78th Annual Meeting of the Southeastern Section of the APS
Roanoke, Virginia
http://www.aps.org/meetings/meeting.cfm?name=SES11
8:30AM BA.00001 Recent developments in four-dimensional supergravity, ERIC SHARPE, Virginia Tech — I will summarize recent work on gauge theories in supergravity, specifically concerning the "Fayet-Iliopoulos" parameter. In rigidly supersymmetric gauge theories, this parameter also appears and can vary continuously. In supergravity old lore held that it should always vanish. I will discuss recent developments showing that in fact it can be nonzero, but is quantized, and will explore various ramifications of that result.

9:00AM BA.00002 Mathematical Surprises From Off-Shell SUSY Representation Theory

9:30AM BA.00003 Real-time finite temperature AdS/CFT and jet quenching, DIANA VAMAN, University of Virginia — I will introduce a simple prescription for computing real-time finite temperature n-point functions in AdS/CFT. When used to compute the stopping distance of a highly energetic jet moving through strongly coupled N = 4 superYang-Mills plasma, the typical jet stopping distance scales with energy as (EL)\(^{1/4}\), where L is the size of the region where the jet was created.

10:00AM BA.00004 Holographic superconductors at low temperatures

Thursday, October 20, 2011 8:30AM - 10:30AM — Session BB Nano Materials

8:30AM BB.00001 Graphene: it’s all about the surface, KIRILL BOLOTIN, Vanderbilt — Every atom of graphene, a monolayer of graphite, belongs to the surface. Therefore, the environment of graphene — the substrate onto which graphene is deposited and the coating on top of graphene — intimately affects the properties of graphene. In this talk, we demonstrate that both mechanical and electrical properties of graphene can be greatly tuned by varying its environment. First, we discuss ultraclean graphene devices suspended in vacuum. We achieve a carrier mobility in excess of 200,000 cm\(^2/Vs\) in these devices and demonstrate previously inaccessible transport regimes, including ballistic transport and the fractional quantum Hall effect. Second, we explore the electrical properties of graphene surrounded by liquid dielectrics. We find that the ions in liquids can cause strong scattering in graphene and demonstrate very large values for room temperature mobility (> 60,000 cm\(^2/Vs\)) in ion-free liquids with high dielectric permittivity. Finally, we demonstrate that the environment of graphene affects its mechanical properties. We develop a novel technique to study the mechanical properties of graphene films attached to substrates by measuring the temperature-dependent deflection of a “bimetallic” cantilever composed of graphene and silicon nitride or gold layers. We demonstrate that the built-in strain, the substrate adhesion force and even the thermal expansion coefficient of graphene depend on the substrate under it.

9:00AM BB.00002 Flat-band Nanostructures, VITO SCAROLA, Virginia Tech — The electronic band structure of many systems, e.g., carbon-based nanostructures, can exhibit essentially no dispersion. Models of electrons in such flat-band lattices define non-perturbative strongly correlated problems by default. Here strong interactions can give rise to novel quantum phases of matter with intriguing collective excitations. Flat bands therefore allow the possibility of discovering emergent physics determined solely by interactions. I will review work that theoretically explores strongly correlated lattice models with flat bands. Zero-field flat-band lattice systems offer arenas to study quantum crystals, quantum liquids, and magnetism. I will also discuss recent results from microscopic modeling of a specific flat-band system, electrons in graphene nanoribbons with zig zag edges. Here I will show that interactions can lead to quantum crystals with ferromagnetic order.
8:30AM BB.00001 A Study of the Ionization of Deuterium Gas by Pyroelectric Crystals — BRYCE TAYLOR, North Carolina School of Science and Math, STEPHEN SHAFFROTH, UNC, WERNER TORNOW, Duke/TUNL — Pyroelectric crystals produce a stream of electrons or positive ions when heated or cooled in a near-vacuum environment. We studied the behavior of these crystals in deuterium gas. We look at what portion of the positive ion beam consists of D+ ions and what portion is D2+ and D3+. Since D2+ contains only half the energy of D+ per deuterium atom after traversing a given potential difference, it has a notably lower cross-section for fusing than D+ does, which lowers neutron yield. Looking at the equivalent dissociation question for HD gas, we find that <0.1% is ionized as H+ based on magnetic deflection of the ions. Analogous results are assumed for D2+. Furthermore, we present a new phenomenon in which groups of positive ions arrive at the detector at the same time similar to multiple peaks present in electron spectra reported by Brownridge and Shafroth.

We provide a new theory on the workings of pyroelectric crystals based on the expulsion of gas trapped inside the crystal to explain these findings and other results. Funding provided by grant DOE DE-FG52-09NA29465.

1Author Acknowledges support of NASA NNX08BA48A and NSF 1002410 grants.
9:18AM BC.00005 Helicity-Correlated Systematics in the \textit{Q}_\text{weak} Experiment \textsuperscript{1}, JOSHUA HOSKINS, College of William and Mary, Q\textit{W}-\textit{E}AKE COLLABORATION — The \textit{Q}_\text{weak} experiment at Jefferson Laboratory will provide a 4\% measurement of the proton’s weak charge \(Q_{\text{weak}}^p\), using parity-violating electron scattering from Hydrogen at low momentum transfer. The experiment will measure a tiny parity-violating asymmetry \(\sim 256\) parts per billion, which means control and precise measurement of systematic errors is a must. While great care is being taken to suppress or eliminate helicity-correlated changes in electron beam properties at the source, broken symmetries in the experimental apparatus can produce false asymmetries in the detected signal. For \(\text{Q}_{\text{weak}}\), we measure the detector sensitivities \(\partial A/\partial x_i\) \((i = 1..5)\) for first order offline correction of beam-related false asymmetries, using both regression against natural beam motion and a driven modulation system. I will discuss the methodology and status of the helicity-correlated detector sensitivities and how they relate to a precision measurement \(\text{Q}_{\text{weak}}\).

9:30AM BC.00006 Møller Polarimetry for the \textit{Q}_\text{weak} Experiment \textsuperscript{1}, JOSHUA MAGEE, College of William and Mary, Q\textit{W}-\textit{E}AKE COLLABORATION — The Standard Model of particle physics has been extremely successful in describing particle interactions in a wide-ranging regime of energy scales. Low-energy, parity-violating experiments enable high-precision experimental tests of Standard Model predictions. Currently, Jefferson Lab is performing one such investigation to determine the weak charge of the proton, \(\text{Q}_\text{weak}\), to 4\% precision using ep scattering. By making a precise measurement of the weak charge, this experiment will provide tighter constraints on some classes of “new physics” at 2 TeV or higher. To calculate the parity-violating asymmetry and determine \(\text{Q}_\text{weak}\) one needs precise knowledge of the incoming electron beam polarization. The \textit{Q}_\text{weak} experiment, which is underway in Jefferson Lab’s Hall C, uses both Møller and Compton polarimetry to determine the 1 GeV beam polarization. The Hall C Møller polarimeter is particularly relevant as it uses a superconductingagnet to saturate thin, pure iron, foils out of plane. This provides precise measurements of beam polarization to within 1\% uncertainty. Since the addition of the Compton device the Møller polarimeter has undergone a re-commissioning phase, followed by myriad studies to reduce the systematic errors to the 0.57\% level required by \textit{Q}_\text{weak}. A brief overview of the Hall C Møller device, followed by preliminary results of these studies and of the Spring 2011 experiment run, will be provided.

9:42AM BC.00007 A Diamond Micro-strip Electron Detector for Compton Polarimetry\textsuperscript{1}, AMRENDRA NARAYAN, Mississippi State University, VLADAS TVASKIS, University of Winnipeg, DIPANGKAR DUTTA, Mississippi State University, JEFFERY MARTIN, University of Winnipeg — The \textit{Q}_\text{weak} experiment in Hall C at Jefferson Lab aims to measure the weak charge of the proton with a precision of 4.1\% by measuring the parity violating asymmetry in polarized electron-proton elastic scattering. Beam polarimetry is the largest experimental contribution to the error budget. A new Compton polarimeter was installed for a non-invasive and continuous monitoring of the electron beam polarization with a goal of 1\% systematic and 1\% per hour statistical precision. The Compton-scattered electrons are detected in four planes of diamond micro-strip detectors. These detectors are read out using custom built electronic modules that include a pre-amplifier, a pulse shaping amplifier and a discriminator for each detector micro-strip. We use Field Programmable Gate Array based general purpose logic modules for event selection and histogramming. The polarimeter was commissioned during the first run period of the \textit{Q}_\text{weak} experiment. We will show the preliminary results from the electron detector obtained during the first run period of \textit{Q}_\text{weak} experiment.

\textsuperscript{1}Grant Number: DE-FG02-07ER41528: Precision Measurements at Medium Energy

9:54AM BC.00008 Sticky Dark Matter in the Effective Field Theory Approach\textsuperscript{1}, ANDRIY BADIN, Duke University, ALEXEY PETROV, Wayne State — There is experimental evidence that Dark Matter (DM) makes up about 25\% of the Universe’s mass and is expected to be nonrelativistic in most models. We explore the possibility of the creation and existence of a bound state of Dark Matter and standard model (SM) particles. Such bound states can potentially be created and detected during direct DM search experiments (DAMA, CDMS, XENON etc.). We work in a model-independent approach to determine conditions under which such bound states can be created. Our results appear to be dependent upon the nuclei used in the DM direct detection experiments. In this scenario we determine the region of DM parameter space that provides a simultaneous fit to DAMA and CDMS data.

\textsuperscript{1}Supported by DOE grants DE-FG02-05ER41368 and DE-FG02-96ER41005.

10:06AM BC.00009 Hadronic loop correction of charmonium decays\textsuperscript{1}, DI-LUN YANG, Dept. of Physics Duke University — Recently, the effect of next leading order correction from intermediate hadronic loops to the charmonium decays has been widely studied. However, the coupling constants of the charmonium multiplets and heavy mesons cannot be directly measured from experiments. In this talk, we will present the investigation of hadronic loop correction to both hadronic decays and radiative decays of the lowest excited states of charmonia and try to extract the reasonable coupling constants.

\textsuperscript{1}Collaborated with Thomas Mehen (Dept. of Physics Duke University)

Thursday, October 20, 2011 8:30AM - 9:00AM – Session BD Physics and Policy Crystal Ballroom DE - Beate Schmittman, Virginia Polytechnic Institute and State University

8:30AM BD.00001 The Role of Physicists in Policy Making \textsuperscript{1}, THOMAS HANDLER, Physics Dept. Univ. of Tennessee — Since World War II, physicists have been involved in various aspects of national life. The roles played have included: 1) Pure or applied researcher, 2) Advisor to policy makers, and 3) Congressman. Today there are many challenges and questions that the United States faces and scientists, physicists included, are often asked on how these challenges should be addressed. In addressing these concerns what is the “proper” role that scientists should play? Do scientists even know what the possible roles are? This talk will briefly address the possible roles that scientists play and what other avenues of input go into the making of policy.

Thursday, October 20, 2011 10:45AM - 12:45PM – Session CA Recent Progress in Nuclear Astrophysics Crystal Ballroom A - Jonathan Link, Virginia Polytechnic Institute and State University
10:45AM CA.00001 Progress towards Low Energy Neutrino Spectroscopy (LENS)¹. JEFF BLACKMON², Louisiana State University — The Low-Energy Neutrino Spectroscopy (LENS) experiment will precisely measure the energy spectrum of low-energy solar neutrinos via charged-current neutrino reactions on indium. LENS will test solar physics through the fundamental equality of the neutrino fluxes and the precisely known solar luminosity in photons, will probe the metallicity of the solar core through the CNO neutrino fluxes, and will test for the existence of mass-varying neutrinos. The LENS detector concept applies indium-loaded scintillator in an optically-segmented lattice geometry to achieve precise time and spatial resolution and unprecedented sensitivity for low-energy neutrino events. The LENS collaboration is currently developing a prototype, miniLENS, in the Kimbalton Underground Research Facility (KURF). The miniLENS program aims to demonstrate the performance and selectivity of the technology and to benchmark Monte Carlo simulations that will guide scaling to the full LENS instrument. We will present the motivation and concept for LENS and will provide an overview of the R&D efforts currently centered around miniLENS at KURF.

¹This work supported by the National Science Foundation.
²On behalf of the LENS Collaboration.

11:15AM CA.00002 Borexino—A Breakthrough in Spectroscopy of Low Energy Neutrinos from the Sun¹, RAMASWAMY S. RAGHAVAN, Virginia Tech — Low energy (< 1 MeV) solar neutrinos account for 99+5% of the emitted flux providing the essential window on energy production in the sun. For many decades of solar neutrino research, these could not be directly measured because of the formidable background barrier below 3 MeV. This constraint was broken by the Borexino experiment which has now measured the flux of 0.862 MeV neutrinos from the decay of 7Be in the sun. Indeed, this result is the most precise (<5%) solar neutrino flux known today. A strong push is being made for results on other solar neutrinos. These results arising from extraordinary technical achievements, far exceed initial goals set for this project some 20 years ago. I will trace the development and brief history of this project, describe the salient features of the detector, point out the principal technical achievements and present the most recent results and their impact on our understanding of energy production in the sun via the proton-proton chain as well as the CNO cycle. The results bear vitally on neutrino phenomenology as well. In addition to the sun, Borexino has also measured neutrinos from the interior of the earth, future directions and plans being discussed presently for Borexino will be indicated.

¹On behalf of the Borexino Collaboration. Supported in part by the National Science Foundation.

