the Fermi momentum. Using state-of-the-art Faddeev calculations, the 3He(e,e’p) reaction channel can also be calculated and it has been shown that the asymmetry as a function of missing momentum is again sensitive to the initial-state wave-function. Jefferson Lab experiment E05-102 measured the polarized-target and polarized-beam asymmetries in the quasi-elastic and x great than one 3He(e,e’p) and 3He(e,e’d) channels. An overview of experiment will be discussed and preliminary (e,e’p) asymmetries as a function of missing momentum will be presented.
A precise extraction of the proton induced polarization in $^4\text{He}(e,e'p)^3\text{H}$.

**S7.00007**

SIMONA MALACE, MICHAEL PAOLONE, STEFFEN STRAUCHAR, University of South Carolina, JEFFERSON LAB E03-104 COLLABORATION — Polarization transfer in quasi-elastic nuclear knock-out is sensitive to the properties of the nucleon in the nuclear medium, including possible modification of the nucleon form factor. In experiment E03-104 at Jefferson Lab we measured the proton recoil polarization in the $^4\text{He}(e,e'p)^3\text{H}$ reaction at a $Q^2$ of 0.8 (GeV/c)$^2$ and 1.3 (GeV/c)$^2$ with unprecedented precision, allowing the individual polarization transfer coefficients and their ratio to be studied as a function of the missing momentum. The data differ from a fully relativistic distorted wave impulse approximation (RDWIA) calculation which uses free space proton form factors, but strong agreement is obtained if medium modified form factors are used. The data also agree with a model calculation including a charge-exchange final-state interaction with no medium modification of the nucleon form factors. The polarization transfer ratios have been studied as a function of the virtuality of the proton; the ratio increases in an almost linear fashion from the farthest off-shell measurements of the recoiling proton to the extrapolated value of an unbound proton expected at virtuality equal to zero.

**Supported in part by DOE under contract DE-FG02-03ER41260.**

11:09AM S7.00003 Parity-violating three-body forces in effective field theory.

**X7.00003**

MATTHIAS R. SCHINDLER, The George Washington University — Hadronic parity violation in the two-nucleon system has been studied using a pionless effective field theory (EFT). The advantage of an EFT over a model-dependent description is that it allows for the consistent description of three- and few-body systems. I will present the extension of the parity-violating EFT program to the three-body system, discussing the leading parity-violating three-body forces and whether these are required to consistently describe nd scattering. These results can then be used in the description of the reaction nd → τγ, for which a new experimental measurement might be performed in the future.

1Supported in part by NSF CAREER-grant PHY-0645498 and DOE grant DE-FG02-95ER40907.
11:21 AM X7.00004 Ab initio no core results for light nuclei with a Woods-Saxon basis\textsuperscript{1}, \textsc{Gianina Alina Negoita}\textsuperscript{2}, \textsc{James Vary}, \textsc{Peter Maris}, Iowa State University, \textsc{Andrey Shirokov}\textsuperscript{3}, Moscow State University — We perform no-core (NCFC) calculations for a set of light nuclei with the realistic NN interaction, JISP16. We perform our calculations both in a harmonic oscillator and Woods-Saxon basis and compare convergence rates for the ground state energies, energies of selected excited states, rms radii and other observables. Initial results for the binding energies and rms radii of \textsuperscript{4}He and \textsuperscript{12}C will be presented. The differences in the convergence rates of these results with increasing basis size reflects the infra-red properties of the basis states. We will discuss factorization of the center-of-mass motion and show how insuring factorization affects the results in the Woods-Saxon basis spaces.