11:45AM CA.00003 Exploring the Cosmos from the Ground: Nuclear Astrophysics at UNC/TUNL, A.L. SALLASKA, UNC/TUNL — Nuclear astrophysics is an inherently interdisciplinary field encompassing observational astronomy, astrophysical modeling, and measurements of thermonuclear reaction rates. In general, a group studies only one of these branches in depth; however, the unique nuclear astrophysics group at University of North Carolina–Chapel Hill and Triangle Universities Nuclear Laboratory (TUNL) incorporates both theoretical and experimental research. Currently focusing on nuclear reaction measurements involved in thermonuclear explosions and heavy-element synthesis, the Laboratory for Experimental Nuclear Astrophysics (LENA) utilizes two accelerators with an energy range of ~50 – 1000 keV and current up to ~1.5 mA to measure proton fusion with various targets. Recent and on-going measurements include 23Na(p, γ)24Mg, 14N(p, γ)15O, and 17,18O(p, γ)18,19F. Our group has also formulated a new Monte Carlo method for calculating thermonuclear reaction rates from experimental results (such as resonance strengths), in which a rigorous statistical definition of uncertainties arises naturally. These rates provide a backbone for a new type of stellar reaction rate library currently in preparation, STARLIB. This library attempts to bridge the gap between experimental nuclear physics data and stellar modelers by providing a convenient tabular format with reliable uncertainties for use in simulating astrophysical phenomena. We expect to submit STARLIB for publication by year’s end, which will coincide with the unveiling of a webpage for ease of dissemination and updating. Finally, our group uses this library to run simplified models of astrophysical events, such as novae or AGB stars, via network calculations. The results from these models indicate which reactions significantly influence various isotopic abundances, thus providing motivation for new reactions to measure at LENA and other laboratories.

12:15PM CA.00004 DIANA - An Underground Accelerator Facility for Nuclear Astrophysics, ARTHUR CHAMPAGNE¹, University of North Carolina and Triangle Universities Nuclear Laboratory — Measuring nuclear reactions of astrophysical interest at stellar energies is usually a daunting task because the cross sections are very small and background rates can be comparatively large. Often, cosmic-ray interactions set the limit on experimental sensitivity, but can be reduced to an insignificant level by placing an accelerator underground — as has been demonstrated by the LUNA accelerators in the Gran Sasso underground laboratory. The Dual Ion Accelerator Facility for Nuclear Astrophysics (DIANA) is a proposed next-generation underground accelerator facility, which would be constructed at the 4850 ft level of the Homestake Mine in Lead, SD. This talk will describe DIANA and the questions in nuclear astrophysics that can be explored at such a laboratory.

¹For the DIANA Collaboration

Thursday, October 20, 2011 10:45AM - 12:45PM – Session CB Strongly Correlated Systems Crystal Ballroom B - Vito Scarola, Virginia Polytechnic Institute and State University

10:45AM CB.00001 Strong Correlation Effects in Fullerene Molecules and Solids, FEI LIN, Physics Department, Virginia Tech — Fullerenes (C20, C36, C60) are a family of Carbon cage molecules that have exactly twelve pentagons. The most famous Fullerene is C60 ("bucky ball"), which when being doped with three electrons per molecule will exhibit superconductivity. Here we describe electronic structures of these molecules with a tight-binding Hubbard model and solve the model with quantum Monte Carlo simulations and exact diagonalization method. We will show how the electronic correlation gets stronger as the molecule becomes more curved, how the strong electronic correlations change the Huckel molecular energy levels, and how we compare the single-particle excitation spectrum for the C60 molecular solid to the photoemission experiments.

11:15AM CB.00002 Interplay of Quantum Criticality and Geometric Frustration in Columbite, RIBHU KAUL, University of Kentucky — CoNb2O6 is a remarkable magnetic material. The interplay between two of the most exciting features of correlated quantum physics, quantum criticality and geometric frustration, results in a rich phase diagram which reflects the fundamental underlying quantum many-body physics in this complex oxide material. Many aspects of the theoretically calculated phase diagram and expectations for quantum criticality have already been observed in beautiful neutron scattering experiments on this material.

Segregated Mixed Phase Dynamics in the Time-domain

11:45AM CB.00003 Ultrafast Dynamics in Vanadium Dioxide: Separating Spatially Segregated Mixed Phase Dynamics in the Time-domain

DAVID HILTON, The University of Alabama at Birmingham — In correlated electronic systems, observed electronic and structural behavior results from the complex interplay between multiple, sometimes competing degrees-of-freedom. One such material used to study insulator-to-metal transitions is vanadium dioxide, which undergoes a phase transition from a monoclinic-insulating phase to a rutile-metallic phase when the sample is heated to 340 K. The major open question with this material is the relative influence of this structural phase transition (Peierls transition) and the effects of electronic correlations (Mott transition) on the observed insulator-to-metal transition. Answers to these major questions are complicated by vanadium dioxide’s sensitivity to perturbations in the chemical structure in VO$_2$. For example, related V$_2$O$_x$ oxides with nearly a 2:1 ratio do not demonstrate the insulator-to-metal transition, while recent work has demonstrated that V:VO$_2$ has demonstrated a tunable transition temperature controllable with tungsten doping. All of these preexisting results suggest that the observed electronic properties are exquisitely sensitive to the sample disorder. Using ultrafast spectroscopic techniques, it is now possible to impulsively excite this transition and investigate the photoinduced counterpart to this thermal phase transition in a strongly nonequilibrium regime. I will discuss our recent results studying the terahertz-frequency conductivity dynamics of this photoinduced phase transition in the poorly understood near threshold temperature range. We find a dramatic softening of the transition near the critical temperature, which results primarily from the mixed phase coexistence near the transition temperature. To directly study this mixed phase behavior, we directly study the nucleation and growth rates of the metallic phase in the parent insulator using non-degenerate optical pump-probe spectroscopy. These experiments measure, in the time-domain, the coexistent phase separation in VO$_2$ (spatially separated insulator and metal islands) and, more importantly, their dynamic evolution in response to optical excitation.

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This research has been partially supported by the Los Alamos National Laboratory Directed Research and Development program. A portion of this work was funded by Department of Education Grant No. P200A090143.

12:15PM CB.00004 Superfluidity in bilayer systems of cold polar molecules

ENRICO ROSSI, Department of Physics, College of William and Mary — An exciton is a quasiparticle state formed by an electron bound to a “hole.” Many years ago it was proposed theoretically that a population of excitons can condense into a spontaneously broken symmetry ground state characterized by excitonic superfluidity. The quest for the experimental realization of the exciton condensate has lasted decades. Recently bilayer systems have emerged as some of the most promising systems in which this state can be realized. The physics of exciton condensation in bilayer systems is very general. In this talk I will present the theory of “excitonic condensation” and spontaneous interlayer superfluidity in cold polar molecules bilayers [1] that because of the great control characteristic of cold atom systems and their intrinsic lack of disorder are ideal systems to study exciton condensates.


Thursday, October 20, 2011 10:45AM - 12:21PM –

Session CC Biophysics and Medical Physics

Crystal Ballroom C - Ken Wong, Virginia Polytechnic Institute and State University

10:45AM CC.00001 Stochastic Modeling of Regulation of Gene Expression by Multiple Post-transcriptional Regulators

CHARLES BAKER, TAO JIA, RAHUL KULKARNI, Virginia Polytechnic Institute and State University — New research indicates that post-transcriptional regulators, such as small RNAs (sRNAs), are key components of global regulatory networks. In particular, it has been discovered that these networks often comprise multiple sRNAs which control expression of a critical master regulator protein. However, the regulation of a single protein by multiple sRNAs is not currently well understood and the impact of multiple sRNA on stochastic gene expression remains unclear. To address these issues, we analyze a general model for post-transcriptional regulation of stochastic gene expression [2]. The results obtained provide new insights into the role of multiple sRNAs in fine-tuning the noise in gene expression.

In particular, we show that, in contrast to regulation by a single sRNA, multiple sRNAs provide a mechanism for independently controlling the mean and variance of the regulated protein distribution.


10:57AM CC.00002 Stochastic models of gene expression and post-transcriptional regulation

HODJAT PENDAR, Department of Engineering Science and Mechanics, Virginia Tech, RAHUL KULKARNI, TAO JIA, Department of Physics, Virginia Tech — The intrinsic stochasticity of gene expression can give rise to phenotypic heterogeneity in a population of genetically identical cells. Correspondingly, there is considerable interest in understanding how different molecular mechanisms impact the ‘noise’ in gene expression. Of particular interest are post-transcriptional regulatory mechanisms involving genes called small RNAs, which control important processes such as development and cancer. We propose and analyze general stochastic models of gene expression and derive exact analytical expressions quantifying the noise in protein distributions [1]. Focusing on specific regulatory mechanisms, we analyze a general model for post-transcriptional regulation of stochastic gene expression [2]. The results obtained provide new insights into the role of post-transcriptional regulation in controlling the noise in gene expression.


11:09AM CC.00003 Regulation by small RNAs via coupled degradation: mean-field and variational approaches

THIERRY PLATINI, Virginia Bioinformatics Institute, TAO JIA, RAHUL V. KULKARNI, Department of Physics, Virginia Tech — Regulatory genes called small RNAs (sRNAs) are known to play critical roles in cellular responses to changing environments. For several bacterial sRNAs, regulation is effected by coupled stoichiometric degradation with messenger RNAs (mRNAs). The nonlinearity inherent in this regulatory scheme implies that exact analytical solutions for the corresponding stochastic models are intractable. Based on the mapping of the master equation to a quantum evolution equation, we use the variational method (introduced by Eyink) to analyze a well-studied stochastic model for regulation by sRNAs. Results from the variational ansatz are in excellent agreement with stochastic simulations for a wide range of parameters, including regions of parameter space where mean-field approaches break down. The results derived provide new insights into sRNA-based regulation and will serve as useful inputs for future studies focusing on the interplay of stochastic gene expression and regulation by sRNAs.

We would like to thank the Stat. Mech. and NDSSL groups at Virginia Tech, especially professor S. Eubank. This research is funded by the US National Science Foundation through PHY-0957430, DMR-0705152 and the NIH MIDAS project 2U01GM070694-7

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11:21AM CC.00004 Utilizing protein networks to determine novel annotations, KENNETH SHIAO, JERRY FENG, TINA DOAN, ANDREY GORIN — Proteins are a key element of life because they are involved in every metabolic process, yet a majority of proteins remain unannotated. Current chemical and physical annotation methods are inaccurate, inefficient, or expensive. Without proper annotation, understanding of organisms’ metabolic pathways is limited. Based on the hypothesis that proteins with similar primary structures have similar characteristics, we theorize that a method for protein annotation can be developed using protein networking, which was previously thought to be useful in determining the evolutionary paths of proteins. A large, diverse database of proteins is used to connect protein fragments by using a preset identity threshold. With this method, unknown proteins are connected to known ones. By observing the number of links to proteins with annotated functions, a likely annotation candidate will be reached. This procedure can potentially facilitate the process of finding more accurate annotations. We have used and validated this approach to annotate putative uncharacterized proteins. Results will be presented at the conference.

11:33AM CC.00005 A Model Comparison for Characterizing Protein Motions from Structure1, CHARLES DAVID, Department of Bioinformatics and Genomics, University of North Carolina at Charlotte, Charlotte, NC, 28223 USA, DONALD JACOBS, Department of Physics and Optical Science, University of North Carolina at Charlotte, Charlotte, NC, 28223 USA — A comparative study is made using three computational models that characterize native state dynamics starting from known protein structures taken from four distinct SCOP classifications. A geometrical simulation is performed, and the results are compared to the elastic network model and molecular dynamics. The essential dynamics is quantified by a direct analysis of a mode subspace constructed from ANM and a principal component analysis on both the FRODA and MD trajectories using root mean square inner product and principal angles. Relative subspace sizes and overlaps are visualized through the projection of displacement vectors on the model modes. Additionally, a mode subspace is constructed from PCA on an exemplar set of X-ray crystal structures in order to determine similarity with respect to the generated ensembles. Quantitative analysis reveals there is significant overlap across the three model subspaces and the model independent subspace. These results indicate that structure is the key determinant for native state dynamics.

11:45AM CC.00006 Using blocking peptides to control and analyze the mechanical properties of single fibrin fibers, PRANAV MADDI, NC School of Science and Mathematics, Durham, NC, E. TIM O’BRIEN III, Dept. of Physics and Astronomy, UNC-Chapel Hill, OLEG GORKUN, Dept. of Pathology and Laboratory Medicine, UNC-Chapel Hill, MICHAEL R. FALVO, Dept. of Physics & Astronomy, UNC-Chapel Hill — Fibrin is the main structural protein involved in blood clotting, and exhibits high strength and elasticity. Fibrin study traditionally focuses on fully formed clots, whereas we employ new AFM manipulation techniques to study single fibrin fiber mechanics. We used 4 and 10 residue peptides to interfere with the knob-hole and αC interactions involved in fibrin polymerization to evaluate the contribution of each interaction to the fiber’s mechanical properties. We varied the concentration of each peptide present during polymerization to find the concentration that inhibited polymerization by half. The presence of either peptide during fibrin polymerization did not affect single fiber breaking strain ( δL1). The breaking force of all treated fibers reduced from 10-50N to 2-10N, suggesting treated fibers are thinner or are the same diameter with some inhibition of interactions. Fibers polymerized with the knob-hole targeting peptide visibly lost elasticity after 100% strain, while fibers polymerized with the αC targeting peptide lost elasticity after reaching 150% strain, suggesting that the knob-hole interactions control single fiber elasticity.

11:57AM CC.00007 A biomimetic model for internal fluid transport based on physiological systems in insects, YASSER ABOELKASSEM, ANNE STAPLES, Virginia Tech — Biomimetics is an increasingly important field in applied science that seeks to imitate systems and processes in nature to design improved engineering devices. In this study, we are inspired by insect respiratory systems, and model, analytically and numerically, the air transport within a single model insect tracheal tube. The tube wall undergoes localized, non-propagative rhythmic contractions. A theoretical analysis based on lubrication theory is used to model the problem at low Reynolds number. Results are then validated by performing meshfree computations based on the method of fundamental solutions (MFS). This meshfree numerical approach is then used to investigate the airflow in more complex geometries: a channel with multiple branching segments and various wall contraction regimes. This study presents a new biomimetic mechanism for valveless pumping that might guide efforts to fabricate novel microfluidic devices with improved efficiency that mimic features of physiological systems in insects.

12:09PM CC.00008 Locomotion of Paramecium in patterned environments, EUN-JIK PARK, AJA EDDINS, Engineering Science and Mechanics, Virginia Tech, US, JUNIL KIM, SUNG YANG, Department of Nanobio Materials and Electronics, GIST, Republic of Korea, SAIKAT JANA, SUNGHWAN JUNG, Engineering Science and Mechanics, Virginia Tech, US — Ciliary organs like Paramecium Multimicronucleatum locomote by synchronized beating of cilia that produce metachronal waves over their body. In their natural environments they navigate through a variety of environments especially surfaces with different topology. We study the effects of wavy surfaces patterned on the PDMS channels on the locomotive abilities of Paramecium by characterizing different quantities like velocity amplitude and wavelength of the trajectories traced. We compare this result with the swimming characteristics in straight channels and draw conclusions about the effects of various patterned surfaces.

Thursday, October 20, 2011 10:45AM - 12:45PM – Session CD Advances in Computing

10:45AM CD.00001 Open Science Grid: Linking Universities and Laboratories In National Cyberinfrastructure, PAUL AVERY, University of Florida — Open Science Grid is a consortium of researchers from universities and national laboratories that operates a national computing infrastructure serving large-scale scientific and engineering research. While OSG’s scale has been primarily driven by the demands of the LHC experiments, it currently serves particle and nuclear physics, gravitational wave searches, digital astronomy, genomic science, weather forecasting, molecular modeling, structural biology and nanoscience. The OSG distributed computing facility links campus and regional computing resources and is a major component of the Worldwide LHC Computing Grid (WLCG) that handles the massive computing and storage needs of experiments at the Large Hadron Collider. This collaborative work has provided a wealth of results, including powerful new software tools and services; a uniform packaging scheme (the Virtual Data Toolkit) that simplifies software deployment across many sites in the US and Europe; integration of complex tools and services in large science applications; multiple education and outreach projects, and new approaches to integrating advanced network infrastructure in scientific computing applications. More importantly, OSG has provided unique collaborative opportunities between researchers in a variety of research disciplines.
11:15AM CD.00002 Evolving from TeraGrid to XSEDE. JOHN TOWNS, University of Illinois — Since 2001, the TeraGrid has developed into a world-class integrated, national-scale computational science infrastructure with funding from the NSF's Office of Cyberinfrastructure (OCI). Recently, the TeraGrid project came to an end and has been supplanted by the NSF's eXtreme Digital program, opening a new chapter in cyberinfrastructure by creating the most advanced, powerful, and robust collection of integrated advanced digital resources and services in the world. This talk will introduce the new project, XSEDE: the eXtreme Science and Engineering Discovery Environment, which began July 1, 2011.

11:45AM CD.00003 Quantum transport and nanoplasmonics with carbon nanorings - using HPC in computational nanoscience. MARK A. JACK, Florida A&M University, Physics Department, Tallahassee, FL 32307 — Central theme of this talk is the theoretical study of toroidal carbon nanostructures as a new form of metamaterial. The interference of ring-generated electromagnetic radiation in a regular array of nanorings driven by an incoming polarized wave front may lead to fascinating new optoelectronics applications. The tight-binding method is used to model charge transport in a carbon nanotorus: All transport observables can be derived from the Green’s function of the device region in a non-equilibrium Green’s function algorithm. We have calculated density-of-states D(E) and transmissivities T(E) between two metallic leads under a small voltage bias. Electron-phonon coupling is included for low-energy phonon modes of armchair and zigzag nanorings with atomic displacements determined by a collaborator’s finite-element based code. A numerically fast and stable algorithm has been developed via parallel linear algebra matrix routines (PETSc) with MPI parallelism to reach significant speed-up. Production runs are planned on the NSF XSEDE network. This project was supported in parts by a 2010 NSF TeraGrid Fellowship and the Sunshine State Education and Research Computing Alliance (SSERCA). Two summer students were supported as 2010 and 2011 NCSI/Shodor Petascale Computing undergraduate interns.

In collaboration with Leon W. Durivage, Adam Byrd, and Mario Encinosa.

12:15PM CD.00004 Discrete Molecular Dynamics Simulation of Biomolecules. FENG DING, University of North Carolina, Chapel Hill — Discrete molecular dynamics (DMD) simulation of hard spheres was the first implementation of molecular dynamics (MD) in history. DMD simulations are computationally more efficient than continuous MD simulations due to simplified interaction potentials. However, also due to these simplified potentials, DMD has often been associated with coarse-grained modeling, and hence continuous MD has become the dominant approach used to study the internal dynamics of biomolecules. With the recent advances in DMD methodology, including the development of high-resolution models for biomolecules and approaches to increase DMD efficiency, DMD simulations are emerging as an important tool in the field of molecular modeling, including the study of protein folding, protein misfolding and aggregation, and protein engineering. Recently, DMD methodology has been applied to modeling RNA folding and protein-ligand recognition. With these improvements to DMD methodology and the continuous increase in available computational power, we expect a growing role of DMD simulations in our understanding of biology.

Thursday, October 20, 2011 1:30PM - 3:00PM
Session DA Complex Fluids Crystal Ballroom A - Beate Schmittman, Virginia Polytechnic Institute and State University

1:30PM DA.00001 Chaotic Advection in Multi-component Melts for the Manufacture of Composite Materials1, DAVID ZUMBRUNNEN, Clemson University — Several forces arise when different liquids are placed into contact. The relative importance of these forces depends on the sizes and shapes of liquid domains and also on molecular characteristics of the liquids. When the liquids are agitated and in the absence of interdiffusion, a composite structure results that is defined by the spatial extent and size of each liquid domain in the presence of the other. Shaking a bottle with about equal parts of water and oil gives a structure that resembles a household sponge, for example. If the oil volume is much smaller than the water volume, oil droplets result instead. In polymer blends and composites, the structure can have feature sizes at the micron scale or smaller. Little has been known about the variety of structural types that can be formed because current information is based on mixing machinery that intrinsically restricts structural outcomes. This shortcoming has important consequences because physical properties of composite materials obtained by solidifying the structured liquids depend appreciably on structure characteristics. A recent approach to overcome this shortcoming makes use of chaotic advection to establish conditions that organize liquid domains into numerous thin layers. A multi-layer construction undergoes morphological changes in situ. Progressive structure development arises, whereby a specific structure leads in sequence to a morphologically different structure. A new manufacturing technology has resulted which allows control of the internal structure in extruded plastic materials. Micro- and nanostructured materials have been obtained. On-line process control allows rapid optimization of physical properties. In this presentation, the underlying physics will be described, examples of novel materials and their applications will be shown, and research opportunities will be highlighted.

1Primary support for this work from the National Science Foundation is gratefully acknowledged.

2:00PM DA.00002 How animals drink and swim in fluids. SUNGHWAN JUNG, Virginia Tech — Fluids are essential for most living organisms to maintain a healthy body and also serve as a medium in which they locomote. The fluid bulk or interfaces actively interact with biological structures, which produces highly nonlinear, interesting, and complicated dynamical problems. We studied the lapping of cats and the swimming of Paramecia in various fluidic environments. The problem of the cat drinking can be simplified or interfaces actively interact with biological structures, which produces highly nonlinear, interesting, and complicated dynamical problems. We

2:30PM DA.00003 Jamming and Fluidization in Granular Flows. BRIAN UTTER, James Madison University — Granular materials exist all around us, from avalanches in nature to the mixing of pharmaceuticals, yet the behavior of these “fluid-y” solids is far from understood. While the interaction of individual particles is simple through friction and inelastic collisions, the non-linear forces and large number of particles leads to an unpredictable, complex system. Flow can be characterized by the continuous forming and breaking of a strong force network resisting flow, leading to jamming, avalanching and shear banding. I’ll present recent work on quasi-static shear and free-surface granular flows under the influence of external vibrations as well as related experiments on particle-fluid suspensions. By using photoelastic grains, we are able to measure both particle trajectories and the local force network in 2D flows. We find through particle tracking that dense granular flow is composed of comparable contributions from the mean flow, elastic deformations, and permanent, plastic deformations. Vibration typically weakens granular materials and removes hysteresis, though small vibrations can lead to strengthening of a pile. Flows of particle-fluid suspensions allow another avenue to probe failure of granular piles and additional control parameters, such as the surface chemistry of the particles.
1:30PM DB.00001 Analyzing Potential Tracking Algorithms for the Upgrade to the Silicon Tracker of the Compact Muon Solenoid. JOHNN HARDIN, University of North Carolina - Chapel Hill, KEVIN MCDERMOTT, University of Notre Dame, CMS COLLABORATION — The research performed revolves around creating tracking algorithms for the proposed ten-year upgrade to the tracker for CMS. One of two main detectors for the LHC at CERN. The proposed upgrade to the tracker for CMS will use fast hardware to trace particle trajectories so that they can be used immediately in a trigger system. The additional information will be combined with other sub-detectors in CMS, enabling mostly the non-background events to be read-out by the detector. The algorithms would be implemented directly into the Level-1 trigger, the first trigger in a 2 trigger system, to be used in real time. Specifically, by analyzing computer generated stable particles over various ranges of transverse momentum and the tracks they produce, we created and tested various simulated trigger algorithms that might be used in hardware. As one algorithm has proved very effective, the next step is to test this algorithm against simulated events with an environment equivalent to SLHC luminosities.

1:42PM DB.00002 Improving the Trigger Efficiency for the WH-lvbb analysis at the CDF experiment. HAO LIU, University of Virginia, CDF COLLABORATION — At CDF, we search for the associated production of a Higgs boson and a W boson, where the Higgs boson decays into a b + anti-b quark pair and the W boson decays into a lepton and the corresponding neutrino. Events are selected with a signature of a lepton, large missing transvers energy, and two or three jets. At CDF, events are selected by a variety of triggers, and those triggers are divided into several classes based on the types of requirements of the trigger. Traditionally, in the WH analysis we used multijets, and it is expected that long-term efficiency of the main jets trigger is 0.75. In this presentation, we will describe two new triggers to select leptons and will demonstrate a new method to calculate the trigger efficiency. We will use a neural network to calculate the efficiency for the event to be triggered by an entire trigger stream, disregarding each individual trigger. In this way, we can maximize the acceptance of events selected.

1:54PM DB.00003 Study of the Sensitivity of Plastic Scintillators to Fast Neutrons. DAVID ABBOTT, University of Virginia — The Mu2e experiment at Fermilab plans to use a two-out-of-three coincident requirement in a plastic scintillator based detector to veto cosmic ray events. This veto system must operate efficiently in a high-radiation environment. In this investigation, three plastic scintillator bars containing wavelength-shifting fibers represent the veto system. These bars were placed together, in series, in front of a deuterium-deuterium neutron generator, which produced fast neutrons of approximately 2.8MeV, in order to study the sensitivity of the plastic scintillators to fast neutrons. Multi-anode photomultiplier tubes read out the light from the fibers. The collected data was analyzed to determine the rate of interaction, approximate amount of energy deposited, and numerous other aspects of the neutrons' interactions. The rate of coincidental and correlated hits in multiple scintillator bars was the primary reason for the investigation, in order to understand the sensitivity of the plastic scintillators to fast neutrons.

2:06PM DB.00004 Geometrical Standard Model Enhancements to the Standard Model of Particle Physics. KEN STRICKLAND, MICHAEL DUVERNOIS, Contractor Scientist — The Standard Model (SM) is the triumph of our age. As experimentation at the LHC tracks particles for the Higgs phenomena, theoreticians and experimentalist struggle to close in on a cohesive theory. Both suffer greatly as expectation waivers those who seek to move beyond the SM and those who cannot do without. When it seems like there are no more good ideas enter Rate Change Graph Technology (RCGT). From the science of the rate change graph, a Geometrical Standard Model (GSM) is available for comprehensive modeling, giving rich new sources of data and pathways to those ultimate answers we punish ourselves to achieve. As a new addition to science, GSM is a tool that provides a structured discovery and analysis environment. By eliminating value and size, RCGT operates with the rules of RCGT mechanics creating solutions derived from geometry. The GSM rate change graph could be the ultimate validation of the Standard Model yet. In its own right, GSM is created from geometrical intersections and comes with RCGT mechanics, yet parallels the SM to offer critical enhancements.

2:18PM DB.00005 Holographic Real-Time Finite-Temperature 3-Point Correlators and Their Applications on Second Order Hydrodynamics. CHAOLUN WU, DIANA VAMAN, PETER ARNOLD, University of Virginia, EDWIN BARNES, University of Maryland, WEI XIAO, University of Virginia — We build up a complete real-time prescription for calculating n-point correlators of finite-temperature conformal field theory operators using holography. We found it amounts to integrating only the right quadrant of the black hole, and then adapting the finite temperature analog of Veltman’s circling rules to gravity tree-level diagrams to calculate correlators. We constructed a complete mapping between the real-time finite- temperature field theory and its real-time dual supergravity description. We subjected our prescription to several checks. We gave, for the first time, concrete formulas for all real-time 3-point correlators. We applied the above to study second order hydrodynamics in 4-d conformal field theories. We derived Kubo relations for second order transport coefficients in terms of 3-point stress tensor retarded correlators. For N=4 super Yang-Mills theory at strong coupling and finite temperature we computed these stress tensor 3-point correlators using AdS5/CFT. The small momentum expansion of the 3-point correlators in terms of transport coefficients is matched with AdS result and the coefficients are retrieved consistently. Our method allows for a unified treatment of hydrodynamic coefficients and can be systematically generalized to higher order hydrodynamics.

2:30PM DB.00006 Constructing a two scintillator paddle telescope for cosmic ray flux measurements. DAVID CAMP, XIAOHANG ZHANG, CAROLA BUTLER, Georgia State University, MATHES DAYANANDA, XIAOHUN HE, Georgia State University — The evolution of the Earth’s climate is of growing concern. There is evidence of a causal relationship between cosmic ray flux and climate variations and is even in the Earth's temperature changes [1]. It has been observed that a muon telescope with a variable angular acceptance at Earth’s surface can be used to study correlations between flux distribution and barometric pressure. The muon flux from the cosmic ray particles positively correlates with seasonal temperature variations and anti-correlates with pressure variations [2]. In this talk, the construction of a new two scintillator paddle telescope prototype will be presented along with preliminary results from this detector.

Correlation study of atmospheric weather and cosmic ray flux variation. MATHES DAYANANDA, XIAOCHUN HE, Georgia State University — There is at present a great debate about the causes of the changing climate of the Earth. In recent years, there has been a growing interest of understanding the effects of cosmic ray radiation on the increase in average global temperature. The studies by Svensmark, show that there is a strong link between cosmic rays and low cloud coverage [1]. Very recently, Lu reported that there is a correlation between cosmic rays and ozone depletion over Antarctic [2]. At Georgia State University (GSU) we are working on a long-term measurement of secondary cosmic ray flux distribution and are focusing on studying the correlations among variations of cosmic ray flux and atmospheric/space weather. In this presentation, we will describe the cosmic ray flux detectors currently taking data at GSU and show the preliminary results from our measurements over the past two years.