\textsuperscript{1}Supported in part by DOE grants and DE-AC02-09ER41582.
\textsuperscript{2}and Horia Hulubei National Institute for Physics and Nuclear Engineering, Bucharest-Magurele, Romania
\textsuperscript{3}and Skobeltsyn Institute of Nuclear Physics, Moscow, Russia

11:33 AM X7.00005 The Similarity Renormalization Group with Spurious Deep Bound States\textsuperscript{1}, \textsc{K.A. Wendt}, \textsc{R.J. Furnstahl}, \textsc{R.J. Perry}, Ohio State Univ. — Similarity Renormalization Group (SRG) transformations decouple low- and high-energy degrees of freedom. The simplest examples are unitary and fixed by relatively simple flow equations that govern how the effective hamiltonian transforms. We study how decoupling emerges in cases where deeply bound states appear (e.g., spurious bound states in some effective field theories with large cutoff). We show that with the appropriate choice of SRG generator, deeply bound states decouple from low energy physics once the cutoff is lowered below the deep scale. Qualitatively, the high-energy region of the hamiltonian is diagonalized (the analog of integrating out these states) and a universal low-energy effective hamiltonian emerges.

\textsuperscript{1}Supported in part by the NSF under Grant No. PHY-0653312.

11:45 AM X7.00006 Effective theory approach to few-fermion systems in a trap\textsuperscript{1}, \textsc{Jimmy Rotureau}, University of Arizona, \textsc{Ionel Stetcu}, University of Washington, \textsc{Bruce Barrett}, University of Arizona, \textsc{Mike Birse}, University of Manchester (UK), \textsc{Ubirajara Van Kolck}, University of Arizona — The properties of strongly interacting Fermi gases have been the object of great interest in recent years. When the scattering length is much larger than the effective range of the interaction, few-atom systems serve as a testing ground for techniques developed for the ab-initio solution of few-nucleon systems. We have applied the principles of Effective Field Theory to describe few-fermions systems in a harmonic trap. The interaction is written as a controllable expansion of contact interactions with derivatives. The no-core shell model is used to solve the many-body Schrödinger equation at leading order and corrections beyond LO are treated in perturbation theory. We have also addressed the relationship between the two-body and many-body couplings needed for a consistent model space. Results for the energies of the 3-fermions system at unitarity will be presented and shown to agree with known results. Results for systems with 3, 4 fermions for different values of \( a_2/b \) (\( b \) being the trap length) and \( r_0/b \) will also be presented.

\textsuperscript{1}This research was supported by the U.S. Department of Energy and the National Science Foundation.

11:57 AM X7.00007 Phase-fluctuating regime of a ring-shaped Bose-Einstein condensate, \textsc{Ludwig Mathey, Anand Ramanathan, Kevin Wright, William Phillips, Charles Clark, NIST} — We study the phase-fluctuating condensate regime of ultra-cold atoms trapped in a ring-shaped geometry. We first consider a simplified box geometry, in which we identify the conditions to create a state that is dominated by thermal phase fluctuations, and then explore the actual experimental geometry. We also address possible ways of detecting this regime.

12:09 PM X7.00008 Dissipative hydrodynamics (DHD) of rigid spherical particles\textsuperscript{1}, \textsc{Albert Kim}, \textsc{Yong Shi}, University of Hawaii at Manoa — Phenomena of many spherical particles in aqueous phase are ubiquitous in a plethora of natural and engineered processes. Brownian dynamics (BD), as originated from molecular dynamics (MD), is inherently limited to point-particles governed by the Oseen diffusion tensor. Stokesian dynamics (SD) incorporates accurate multi-pole expansions and lubrication for accurate far- and near-field hydrodynamic interactions, respectively. Dissipative particle dynamics (DPD) overcame the relaxation-time restriction of BD and SD by developing Fokker-Planck equations including the Wiener process, but allowed pair-wise superposition of approximate hydrodynamic interactions. We unified DPD and SD and developed dissipative hydrodynamics (DHD) of rigid spherical particles, which incorporates many-body hydrodynamics of SD formalism and satisfies the fluctuation-dissipation theorem. DHD is more rigorous than SD and BD, and its accuracy is controllable with the choice of time step. Translations and rotations, influenced by both deterministic and random forces exerted on all the particles, can be accurately mimicked in a given uniform or shear flow within a range of the mean free path of a particle.

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