The Double Chooz Collaboration — Double Chooz is a reactor antineutrino experiment probing the non-vanishing value of the neutrino mixing angle θ13. The experiment is searching for antineutrino disappearance from nuclear reactors located in northeastern France. The Double Chooz concept is to deploy two identical detectors. One detector near to the reactor cores to measure the flux of electron antineutrinos and one detector at a distance from the reactors to measure the disappearance of electron antineutrinos due to oscillations. The far detector began data taking in the spring of 2011 and the near detector will be installed in 2012. Double Chooz has the opportunity of sensitivity for probing sin^2(2θ13) to 0.03 (90%CL) with both detectors running.

Thursday, October 20, 2011 1:30PM - 3:30PM
Session DC Atomic and Molecular Physics Crystal Ballroom C - Leo Piilonen, Virginia Polytechnic Institute and State University

1:30PM DC.00001 Laser Photodetachment Spectroscopy of the S^−_2 Ion \(^1\), JOHN YUKICH, WADE MORGAN, Davidson College — Numerous experiments have investigated the properties and dynamics of single-atom negative ions. Similar experiments can be conducted with molecular negative ions. Laser photodetachment spectroscopy of such ions is more complicated due to rotational and vibrational structure, and often yields spectroscopic benchmarks such as rotational constants. We have conducted low-resolution photodetachment spectroscopy of the S^−_2 ion over a range of roughly 2000 cm\(^{-1}\). The ions are created in a Penning ion trap by a two-step dissociative attachment process. The photodetachment is achieved with a tunable ring-cavity titanium:sapphire laser. Our results yield a lower-limit estimate of the minimum detachment threshold energy and exhibit structure that may be due to rotational energy levels. Future experiments will focus on high-resolution detachment spectroscopy of these and other ions with an eye toward measurement of their molecular constants.

\(^1\)Support from Davidson College and the American Chemical Society.

1:42PM DC.00002 Identification and Analysis of Atomic and Molecular Superposition Spectra Following Laser-Induced Optical Breakdown \(^1\), ALEXANDER C. WOODS, CHRISTIAN G. PARIĞGER, Center for Laser Applications, University of Tennessee Space Institute — Molecular recombination and excitation of atoms following laser-induced optical breakdown provide means for simultaneous detection of atomic and molecular species. Atomic emission spectra may be analyzed to infer electron number and temperature. Careful analysis of select atomic spectra may reveal superposed diatomic molecular spectra. Nonlinear fitting of synthetic molecular spectra, calculated via diatomic quantum theory, provides tools for identification, temperature measurement, and further analyses of the diatomic molecules present. This presentation investigates the presence of C\(_2\) molecular Swan bands in Balmer Series atomic hydrogen spectra. Combustion plumes are also studied, including comparisons of temperatures obtained using a two-color pyrometer and from data reduction analysis of measured spectroscopic AlO data.

1:54PM DC.00003 Highly parallelized detection of single fluorescent molecules: simulation and experiment \(^1\), BRIAN K. CANFIELD, JASON K. KING, WILLIAM N. ROBINSON, WILLIAM H. HOFMEISTER, LLOYD M. DAVIS, Center for Laser Applications, University of Tennessee Space Institute — We are developing an ultrasensitive, fluorescence-based detection system in highly parallel microchannels. Multichannel microfluidic devices have been fabricated by direct femtosecond laser machining of fused silica substrates. We approach single-molecule detection sensitivity by introducing dilute aqueous solutions (~pM) of fluorescently labeled molecules into the microchannels. In a custom-built, wide-field microscope, a line-generating red diode laser provides narrow epi-illumination across a 500 μm field of view. Fluorescence is detected with an electron-multiplying CCD camera allowing readout rates of several kHz. Rapid initial assessment is performed through digital filtering derived from simulations based on experimental parameters. Good agreement has been shown between simulation and experimental data. Fluorescence correlation spectroscopy then provides more detailed analysis of each separate channel. Following optimization, microfluidic devices could easily be mass-produced in low-cost polymers using imprint lithography.

\(^1\)Supported by NIH Grant No. EB-006639.

2:06PM DC.00004 Terahertz Rotational Spectroscopy of the v5/2v9 Dyad of Nitric Acid \(^1\), PAUL HELMINGER, University of South Alabama, DOUGLAS T. PETKIE, IVAN MEDVEDEV, Wright State University, FRANK C. DE LUCIA, Ohio State University — Our studies of the terahertz rotational spectrum of nitric acid now include the ground state and the four lowest excited states. We report good progress in the assignment and analysis of the next higher energy states, the v5/2v9 interacting states. This very complex spectrum includes torsional splitting of both states and Fermi and Coriolis type interactions between them. The current analysis includes both microwave and infrared transitions for improved stability. Microwave studies of the rotational spectrum of the nitric acid molecule in the ground and excited vibration states contribute both to a better understanding of this fundamental molecule and to the construction of accurate spectral maps for remote sensing in the atmosphere.

\(^1\)This work was supported by a grant from NASA.
2:18PM DC.00005 Microfluidic device for three-dimensional electrophoretic manipulation of single fluorescent molecules1, JASON K. KING, BRIAN K. CANFIELD, LLOYD M. DAVIS, WILLIAM H. HOFMEISTER, Center of Laser Applications, The University of Tennessee Space Institute — The ability to manipulate and trap single molecules in solution through the application of actively controlled electric fields is a valuable tool for a number of bio-molecular studies of proteins and nucleic acids. Here we report the development of a microfluidic device consisting of four electrodes sputtered onto two glass coverslips and fixed in a tetrahedral arrangement. This geometrical configuration allows for a uniform electric field of any orientation through the application of appropriate voltages. Three-axis control has been demonstrated for micron-sized polystyrene beads and 40 nm fluorescent spheres in phosphate buffered solution. Previous work has characterized planar motion. Recent changes to the experimental setup include the addition of a cylindrical lens in the detection arm to quantify axial position and a National Instruments PCI-7833R to provide precise voltage control. Finally, a real-time tracking algorithm and its use for trapping will be discussed.

2:30PM DC.00006 Impact of Recent Laboratory N2 Data to our Understanding of Thermospheric Nitric Oxide (NO). JUSTIN YONKER, KARTHIK VENKATARAMANI, SCOTT BAILEY, Virginia Tech — In spite of its status as a minor species, NO plays key roles in many upper atmospheric processes. As the only heteronuclear molecule, its fundamental, $\nu=1$ emission cools the thermosphere ($z>100$ km). Its low ionization potential ensures that NO$^+$ is the end product of the ion-neutral chemistry in the ionospheric E-region. And in the presence of excess atomic oxygen, NO will catalytically destroy ozone. The production of NO is initiated when N$_2$ is ionized, dissociated, or excited by the solar EUV irradiance ($\lambda<100$ nm). In the mesosphere and lower thermosphere (MLT), much of the irradiance is contained in the highly variable soft x-ray region ($1<\lambda<20$ nm). The resulting photoelectrons produce additional ionization as well as excitation of metastable, chemically-reactive species like the first electronically excited NO$_2$ state, N$_2$(A$^3\Sigma_u^+$). This talk will incorporate recent laboratory data on the N$_2$ photoabsorption and electron-impact cross-sections into a 1D photochemical reaction-diffusion model of the thermosphere. It is shown that spin-forbidden ($\Delta S=1$) excitation to the N$_2$ triplet manifold enables neutral N$_2$ to participate in the NO production. Additional physical and chemical uncertainties relevant to NO production and loss are also presented.

2:42PM DC.00007 Quasibound States of Single-Particle Systems, CURT MOYER, Department of Physics and Physical Oceanography, UNC Wilmington — We have developed a formalism that describes both quasibound and resonant states within the same theoretical framework, and that admits a clean and unambiguous distinction between these states and the states of the embedding continuum. The approach described here builds on our earlier work by clarifying several crucial points and extending the theory to encompass a variety of continuous spectra, including those with degenerate energy levels. The result is a comprehensive and compelling formalism for the study of quasibound states. The difference between ‘quasibound’ and ‘resonant’ states turns out to be largely semantic, inasmuch as both arise from imposing what is arguably the same mathematical rule (a point condition in a novel basis set). Enforcing that rule in a given application is straightforward in principle. The formalism is illustrated by examining several cases pertinent to applications widely discussed in the literature.

2:54PM DC.00008 Three-dimensional flow measurements with a four-focus microscope, JAMES A. GERMANN, BRIAN K. CANFIELD, JASON K. KING, ALEXANDER TEREKHOV, LLOYD M. DAVIS, Center for Laser Applications University of Tennessee Space Institute — The measurement of a one-dimensional flow using a confocal fluorescence microscope with two excitation volumes has been well documented. This technique can be extended to measure flow in all three dimensions simultaneously through a four-focus, two-photon microscope. To this end, an apparatus has been constructed in which the beam from a modelocked Ti-Sapphire laser is passed through a double interferometer configuration to create four displaced focal volumes. Fluorescence is gathered onto a single photon avalanche diode and time-gated by a TimeHarp 200 timer card. Calibration of one-dimensional flow through a square bore capillary has been performed. Flow of adjustable speed and direction in three dimensions is measured using a cross-channel microfluidic device. To evaluate flow measurements, Monte Carlo simulations of fluorescence cross-correlation spectroscopy between the four foci was conducted and a LabView program was created to discern the flow parameters from the 16 cross-correlation functions. For simplicity, the model for the correlation functions assumes each focal volume is a three-dimensional Gaussian, but a Gaussian-Lorentzian model may improve fitting.

3:06PM DC.00009 Rapid fabrication of long nanochannels with a single femtosecond laser pulse focused to a line1, LLOYD M. DAVIS, ALEXANDER TEREKHOV, KATHLEEN LANSFORD, Center for Laser Applications, University of Tennessee Space Institute, JOSHUA W. BRADFIELD, CHARLES A. ROHDE, M. CATHER SIMPSON, BRYON E. WRIGHT, The Photon Factory, University of Auckland — We have recently reported the use of tight line-focusing of an amplified femtosecond laser beam to fabricate very long, sub-micron wide features in glass with just a single laser pulse [Davis et al., IQEC/CLEO Pacific Rim, August 2011]. The optical configuration used in these experiments presents distinct advantages and can be expected to have numerous applications, including the rapid creation of micro/nano-fluidic devices and waveguides. Here we review that work and also discuss recent results on imaging features created at the surface or at various depths internal to a substrate using a number of methods, including SEM images of acetate replicas, atomic force microscopy, and optical imaging of sections that show the depths of internal features. We also discuss the physical mechanisms that can occur during femtosecond laser-induced plasma formation under different conditions, while emphasizing the non-linear mechanisms that can produce sub-diffraction features and the use of aberrations and spatio-temporal focusing to control the feature depth.

3:18PM DC.00010 Application of X-ray Fluorescence Spectroscopy in Analysis of Oil Paint Pigments1, CASSANDRA MAJOR, SARAH FORMICA, North Georgia College & State University — X-ray Fluorescence (XRF) spectroscopy is a rapid, noninvasive technique for both detecting and identifying chemical elements within a given sample. At North Georgia College and State University, a sealed tube x-ray source and slightly focusing polycapillary optic are used in nondestructive XRF analysis of oil paint pigments. Oil paints contain both organic and inorganic matter, and the inorganic ingredients such as titanium, vanadium, iron, zinc, and other elements are easily detected by XRF, which can be used to uniquely differentiate between various paint pigments. To calibrate the XRF system for paint color identification, six different colors of oil paint were fluoresced and identified based off of their characteristic spectra. By scanning the paint sample in two dimensions, the characteristic XRF spectra obtained were compiled to produce an XRF replica of the painting.

1Partially supported by NIH Grant No. EB-006639.

1Financial support from the NASA Georgia Space Grant Consortium.

Thursday, October 20, 2011 1:30PM - 3:00PM
Session DD Advances in Energy
Crystal Ballroom DE - Bruce Vogelaar, Virginia Polytechnic Institute and State University
1:30PM DD.00001 Photonic Structuring of Bulk Heterojunction Organic Solar Cells, RENE LOPEZ, University of North Carolina at Chapel Hill — The major challenge in solar cell technology dwells in achieving an efficient absorption of photons with an effective carrier extraction. In all cases, light absorption considerations call for thicker modules while carrier transport would benefit from thinner ones. This dichotomy is the fundamental problem limiting the efficiencies of photovoltaics, especially promising low-cost polymer solar cells. We present experimental and theoretical solutions to this problem applying photonic crystal nanostucturing in bulk heterojunction solar cells made of poly-3-hexylthiophene:[6,6]-phenyl-C61-butyric acid methyl ester (P3HT:PCBM). We discuss theoretical models of optical absorption that occur for the photonic design that result in a 22% enhancement over a conventional planar cell. We also calculate the local exciton creation profile within the photonic crystal structure to show nanopatterning also reduces carrier transport length. Finally, experimental results are presented that follow the theoretical predictions along with our nano fabrication method to show this approach can be used to produce improved large-area nanostructured P3HT:PCBM solar cells.

2:00PM DD.00002 Advances in Polymer-Fullerene Photovoltaic Devices, JAMES HEFLIN, Department of Physics, Virginia Tech — Polymer solar cells are of high interest due to their potential as efficient, lightweight, large area, flexible renewable energy sources. The basic mechanism for the photovoltaic effect in polymers consists of transfer of a photoexcited electron from the polymer donor to a fullerene electron acceptor followed by transport of the electron and hole through the acceptor and donor, respectively, to the opposite electrodes. Polymer photovoltaic efficiencies can be increased by utilizing improved materials as electron donors and acceptors as well as controlling the nanoscale morphology of the thin film devices. The highest efficiencies (~7%) obtained thus far utilize a nanoscale polymer-fullerene blend referred to as a bulk heterojunction, which undergoes phase separation on the 10 nm length scale in order to facilitate charge transfer from the photoexcited polymer to the fullerene electron acceptor. More organized geometries that maximize the majority carrier materials at the respective electrodes could lead to enhanced efficiencies. In one approach, thermal interdiffusion of an initial bilayer of the donor and acceptor materials can be employed to create a concentration gradient in order to optimize both the charge transfer and charge transport processes. This presentation will overview the state-of-the-art in polymeric solar cells and describe the development of thermally-interdiffused concentration gradient geometries as an alternative route towards increased efficiencies.

2:30PM DD.00003 Nuclear Energy: Challenges and Directions, MARK PIERSON, Virginia Tech — There are many myths regarding nuclear energy. Nuclear energy provides many advantages but like all other power generation methods it has some drawbacks. There have been some serious accidents involving nuclear power generation with the most recent occurring at Fukushima Daiichi. What role will nuclear energy play in the future? What are the challenges of the nuclear landscape as we move forward? Are there changes in policy or technology that should be considered? A vision of nuclear energy will be provided in an attempt to address these upcoming opportunities and challenges.

Thursday, October 20, 2011 3:45PM - 5:15PM – Session EA Physics at Jefferson Lab Crystal Ballroom A - Romulus Godang, University of South Alabama

3:45PM EA.00001 Qweak: A Precision Standard Model Test at Jefferson Lab, MARK L. PITT, Virginia Tech — The Qweak collaboration is currently performing the first precision measurement of the proton’s neutral weak charge at Jefferson Lab. The Standard Model gives a firm prediction for the weak charge; any deviation from that can be interpreted as new physics beyond the Standard Model. This precision, low energy measurement is sensitive to new physics signatures at energy scales up to 2 TeV. The experiment measures the parity-violating asymmetry in the scattering of longitudinally polarized electrons on the proton at low momentum transfer. An overview of the motivation and experimental approach will be presented, along with an update on the current status.

4:15PM EA.00002 Hadron Spectroscopy at Jefferson Lab: Search for new States of Hadronic Matter, VOLKER CREDE, Florida State University — Hadrons are complex systems of confined quarks and gluons and exhibit the characteristic spectra of excited states. Quantum Chromodynamics (QCD) is only poorly understood in this non-perturbative regime. It is one of the key issues in hadronic physics to identify the relevant degrees of freedom giving rise to the observed mass spectra and the effective forces between them. Current efforts of the CLAS Collaboration at Jefferson Lab focus on the search for new baryon resonances utilizing polarized beams and targets. A further particular interesting question in hadron spectroscopy concerns the role of glue and how this is related to the confinement in QCD. I will briefly discuss the efforts of the GlueX Collaboration to search for new forms of hadronic matter beyond simple quark-antiquark systems.

4:45PM EA.00003 High Precision Measurement of the $\pi^0$ Radiative Decay Width, LIPING GAN, University of North Carolina, Wilmington — As the lightest particle in the hadron spectrum, the $\pi^0$ plays an important role in understanding the fundamental symmetries of QCD. The $\pi^0 \rightarrow \gamma\gamma$ decay provides a key process for test of the chiral anomaly, and at the same time a test of the Nambu-Goldstone nature of the $\pi^0$ meson due to spontaneous chiral symmetry breaking. Theoretical activities over the last decade have resulted in high precision (1% level) predictions for the decay amplitude of the $\pi^0$ into two photons. The experimental measurement of this parameter with a comparable precision will be critical to test these important QCD predictions. The PrimEx collaboration at Jefferson Lab has developed and performed new experiments to measure the $\pi^0$ radiative decay width via the Primakoff effect. A new level of experimental precision has been achieved by implementing the high intensity and high resolution photon tagging facility and by developing a novel, high resolution, electromagnetic hybrid calorimeter (HYCAL). A recently published result from the first experimental data (PrimEx-I) with a 2.8% total uncertainty is a factor of 2.5 more precise than the current Particle Data Group average. The second experiment (PrimEx-II) was carried out in fall 2010 with the final goal of 1.4% precision. The result of PrimEx-I and the status of PrimEx-II will be presented.

Thursday, October 20, 2011 3:45PM - 5:15PM – Session ED Mentoring Workshop Crystal Ballroom DE - Leo Piilonen, Virginia Polytechnic Institute and State University

3:45PM ED.00001 Mentoring Workshop, MONICA PLISCH, American Physical Society —
To achieve this, bats employ structural features such as resonance to reliably encode selectivity filters into the acoustic signals received at the ear drum. To this end, bats can manipulate the emitted and received signals in the physical domain. By diffracting the outgoing and incoming ultrasonic waves with intricate baffle shapes (i.e., noseleaves and outer ears), the animals can generate selectivity filters that are joint functions of space and frequency. Given the limited computational resources of the bat’s brain, this performance is unlikely to be explained as the result of brute-force, black-box-style computations. Instead, the animals must rely heavily on in-built physics knowledge in order to ensure that all required information is encoded into the acoustic signals received at the ear drum. To this end, bats can manipulate the emitted and received signals in the physical domain. By diffracting the outgoing and incoming ultrasonic waves with intricate baffle shapes (i.e., noseleaves and outer ears), the animals can generate selectivity filters that are joint functions of space and frequency. To achieve this, bats employ structural features such as resonance cavities and diffracting ridges. In addition, some bat species can dynamically adjust the shape of their selectivity filters through muscular actuation.

Many species of songbirds do not sing instinctively but learn their songs by a process of auditory-guided vocal learning that starts with a kind of babbling that converges over several months and through tens of thousands of iterations to a highly precise adult song. How the neural circuitry of the songbird brain learns, generates, and recognizes temporal sequences related to song are important questions for neurobiologists and also interest an increasing number of physicists with interests in biophysics, statistical mechanics, nonlinear dynamics, and networks. I will discuss some interesting questions posed by recent experiments on songbirds, especially in regard to extremely sparse neuronal firing associated with song production. I will then discuss a theoretical model known as a synfire chain that my group and others have invoked to explain some features of the experimental data.

We probe the relevant cellular mechanics in vivo using laser-microsurgery – both qualitatively, to assess whether removal of specific cells alters the dynamics of tissue reshaping, and quantitatively, to measure sub-cellular mechanical properties and stresses. I will detail two quantitative microsurgical measurements. The first uses a laser to drill a sub-cellular hole in a sheet of cells. The subsequent retraction of surrounding cells allows one to infer the local mechanical stress. The second uses a laser to isolate a single cell from the rest of a cell sheet. Isolation is accomplished on a microsecond time scale by holographically shaping a single laser pulse. The subsequent retraction (or expansion) of the isolated cell allows one to separate and quantify the effects of internal and external stresses in the determination of cell shape. I will discuss application of these techniques to the time-dependent biomechanics of epithelial tissues during early fruit fly embryogenesis – specifically during the processes of germband retraction and dorsal closure.

This work supported by the National Science Foundation (IOB-0545679) and the Human Frontier Science Program (RGP0021/2007C).

Computational modeling is a central enterprise in both theoretical and experimental physics but it can also be an excellent means for students in the introductory courses to develop a deeper conceptual understanding of fundamental physics principles. Many instructional benefits are associated with computational modeling, including visualizing 3D phenomena, modeling complex, real-world systems, and reasoning algorithmically. In this talk, I will discuss many of these benefits as well as some of the ongoing research on how students build conceptual understanding from computational models.

Transforming the undergraduate physics program at Florida International University

Supported by NSF Award # PHY-0802184.
9:30AM GB.00003 Collaborative Group Learning using the SCALE-UP Pedagogy.
GERALD FELDMAN, George Washington University — The time-honored conventional lecture ("teaching by telling") has been shown to be an ineffective mode of instruction for science classes. In these cases, where the enhancement of critical thinking skills and the development of problem-solving abilities are emphasized, collaborative group learning environments have proven to be far more effective. In addition, students naturally improve their teamwork skills through the close interaction they have with their group members. Early work on the Studio Physics model at Rensselaer Polytechnic Institute in the mid-1990's was extended to large classes via the SCALE-UP model pioneered at North Carolina State University a few years later. In SCALE-UP, students sit at large round tables in three groups of three — in this configuration, they carry out a variety of pencil/paper exercises (ponderables) using small whiteboards and perform hands-on activities like demos and labs (tangibles) throughout the class period. They also work on computer simulations using a shared laptop for each group of three. Formal lecture is reduced to a minimal level and the instructor serves more as a "coach" to facilitate the academic "drills" that the students are working on. Since its inception in 1997, the SCALE-UP pedagogical approach has been adopted by over 100 institutions across the country and about 20 more around the world. In this talk, I will present an overview of the SCALE-UP concept and I will outline the details of its deployment at George Washington University over the past 4 years. I will also discuss empirical data from assessments given to the SCALE-UP collaborative classes and the regular lecture classes at GWU in order to make a comparative study of the effectiveness of the two methodologies.

10:00AM GB.00004 Transforming Introductory Physics for Life Scientists: Researching the consequences for students, CHANDRA TURPEN, University of Maryland, College Park — In response to policy documents calling for dramatic changes in pre-medical and biology education [1-3], the physics and biology education research groups at the University of Maryland are rethinking how to teach physics to life science majors. As an interdisciplinary team, we are drastically reconsidering the physics topics relevant for these courses. We are designing new in-class tasks to engage students in using physical principles to explain aspects of biological phenomena where the physical principles are of consequence to the biological systems. We will present examples of such tasks as well as preliminary data on how students engage in these tasks. Lastly, we will share some barriers encountered in pursuing meaningful interdisciplinary education.

Co-authors: Edward F. Redish and Julia Svaboda

Friday, October 21, 2011 8:30AM - 10:18AM – Session GC Condensed Matter Physics/Nanophysics I
Crystal Ballroom C - Hans Robinson, Virginia Polytechnic Institute and State University

8:30AM GC.00001 Capturing Ion-Solid Interactions with MOS structures, R. SHYAM, D.A. FIELD, Dept. of Physics and Astronomy, Clemson University, S. CHAMBERS, W.R. HARRELL, Dept. of Electrical and Computer Engineering, Clemson University, C.E. SOSOLIK, Dept. of Physics and Astronomy, Clemson University — We have fabricated metal-oxide-semiconductor (MOS) devices for a study of implantation rates and damage resulting from low energy ion-solid impacts. Specifically, we seek to capture ion irradiation effects on the oxides. Fabrication of the MOS devices follows a standard procedure where Ohmic contacts are first created on the wafer backside followed by the thermal growth of various thicknesses of SiO$_2$ (from 50 nm to 200 nm) on the wafer frontside. As-grown SiO$_2$ layers are then exposed to various singly-charged alkalis ions with energies in the range of 100 eV to 10 keV in our beamline setup. Following this exposure, the MOS devices are completed in situ with the deposition of a top Al contact. Characterization of the ion-modified devices involves the standard device technique of biased capacitance-voltage (C-V) measurements where a field is applied across the MOS structure at an elevated temperature to move implanted ions resulting in changes in surface charge density that are reflected as shifts in the flatband voltage ($V_{FB}$). Similarly, a triangular voltage sweep (TVS) test can be utilized to measure the ionic displacement current as it is driven by a slow linear voltage ramp and it should reveal the total ionic space charge in an MOS.

8:42AM GC.00002 Free flux flow in two single crystals of V$_3$Si with differing pinning strengths
O. GAFAROV, A.A. GAPUD, S. MORAES, University of South Alabama, J.R. THOMPSON, University of Tennessee Knoxville, D.K. CHRISTEN, Oak Ridge National Laboratory, A.P. REYES, National High Magnetic Field Laboratory — Results of measurements on two very clean, single-crystal samples of the A15 superconductor V$_3$Si are presented. Magnetization and transport data have confirmed the "clean" quality of both samples, as manifested by: (i) high residual electrical resistivity ratio, (ii) very low critical current densities $J_c$, and (iii) a "peak" effect in the field dependence of critical current. The (H,T) phase line for this peak effect is shifted down for the slightly "dirtier" sample, which consequently also has higher critical current density $J_c$. Large Lorentz forces are applied on mixed-state vortices via large currents, in order to induce the highly ordered free flux flow (FFF) phase, using experimental methods developed previously. The traditional model by Bardeen and Stephen (BS) predicts a simple field dependence of flux flow resistivity $\rho_f(H) \sim H/H_{c2}$, presuming a field-independent flux core size. A model by Kogan and Zelezhina (KZ) takes into account the effects of magnetic field on core size, and predict a clear deviation from the linear BS dependence. In this study, $\rho_f(H)$ is confirmed to be consistent with predictions of KZ.

This Research in Undergraduate Institutions work is funded by NSF.

8:54AM GC.00003 Double-Paddle Oscillators for the Mechanical Spectroscopy of Ion-Surface Modifications
D.A. FIELD, Dept. of Physics & Astronomy, Clemson University, T.H. METCALF, Naval Research Laboratory, C.E. SOSOLIK, Dept. of Physics & Astronomy, Clemson University — We discuss the use of silicon double-paddle oscillators (DPOs) as a technique for following atomistic changes in mechanical properties under energetic ion irradiation conditions in ultra high vacuum (UHV). For these DPOs, it is well known that it is much more reliable to use a triangular voltage sweep with a current limit of 40 pA, following the scheme of Bardeen and Stephen (BS). Specifically, we observe that the DPOs are sensitive to changes in the mechanical properties of thin deposited films or of the oscillator crystal itself.

In this talk, we will present an overview of the SCALE-UP concept and I will outline the details of its deployment at George Washington University over the past 4 years. I will also discuss empirical data from assessments given to the SCALE-UP collaborative classes and the regular lecture classes at GWU in order to make a comparative study of the effectiveness of the two methodologies.
9:06AM GC.00004 Measurement of DC resistivity of new quasi-one-dimensional conducting platinate$^1$, A.A. GAPUD, U. of South Alabama Dept of Physics, J. ALEXANDER, R.I. LEATHERBURY, O. GAFAROV, A.A. GAPUD, U. of South Alabama Dept. of Physics, A.P. WEBER, L. PHAM, R.E. SYKORA, U. of South Alabama Dept. of Chemistry, A.K. KHAN, U. of South Alabama Dept. of Electrical and Computer Engineering — Cs$_2$[Pt(CN)$_4$](CF$_3$SO$_3$)$_2$ (TCP) is the newest platinate, quasi-one-dimensional conductors with parallel “chains” of Pt maintained by peripheral materials and with well known properties, especially in the potassium-containing material, KCP. Unlike KCP, however, we are finding properties unique to TCP. First, we discuss technical difficulties in measuring the DC resistivity of this material: Unlike with KCP, the samples of TCP were relatively small and very fragile, their contact surface had an insulating film, and the crystal had a very sensitive pressure dependence, coupled with significant thermal contraction/expansion. These issues were addressed with reasonable success, using proper handling methods, sputtered electrical contacts, and a floating sample mount, as will be discussed. The resulting temperature dependence of resistivity is radically different from KCP, showing an anomalous “peak” at around 150 K.

$^1$This work is funded by the National Science Foundation, for Research in Undergraduate Institutions.

9:18AM GC.00005 NMR study of $^{133}$Cs in new quasi-one-dimensional conducting platinate$^1$, R.I. LEATHERBURY, J. ALEXANDER, O. GAFAROV, A.A. GAPUD, U. of South Alabama Dept. of Physics, A.P. WEBER, L. PHAM, R.E. SYKORA, U. of South Alabama Dept. of Chemistry, A.P. REYES, P. KUHNS, National High Magnetic Field Laboratory — Cs$_2$[Pt(CN)$_4$](CF$_3$SO$_3$)$_2$ (TCP) is a new Krogmann’s salt, consisting of quasi-one-dimensional conducting chains of Pt with well known properties, especially in the potassium-containing material, KCP. Unlike KCP, however, there are properties unique to TCP, e.g., longer Pt-Pt separation, insulating at room temperature, and non-magnetic. Previous NMR studies on KCP have mainly been on $^{195}$Pt, which does not produce a usable NMR signal in TCP; our study utilizes $^{133}$Cs instead, which are peripheral to the Pt chains. Splitting of spin states due to quadrupole interaction with local electric field gradient has been measured as a function of orientation versus applied static field. Modeling of the frequency shifts reveals consistency with the known symmetry axes of $^{133}$Cs determined by single-crystal x-ray diffraction. Relaxation time T1 versus temperature reveals a weak relaxation mechanism and absence of magnetism. Relaxation data has a sharp anomaly around 119 K where T1 jumps 3 orders of magnitude, consistent with critical fluctuations but not yet well understood.

$^1$This work is funded by an NSF-RUI grant.

9:30AM GC.00006 Controlled release from stimuli-sensitive microgel capsules$^1$, HASSAN MASoud, ALEXANDER ALEXEEV, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology — We introduce a mesoscale computational model for the transport of charged polymer networks immersed in Newtonian fluids, and use it to probe the release of nanoparticles from hollow microgel capsules that swell and deswell in response to external stimuli. Our model explicitly describes the transport of nanoparticles in swelling/deswelling polymer networks with complex geometries and associated fluid flows. Our simulations reveal that responsive microcapsules can be effectively utilized for steady and pulsatile release of encapsulated solutes. Steady, diffusive release of nanoparticle takes place from swollen gel capsules, whereas capsule deswelling cause burst-like discharge of solutes driven by a flow from the shrinking capsule interior. We demonstrate that this hydrodynamic release can be regulated by introducing rigid microscopic rods inside the capsule. Our calculations indicate that the rods stretch the deswelling membrane and promote the formation of large pores in the shell, which allow massive flow-driven release of nanoparticles. Thus, our findings unveil a new approach for regulating the release from stimulus responsive micro-carriers that will be especially useful for designing new drug delivery systems.

$^1$Financial support from the Donors of the Petroleum Research Fund, administered by the ACS, is gratefully acknowledged.

9:42AM GC.00007 Study the friction behaviour of poly[2-(dimethylamino)ethyl methacrylate] brush with AFM probes in contact mechanics$^1$, MARYAM RAFTARI, Department of Physics and Astronomy, University of Sheffield, UK, ZHENYU ZHANG, Department of Physics, University of Sheffield, UK, GrahAM J. LEGGETT, Department of Chemistry, University of Sheffield, UK, MARK GEOGHEGAN, Department of Physics and Astronomy, University of Sheffield, UK — We have studied the frictional behaviour of grafted poly[2-(dimethylamino)ethyl methacrylate] (PDMAEMA) films using friction force microscopy (FFM). The films were prepared on native oxide-terminated silicon substrates using the technique of atom transfer radical polymerization (ATRP). We show that single asperity contact mechanics (Johnson-Kendall-Roberts(JKR) and Derjaguin-Muller-Toporov(DMT)) as well as a linear (Amontons) relation between applied load and frictional load depending on the pH of the FFM probe. Measurements were made using functionalized and unfunctionalized silicon nitride triangular probes. Functionalized probes included gold-coated probes, and ones coated with a self-assembled monolayer of dodecanethiol (DDT). The frictional behaviour between PDMAEMA and all tips immersed in pH 3 to 11 are corresponded to the DMT or JKR model and are linear in pH−1, 2, and 12. These results show that contact mechanics of polyelectrolytes in water is complex and strongly dependent on the environmental pH.

$^1$Supported by the European Research Council under the EU's Framework Program for Research and Technological Development 2007-2013, Grant Agreement number 881600.

9:54AM GC.00008 Dynamics of Polydisperse Foam-like Emulsion$^1$, HARRY NICOL, KLEBERT FEITOSA, Dept. of Physics and Astronomy - James Madison University — Foam is a complex fluid whose relaxation properties are associated with the continuous diffusion of gas from small to large bubbles driven by differences in Laplace pressures. We study the dynamics of bubble rearrangements by tracking droplets of a clear, buoyantly neutral emulsion that coarsens like a foam. The droplets are imaged in three dimensions using confocal microscopy. Analysis of the images allows us to measure their positions and radii, and track their evolution in time. We find that the droplet size distribution fits a Weibull distribution characteristics of foam systems. Additionally, we observe that droplets undergo continuous evolution interspersed by occasional large rearrangements in par with local relaxation behavior typical of foams.

$^1$We gratefully acknowledge support from DOD-ASSURE/NSF-REU grant # DMR-0851367.

10:06AM GC.00009 Patterning the adhesive properties of amine-rich polymer films$^1$, STEFAN STOIANOV, Virginia Tech Department of Physics, CHALONGRAT DAENGNGAM, MALIHE BORHANI, Virginia Tech Department of Physics, YONG XU, Virginia Tech ECE, HANS ROBINSON, Virginia Tech Department of Physics — Full integration of top-down and bottom-up nanofabrication technologies will require the ability to accurately place nanostructures onto well-defined locations on a surface, where the nanostructures initially only exist suspended in a liquid. As the nanostructures may be quite fragile, perhaps the best way to do this is to pattern the adhesiveness of the surface in order to guide assemblies to the desired locations. We have demonstrated two routes for achieving this using the amine-rich, nm thick polymer films based on poly(allylamine hydrochloride). The adhesive properties of the films can be patterned with standard lithographic techniques, where adhesion to selected portions of the surface is suppressed either by treatment with acetic anhydride or by direct exposure to ultraviolet light. We applied these techniques both to flat and curved substrates and demonstrate spatial resolution better than 100 nm.
Friday, October 21, 2011 8:30AM - 10:30AM –
Session GD The 100th Anniversary of the Discovery of the Atomic Nucleus: A historical reflection of nuclear science in the Southeast Crystal Ballroom DE - Paul Cottle, Florida State University

8:30AM GD.00001 Selected Highlights in Nuclear Research in the Southeast by Vanderbilt and ORNL, JOSEPH HAMILTON, Vanderbilt University — On the one hundredth anniversary of the discovery of the nucleus, selected highlights in nuclear research by Vanderbilt scientists and by Oak Ridge National Laboratory scientists as well as their joint research are described. These will include the earliest work involving the first confirmation of neutron induced fission and classic papers on the fission process. This was followed by the development of the barrier for the gaseous diffusion separation of 235U from 238U. In the 1940’s the first working nuclear reactor became operational at ORNL, to make 239Pu followed by the first radioisotopes for nuclear medicine, neutron scattering to probe materials leading to a Nobel Prize and the first observation of the β decay of the free neutron. In 1953 Hill and Wheeler published their classic nuclear theory paper that has over 2000 citations. In the 1960’s large E0 transitions were observed in decays of β but not γ vibrational bands to confirm the predictions of Bohr and Mottelson that β vibrations change the nuclear deformation. Then the first failures of the B-M model were observed. In the 1970’s the paradigm that each nucleus had one fixed shape was changed when the discovery of the coexistence of overlapping bands built on different deformations were observed. This was made possible, in part, by universities building the first isotope separator on-line to the Oak Ridge cyclotron. This was followed by the discovery of the reinforcement of proton and neutron shell gaps at the same deformation to give superdeformed double magic nuclei. Other highlights will be presented, including the recent discovery of the new element 117 and confirmation of new elements 113 and 115.

9:00AM GD.00002 A Personal Perspective on Triangle Universities Nuclear Laboratory Development1, THOMAS B. CLEGG, UNC-Chapel Hill, Dept of Physics & Astronomy and TUNL — Nuclear physics research in NC began seriously in 1950 when Henry Newson and his colleagues at Duke attracted support for a 4 MeV Van de Graaff accelerator with which they grew their doctoral training program. The lab’s scientific achievements also grew, including the discovery in 1966 of fine structure gaps at the same deformation to give superdeformed double magic nuclei. Other highlights will be presented, including the recent discovery of the new element 117 and confirmation of new elements 113 and 115.

1Work supported in part by the US Dept of Energy Office of Nuclear Physics.

9:30AM GD.00003 A personal view of nuclear physics in the Southeast, KIRBY KEMPER, Florida State University — Numerous physicists who have carried part or all of their work in the Southeast have made major contributions to our present understanding of the nucleus, from Robert Van de Graaff whose accelerator became the work horse of experimental nuclear physics to John Wheeler whose early work at North Carolina began a tradition there that continues until today. Many early major results from southern researchers will be presented as well as some outstanding current work. The shift from exploring nuclear structure to generating the chemical elements in stars to unraveling the structure of the nucleon are evidence of the impact made in the field of nuclear physics by the Southeast.

10:00AM GD.00004 Early History of Jefferson Laboratory1, FRANZ GROSS, Jefferson Laboratory — This talk will focus on the history of Jefferson Laboratory from its inception as the NEAL proposal by the Southeastern Universities Research Association (SURA) in 1980, to about 1986 — two years after the arrival of Hermann Grunder and his Berkeley team. Major themes are (i) a national decision to build a high energy, high duty factor electron accelerator for basic nuclear physics research, (ii) open competition established by the DOE, (iii) formation of SURA, and (iv) in interest of SURA physicists (particularly at UVA and W&M) in this research. I will discuss the scientific, technical, and political issues that eventually lead to the selection of the SURA proposal, the choice of Newport News as the site, and the decision to adopt a recirculating superconducting ring for the final design.

1Supported by Jefferson Science Associates, LLC under U.S. DOE Contract No. DE-AC05-06OR23177.

Friday, October 21, 2011 10:45AM - 11:57AM –
Session HA Gravitation Crystal Ballroom A - George Siopsis, University of Tennessee

10:45AM HA.00001 LISA: the space-based gravitational wave observatory, JOSEP SANJUAN, University of Florida — The Laser Interferometer Space Antenna (LISA) is a space-based gravitational wave (GW) observatory with the primary scientific goal of detecting and observing GW from astronomical sources in the milli-Hertz range. Such observations will provide a new way to explore the Universe and they will bring new rich information about its structure and evolution. However, GWs signals are very weak and thus very precise and low-noise measurements are required. GWs are detected by measuring the relative change in distance between free falling proof masses inside widely separated spacecraft. These changes are measured with pico-meter sensitivity by means of laser interferometry. I will give an overview of the LISA mission and a summary of the research done at the University of Florida.

10:57AM HA.00002 Ring Heater for Advanced LIGO, ERIC DELEEUW, GIACOMO CIANI, GUIDO MUELLER, University of Florida — The Laser Interferometer Gravitational-wave Observatory (LIGO) is currently being upgraded to Advanced LIGO. One of the main changes is the increase in input laser power from 30W to 165W. In Advanced LIGO up to 600kW laser power will circulate inside the interferometer. Some of the power will be absorbed by the LIGO test masses, creating a thermal gradient that will deform them changing the spatial mode of the laser field inside the interferometer. Radiative ring-shaped heaters will be installed close to the test masses to provide additional heat to counteract this effect and minimize the deformation. In this talk we will present the proposed University of Florida ring heater design, and measurements of the thermal profile homogeneity to be compared with initial requirements. In addition, we present initial results of outgassing measurements to qualify our ring heater for use in the LIGO vacuum system.
11:09AM HA.00003 Laser frequency stabilization¹. DARS A DONELAN, GUIDO MUELLER, University of Florida, JAMES THORPE, JEFFREY LIVAS, NASA Goddard Space Flight Center, LISA COLLABORATION — Laser ranging and interferometry are essential technologies allowing for many astounding new space-based missions such as the Laser Interferometer Space Antenna (LISA) to measure gravitational radiation emitted from distant super massive black hole mergers or distributed aperture telescopes with unprecedented angular resolution in the NIR or visible regime. The requirements on laser frequency noise depend on the residual motion and the distances between the spacecraft forming the interferometer. The intrinsic frequency stability of commercial lasers is several orders of magnitude above these requirements. Therefore, it is necessary for lasers to be stabilized to an ultrastable frequency reference so that they can be used to sense and control distances between spacecraft. Various optical frequency references and frequency stabilization schemes are considered and investigated for the applicability and usefulness for space-based interferometry missions.

¹This work is supported by NASA grant NNX11AO26G.

11:21AM HA.00004 High Speed Alignment Control of an Optical Resonator, DANIEL AMARIUTEI, University of Florida, LIGO UF TEAM — Laser interferometric gravitational wave detectors are by far the most sensitive interferometer in the world. They require exquisite control over all degrees of freedom of the optical components comprising the main detector but also over all degrees of freedom of the used laser beam. One of the most critical degrees of freedom is the propagation direction and beam location of the input beam when it enters the interferometer. Any variations in these two parameters will couple to static misalignments inside the interferometer and will generate spurious signals, which can easily limit the sensitivity of gravitational wave detectors such as Advanced LIGO. This has long been recognized and has led to alignment sensing and control systems, which use piezo mounted mirrors to control the alignment of the laser beam. The disadvantage of these systems is their low bandwidth and intrinsic noise. We have are in the process of characterizing actuators which use the electro-optical effect to steer the laser beam. These systems have a significantly higher bandwidth and don’t require any moving parts which usually means much higher reliability. We report on the performance of these devices.

11:33AM HA.00005 Orbits and Scaling for an Isotropic Metric, JOSEPH RUDMIN, James Madison University — Scaling of physical quantities shows the symmetries of an isotropic metric. For example, invariance of Planck’s constant under gravitational scaling provides consistency of general relativity with quantum mechanics. Invariance of charge and electric field strength provide consistency with electromagnetism. Transitivity of scaling eliminates the traditional need for a globally preferred reference frame. Rather, diagonalization of the metric yields local rest frames. Conventional application of the Einstein Equation has inconsistencies and contradictions, such as gravitational fields without energy, objects crossing event-horizons, objects exceeding the speed of light, and inconsistency in scaling the speed of light and its factors. An isotropic metric resolves such problems by attributing energy to the gravitational field, in the energy-momentum tensor of the Einstein Equation. Scattering, orbital period, and precession offer ways to distinguish an isotropic from a Schwarzschild metric.

11:45AM HA.00006 Telescope Spacer Design Investigations¹. DANILA KORYTOV, JOSEP SANJUAN, GUIDO MUELLER, University of Florida, JEFFREY LIVAS, ALIX PRESTON, PETAR ARSENOVIC, NASA Goddard Space Flight Center, UNIVERSITY OF FLORIDA COLLABORATION, NASA GODDARD SPACE FLIGHT CENTER COLLABORATION — Space-based interferometric gravitational wave observatories will measure changes in the distance between free falling proof masses inside widely separated spacecraft with pm sensitivity. These observatories will use fast telescopes to exchange laser beams. These telescopes are part of the probed optical distances and any length change in the gravitational wave band between secondary and primary can limit the sensitivity of the observatories. Furthermore, the large distance between and space constrains on the spacecraft require to use very fast telescopes with f-numbers approaching unity. These telescopes are very sensitive against any absolute length change which would reduce interferometer visibility and, ultimately, sensitivity. Our group has assembled a Silicon Carbide test structure and investigated its dimensional stability in the $10^{-4}$ to 1Hz frequency band at different operating temperatures. We also measured the overall length change and started investigating asymmetric length changes during cool down which would lead to misalignments in the telescope

¹This work is supported by NASA grant NNX10AJ38G.

Friday, October 21, 2011 10:45AM - 12:21PM – Session HB Statistical and Nonlinear Physics | Crystal Ballroom B - Michel Pleimling, Virginia Polytechnic Institute and State University

10:45AM HB.00001 Boundary conflicts and cluster coarsening: Waves of life and death in the cyclic competition of four species¹. AHMED ROMAN, MICHEL PLEIMLING, Virginia Tech — In the cyclic competition among four species on a two-dimensional lattice, the partner particles, which swap positions on the lattice with some probability, produce clusters with a length that grows algebraically as $t^{1/z}$ where z is the dynamical exponent. Further investigation of the dynamics at the boundary of the clusters is realized by placing one partner particle pair in the upper half of the system and the other pair in the lower half. Using this technique, results about the fluctuations of the interface are obtained. We also observe wave fronts in the case of non-symmetric reaction rates where extinction of a partner particle pair takes place.

¹Supported in part by the US National Science Foundation through Grant DMR-0904999.

10:57AM HB.00002 Stochastic evolution of four species in cyclic competition: exact and simulation results¹. SARA CASE, CLINTON DURNEY, MICHEL PLEIMLING, R.K.P. ZIA, Virginia Tech — We study a stochastic system with $N$ individuals, consisting of four species competing cyclically: $A + B \rightarrow A + A$, $\cdots$, $D + A \rightarrow D + D$. Randomly choosing a pair and letting them react, $N$ is conserved but the fractions of each species evolve non-trivially. At late times, the system ends in a static, absorbing state — typically, coexisting species $AC$ or $BD$. The master equation is shown and solved exactly for $N = 4$, providing a little insight into the problem. For large $N$, we rely on simulations by Monte Carlo techniques (with a faster dynamics where a reaction occurs at every step). Generally, the results are in good agreement with predictions from mean field theory, after appropriate rescaling of Monte Carlo time. The theory fails, however, to describe extinction or predict their probabilities. Nevertheless, it can hint at many remarkable behavior associated with extinction, which we discover when studying systems with extremely disparate rates.

¹Supported in part by NSF-DMR-0705152, 0904999, 1005417.
10:45AM HC.00001 Image guidance and Motion Adaptation in Radiation Therapy

Session HC Medical Physics: Improving Health, Saving Lives

Crystal Ballroom C - Ken Wong, Virginia Polytechnic Institute and State University

10:45AM HC.00001 Image guidance and Motion Adaptation in Radiation Therapy

MARTIN MURPHY, Medical College of Virginia - Virginia Commonwealth University — Modern radiation therapy can achieve a very high level of conformity, meaning that the size and shape of nearly any disease site (such as a tumor) can be irradiated to uniform dose while sparing surrounding normal tissue. However, an inherent limitation in many treatment planning and delivery systems is that the body region under treatment is considered to be static and unchanging. This assumption is false, as there are many processes over varying time scales that occur in our daily lives. It is essential in ink-jet printers and spray cooling technology. However, most research has already been done on the pinch-off mechanism from a non-wettable nozzle. In this study, we focus on the formation of a drop from a wettable nozzle. Initially, a drop will climb the outer walls of the wettable nozzle because of surface tension. This initial upward motion is closely related to the capillary rise phenomenon. Then, when the weight of the drop becomes large enough, the force of gravity would overcome surface tension causing the drop to fall. By changing the nozzle size and fluid flow rate, we have observed different behaviors of the droplets and developed a mathematical model that predicts the motion of the drop. Two asymptotic solutions in the initial and later stages of drop formation are then obtained and show good agreement with the experimental observations.

Supported in part by the US National Science Foundation through Grant DMR-0904999.

11:09AM HB.00003 The effects of mobility on the one-dimensional four-species cyclic predator-prey model

DAVID KONRAD, MICHEL PLEIMLING, Virginia Tech — The dynamics of a one-dimensional lattice composed of four species cyclically dominating each other is very much dependent on the rates of mobility in the system. We realize mobility as the exchange of two particles located at two nearest neighbor sites with some species dependent rate $s$. Allowing for only one particle per site, the different species interact cyclically, with species dependent consumption rate $k$, such that $k+s \leq 1$. When varying the exchange rates, we see vastly different behavior when compared to the three-species model. The patterns of domain growth and decay still show an overall power law behavior, however the fundamental trend of domain growth does not follow the three-species case. We also look at the space-time diagrams to see precisely how the domains form, grow, and decay.

1Supported in part by the US National Science Foundation through Grant DMR-0904999.

11:21AM HB.00004 Quenched Spatial Disorder in Cyclic Three-Species Predator-Prey Models

QIAN HE, UWE C. TAUBER, Department of Physics, Virginia Tech, Blacksburg, Virginia 24061-0435, USA — We employ individual-based Monte Carlo simulations to study the effects of quenched spatial disorder in the reaction rates on the co-evolutionary dynamics of cyclic three-species predator-prey models with conserved total particle density. To this end, we numerically explore the oscillatory dynamics of two different variants: (1) the model with symmetric interaction rates near the center of the configuration space, and (2) a strongly asymmetric model version located in one of the three “corners” of configuration space. We find that spatial rate variability has only minor effect on the dynamics of generic, not strongly asymmetric systems (variant 1). In stark contrast, spatial disorder can greatly enhance the fitness of both minor species in “corner” systems (2). Furthermore, through both mean-field analysis and numerical simulation, we conclude that the evolutionary dynamics of two-species Lotka-Volterra predator-prey models is well approximated by such strongly asymmetric cyclic three-species predator-prey systems. Refs.: Qian He, Mauro Mobilia, and Uwe C. Tauber, Phys. Rev. E 82, 051909 (2010); Qian He and Uwe C. Tauber, in preparation (2011).

11:33AM HB.00005 Epidemic spreading on preferred degree adaptive networks

SHIVAKUMAR JOLAD, WENJIA LIU, R.K.P. ZIA, BEATE SCHMITTMANN, Virginia Tech — We report our study of SIS epidemic spreading model on networks where individuals have a fluctuating number of connections around some preferred degree. By making our preferred degree depend on the level of infection, we model the response of individuals to the prevailing epidemic. This helps us to explore the feedback mechanisms between the dynamics on the network and dynamic of the network. We will discuss the effect of such feedback mechanisms on the SIS phase diagram. We have also explored the SIS model on two communities with a coupling between them.

1This work was supported by the US Department of Energy through grant DE-FG02-09ER46613.

11:45AM HB.00006 Aging behavior in disordered systems

HYUNHANG PARK, MICHEL PLEIMLING, Virginia Tech — Using Monte Carlo simulations we investigate aging behavior during phase ordering in two-dimensional Ising models with disorder and in three-dimensional Ising spin glasses. The time-dependent dynamical correlation length $L(t)$ is determined numerically and the scaling behavior of various two-time quantities as a function of $L(t)/L(s)$ is discussed. For disordered Ising models deviations of $L(t)$ from the algebraic growth law show up. The generalized scaling forms as a function of $L(t)/L(s)$ reveal a simple aging scenario for Ising spin glasses as well as for disordered Ising ferromagnets.

1Supported in part by grants from the NSF:DMR-0705152 and DMR-1005417.

11:57AM HB.00007 Time-dependent mechanical response of the cytoskeleton

NASRIN AFZAL, MICHEL PLEIMLING, Virginia Tech — Motivated by a series of experiments that study the response of the cytoskeleton in living cells to time-dependent mechanical forces, we investigate, through Monte Carlo simulations, a three-dimensional network subjected to perturbations. After having prepared the system in a relaxed state, shear is applied and the relaxation processes are monitored. We measure two time quantities and discuss the possible implications of our results for relaxation processes taking place in the cytoskeleton.

Supported in part by the US National Science Foundation through Grant DMR-0904999.

12:09PM HB.00008 Drop Formation from a Wettable Nozzle

BRIAN chang, Gary Nave, SUNGHWAN JUNG, Department of Engineering Science and Mechanics at Virginia Tech — Drop formation from a nozzle is a common occurrence in our daily lives. It is essential in ink-jet printers and spray cooling technology. However, most research has already been done on the pinch-off mechanism from a non-wettable nozzle. In this study, we focus on the formation of a drop from a wettable nozzle. Initially, a drop will climb the outer walls of the wettable nozzle because of surface tension. This initial upward motion is closely related to the capillary rise phenomenon. Then, when the weight of the drop becomes large enough, the force of gravity would overcome surface tension causing the drop to fall. By changing the nozzle size and fluid flow rate, we have observed different behaviors of the droplets and developed a mathematical model that predicts the motion of the drop. Two asymptotic solutions in the initial and later stages of drop formation are then obtained and show good agreement with the experimental observations.

Supported in part by the US National Science Foundation through Grant DMR-0904999.

Friday, October 21, 2011 10:45AM - 12:45PM
Session HC Medical Physics: Improving Health, Saving Lives
Crystal Ballroom C - Ken Wong, Virginia Polytechnic Institute and State University

10:45AM HC.00001 Image guidance and Motion Adaptation in Radiation Therapy

MARTIN MURPHY, Medical College of Virginia - Virginia Commonwealth University — Modern radiation therapy can achieve a very high level of conformity, meaning that the size and shape of nearly any disease site (such as a tumor) can be irradiated to uniform dose while sparing surrounding normal tissue. However, an inherent limitation in many treatment planning and delivery systems is that the body region under treatment is considered to be static and unchanging. This assumption is false, as there are many processes over varying time scales that change the shape, location, and size of the treatment target and surrounding tissue. Technological advances are now making it feasible to treat tumors adaptively, so that the radiation delivered is modulated in real time to match the changes in the body. These advances will enable more accurate and precise radiation treatments, which should improve cure rates and patient survival times. In this talk, I will present methods for observing the dynamic tumor, determining its changes in shape, size, and position, and delivering adaptive therapy.
11:15AM HC.00002 Monitoring electrical and thermal burns with Spatial Frequency Domain Imaging, JESSICA RAMELLA-ROMAN, The Catholic University of America — Thermal and electrical injuries are devastating and hard-to-treat clinical lesions. The pathophysiology of these injuries is not fully understood to this day. Further elucidating the natural history of this form of tissue injury could be helpful in offering stage-appropriate therapy. Spatial Frequency Domain Imaging (SFDI) is a novel non-invasive technique that can be used to determine optical properties of biological media. We have developed an experimental apparatus based on SFDI aimed at monitoring parameters of clinical interest such as tissue oxygen saturation, methemoglobin volume fraction, and hemoglobin volume fraction. Co-registered Laser Doppler images of the lesions are also acquired to assess tissue perfusion. Results of experiments conducted on a rat model and discussions on the systemic changes in tissue optical properties before and after injury will be presented.

11:45AM HC.00003 Medical Imaging for Understanding Sleep Regulation, KENNETH WONG, Virginia Tech — Sleep is essential for the health of the nervous system. Lack of sleep has a profound negative effect on cognitive ability and task performance. During sustained military operations, soldiers often suffer from decreased quality and quantity of sleep, increasing their susceptibility to neurological problems and limiting their ability to perform the challenging mental tasks that their missions require. In the civilian sector, inadequate sleep and over sleep pathologies are becoming more common, with many detrimental impacts. There is a strong need for new, in vivo studies of human brains during sleep, particularly the initial descent from wakefulness. Our research team is investigating sleep using a combination of magnetic resonance imaging (MRI), positron emission tomography (PET), and electroencephalography (EEG). High resolution MRI combined with PET enables localization of biochemical processes (e.g., metabolism) to anatomical structures. MRI methods can also be used to examine functional connectivity among brain regions. Neural networks are dynamically reorganized during different sleep stages, reflecting the disconnect with the waking world and the essential yet unconscious brain activity that occurs during sleep. In collaboration with Linda Larson-Prior, Washington University; Alpay Ozcan, Virginia Tech; Seong Mun, Virginia Tech; and Zang-Hee Cho, Gachon University.

12:15PM HC.00004 Radiation Oncology Physics and Medical Physics Education, DAN BOURLAND, Wake Forest School of Medicine — Medical physics, an applied field of physics, is the applications of physics in medicine. Medical physicists are essential professionals in contemporary healthcare, contributing primarily to the diagnosis and treatment of diseases through numerous inventions, advances, and improvements in medical imaging and cancer treatment. Clinical service, research, and teaching by medical physicists benefits thousands of patients and other individuals every day. This talk will cover three main topics. First, exciting current research and development areas in the medical physics specialty of radiation oncology will be described, including advanced oncology imaging for treatment simulation, image-guided radiation therapy, and biologically-optimized radiation treatment. Challenges in patient safety in high-technology radiation treatments will be briefly reviewed. Second, the educational path to becoming a medical physicist will be reviewed, including undergraduate foundations, graduate training, residency, board certification, and career opportunities. Third, I will introduce the American Association of Physicists in Medicine (AAPM), which is the professional society that represents, advocates, and advances the field of medical physics (www.aapm.org).

Friday, October 21, 2011 10:45AM - 12:45PM
Session HD Neutrinos

10:45AM HD.00001 $\theta_{13}$ and Beyond, PATRICK HUBER, Virginia Tech — I will briefly review the current status of neutrino oscillation and highlight the open issues. The current generation of neutrino experiments Double Chooz, Daya Bay, T2K and NOvA have started to probe $\theta_{13}$ and soon will deliver a first measurement. However, they can not test the mass hierarchy or study leptonic CP violation, therefore even larger facilities are needed. I will present the underlying physics and the various different proposals in detail.

11:15AM HD.00002 The T2K Experiment, JOSHUA ALBERT, Duke University, T2K Collaboration — The T2K experiment is designed to study neutrino oscillation. In particular, it is designed to measure the final, previously unmeasured oscillation mixing angle, known as $\theta_{13}$. This mixing angle is responsible for allowing muon neutrinos to oscillate to electron neutrinos. T2K features a nearly pure beam of muon neutrinos, produced at the J-PARC accelerator complex in Tokai, on the East coast of Japan. This beam travels 295 km through the earth, and emerges at the Super-Kamiokande detector, in the mountains in Western Japan, where the neutrinos are detected. The appearance of electron neutrinos from the $\nu_{\mu}$ beam can indicate non-zero $\theta_{13}$. Six electron neutrino candidate events were observed at Super-Kamiokande, with an expected background of 1.5. The probability of observing six or more events from just background is just 0.7%.

11:45AM HD.00003 The MINOS and NOvA Experiments, PATRICIA VAHLE, College of William and Mary — Massive neutrinos provide the first hints at physics beyond the standard model. Current and future neutrino experiments aim to further refine our understanding of neutrino mixing, one of the implications of neutrino mass. Two of these experiments, MINOS and NOvA, are long-baseline neutrino oscillation experiments in the Fermilab NuMI neutrino beam line. Both the currently running MINOS experiment, and the future NOvA experiment, employ two detectors hundreds of km apart. Comparisons of the energy spectra and beam composition at the two sites yield precision measurements of neutrino oscillations for L/E=500 km/GeV. In this talk, I will describe the two experiments, presenting updated measurements from MINOS on the probability of muon-neutrino and antineutrino disappearance as a function of energy. I will report on the MINOS measurement of neutral current interaction rates in each detector, which enables a search for light neutrino families that do not couple via the weak interaction, and I will also discuss the latest results from the search for electron-neutrino events in the MINOS Far Detector, which probes the value of the mixing angle $\theta_{13}$. Finally, I will discuss the goals and status of the NOvA experiment.

12:15PM HD.00004 Neutrino Oscillations with the Daya Bay Reactor Neutrino Experiment, JONATHAN LINK, Virginia Tech — The last unknown neutrino mixing matrix element, $\theta_{13}$, holds the key to lepton based CP violation and to determining the ordering of the neutrino mass states. The Daya Bay Reactor Neutrino Experiment, which has just started to take data will have the best reach in $\theta_{13}$ sensitivity for the next decade. The experiment will be discussed, including current status and future prospects.

Friday, October 21, 2011 1:30PM - 2:42PM
Session JA Astrophysics, Crystal Ballroom A - Michael Kavic, Long Island University
The microLENS prototype is currently being finished and deployed at the Kimballton Underground Research Facility (KURF) near Virginia. An effort to reach this goal we have developed a two phase prototype program. The first of these is microLENS, a small prototype to study the goal is the construction of a low energy neutrino spectrometer (LENS) that will measure the entire solar neutrino spectrum above 115 keV. In 7 MicroLENS University of Tennessee because the Super Universe was a googol larger than our universe. Radiation. Entropy switched from maximum to minimum in the transformation “resurrecting” life. The cosmological constant problem existed solar masses) quark stars (matter) were to galaxies. Information was lost in quark star/black hole formation and none was emitted as Hawking radiation. The reaction yields the prompt emission of an electron and the delayed emission of 2 gamma rays that serve as a time & space coincidence tag. Advancement Geant4 analysis methods have been developed to suppress adequately the total internal reflection by suitable low index gaps in the segmentation. The spatial resolution of a nuclear event is obtained digitally, much more precisely than possible by common time of flight methods. Advanced Geant4 analysis methods have been developed to suppress adequately the severe background due to 115In beta decay, achieving at the same time high detection efficiency.

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This work is supported by the National Science Foundation and Department of Energy.

Currently, the precision measurement on the Neutrino Spectrum (pp, 7Be, and CNO)1 is supported by the National Science Foundation and Department of Energy.

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1:30PM JB.00001 Recent Results from PHENIX. XIAOCHUN HE. Georgia State University — Studying the property of quark-gluon plasma and its implication to the Big Bang model of cosmology has been the focal point of research in the field of relativistic heavy ion collisions over the past three decades. The Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory started taking data in 2000. The PHENIX Collaboration at RHIC has carried out a comprehensive study of particle production that includes baseline measurement in p+p collisions, and the measurement from d+Au, Cu+Cu and Au+Au collisions at multiple energies. This talk will focus on the most recent and exciting results from PHENIX.

1On behalf of the PHENIX Collaboration

2:00PM JB.00002 Recent Results from ALICE at LHC. CHRISTINE NATTRASS. University of Tennessee — The ALICE experiment at the Large Hadron Collider at CERN is optimized to study the properties of the hot, dense matter created in high energy nuclear collisions in order to improve our understanding of the properties of nuclear matter under extreme conditions. In 2009 the first proton beams were collided at the Large Hadron Collider and since then data from proton-proton collisions at sqrt(s) = 0.7, 2.76, and 7 TeV have been taken. In 2010 the first lead nuclei were collided at 2.76 TeV. Recent results from ALICE will be presented. These results are consistent with expectations based on data available at lower energies at RHIC and the SPS, indicating that the matter created in collisions at the LHC is hotter and larger than that at lower energies and behaves like a strongly interacting, nearly perfect liquid.

1On behalf of the ALICE collaboration.

2:30PM JB.00003 Results from PbPb Collisions Measured by the CMS Detector. CHARLES MAGUIRE. Vanderbilt University — We will survey the results obtained from the analyses of PbPb collisions taken by the CMS detector during the first heavy ion run at the LHC. The physics topics will include quarkonium suppression studies, the non-suppression of the electro-weak Z and photon gauge bosons, the new insights into jet suppression dynamics afforded by di-jet energy asymmetry measurements, and the extensive investigations into the multiple harmonics of hydrodynamic flow. The quarkonium results will include both the J/Psi prompt and non-prompt production yields, and the Upsilon excited state production modifications in heavy ion collisions. The discussion of the hydrodynamic flow will extend across a variety of complementary methods aimed at disentangling the flow and non-flow contributions to the observed signals.

3:00PM JB.00004 What do we know about the shear-viscosity of QCD matter? STEFFEN BASS. Duke University — The success of viscous Relativistic Fluid Dynamics (RFD) in describing hadron spectra and elliptic flow at RHIC has led to a strong interest in the transport coefficients of QCD, in particular the shear- and bulk-viscosity as well as the shear-viscosity over entropy-density ratio η/s. In my talk I will review our current state of knowledge on the shear viscosity of QCD matter at RHIC. In particular I will focus on the latest attempts to constrain η/s via model to data comparisons, the question whether low viscosity matter needs to be strongly interacting in the deconfined phase and on recent calculations of η/s for a hadron gas in and out of chemical equilibrium.

Friday, October 21, 2011 1:30PM - 3:06PM
Session JC Nuclear Physics II
Crystal Ballroom C - Paul Cottle, Florida State University

1:30PM JC.00001 New Levels in 162Gd. BRAYTON DOLL. NBPHS. Vanderbilt University. N.T. BREWER. J.H. HAMILTON. A.V. RAMAYYA. J.K. HWANG. Vanderbilt University. Y.X. LUO. Vanderbilt University. LBNL. J.O. RASMUSSEN. LBNL. S.J. ZHU. Vanderbilt University. Tsinghua University. G.M. TER-AKOPIAN. JINR — We’ve measured prompt gamma rays from the fission fragments of the spontaneous fission of 252Cf in Gammasphere. The data from the experiment have high statistics with 5.7*10^11 triple and higher gamma coincidences. We examined levels in 162Gd in this data set which shows very consistent I(I+1) level spacing in the yrast band. This demonstrates consistency with a rotational nucleus that has a large quadrupole deformation. This is common for nuclei in between closed spherical shells. To find new levels and gamma transitions, we looked at triple coincidence gates in the Radware software in which we see population of yrast states up to 16+. We found new evidence for proposed collective bands in this isotope. Results will be discussed.

1:42PM JC.00002 Octupole correlations in Ba and Ce nuclei. N.T. BREWER. W.A. YZAGUIRRE. J.H. HAMILTON. A.V. RAMAYYA. S.H. LIU. C. GOODIN. J.K. HWANG. Vanderbilt University. Y.X. LUO. Vanderbilt and LBNL. J.O. RASMUSSEN. LBNL. S.J. ZHU. Vanderbilt. Tsinghua University. G.M. TER-AKOPIAN. A.V. DANIEL. JINR — γ-rays from the Spontaneous Fission of 252Cf were measured with Gammasphere and have given great insight into the structure of neutron rich nuclei. We have examined high-spin states and the γ-transitions associated with octupole correlations in 141–146Ba and 144Ce. Coexisting quadrupole/octupole deformation is characterized by two ΔI = 1 rotational bands with opposite parities. The states in these two rotational bands are described by a quantum number called simplex with s^2 = (-1)^l. In 143Ba, the levels are extended to 43/2^+ with a total of six new levels along with two new transitions. In 144Ba, we have placed new levels including three E1 transitions and 8 linking transitions to the s = +1 band to give more definitive evidence for the s = -1 band. Six new levels are found in 147Ba. For 144Ba and 148Ce we have, for the first time in even-even isotopes, confirmed the spin/parity of some s = -1 levels using angular correlations.

1:54PM JC.00003 Neutron emission anisotropies from linearly polarized γ rays on natCd, natSn, and 181Ta. W. CLARKE SMITH. GERALD FELDMAN. George Washington University. HI-γS COLLABORATION — Azimuthal asymmetries in neutron yields produced by bombarding targets with linearly polarized photons via γ(n,γ), γ(2n), and γ(f) reactions are being investigated as a possible means of identifying various nuclear isotopes. The High Intensity γ-ray Source (HI-γS) at Duke University provides nearly monochromatic, circularly or linearly polarized γ rays with high intensity by Compton backscattering free-electron-laser photons from stored electrons. Linearly polarized γ rays produced by HI-γS were incident on natCd, natSn, and 181Ta targets at six energies Eγ between 11.0 and 15.5 MeV and emitted neutrons were detected both parallel and perpendicular to the plane of polarization by an array of 18 liquid-scintillator detectors at angles in the range θ = 55°–142°. Detected neutrons were distinguished from Compton scattered photons by pulse-shape-discrimination and timing cuts, and their energies (E_n) were determined using time-of-flight information over a 0.5 m flight path. The characteristic plots of R_{α,β}, the ratio of neutron counts parallel to neutron counts perpendicular to the plane of the incident γ-ray polarization, against E_n were constructed for each value of E_n and θ and then compared to those for other targets studied at HI-γS, including fissile nuclei 235U and 238U.
2:06PM JC.00004 Sensitivity of the Reaction Cross Section Calculation in the Glauber Theory Framework to the Parameters of Random Number Generation. John Wilson, Western Kentucky University — To extract the nuclear size information, the experimentally measured interaction cross-section is compared to cross-sections calculated in the framework of Glauber theory or in its various approximations. These calculations are usually performed using a Monte Carlo technique. In the presented paper, we discuss the sensitivity of the reaction and interaction cross sections’ calculation to the parameters of the Metropolis-Hasting algorithm which is used to produce nucleon coordinates distributed according to the chosen nuclear density distribution. We evaluate generated sequence of the random nucleon coordinates using lag-1 autocorrelation, correlation of multiple data sets, and running first and second moments. We show that an non-optimal Metropolis-Hasting proposal distribution increases uncertainty of the cross section calculation. The obtained dependence of the accuracy of the determined nuclear density parameters on the various statistical diagnostics of the Metropolis-Hasting for the various types of nuclear density distributions is also discussed.

2:18PM JC.00005 From Finite Nuclei to Neutron Stars. Wei-Chia Chen, Jorge Piekarewicz, Florida State University — We will discuss attempts to build a relativistic density functional using constraints from both finite nuclei and neutron stars. The calibration of the model will proceed through a standard minimization of a quality chi-square measure. Moreover, by studying the model-parameter landscape around the minimum we will be able to provide meaningful theoretical error bars as well as to uncover correlations between physical observables.

2:30PM JC.00006 Neutrino oscillations: latest mixing parameters. Bernadette Cogswell, Vanderbilt and Fisk Universities, David Latimer, Reed College, Jesus Escamilla Roa, Vanderbilt University — Assuming three neutrinos, the neutrino oscillation mixing parameters are extracted from a global analysis of the Super-K atmospheric, MINOS disappearance and appearance neutrino, CHOOZ, T2K, KamLAND, and all solar data. MINOS anti-neutrino data is not included. The full oscillation probabilities are used so that we can address the question of the sign of \( \theta_{13} \). How to extract the allowed confidence level regions without assuming Gaussian statistics is explain. The probability that \( \theta_{13} \) is negative will be given, as well as the probability that Double CHOOZ and Daya Bay will measure a non-zero value of \( \theta_{13} \). Correlations between \( \theta_{13} \) and \( \theta_{23} \) will be examined.

1Supported, in part, by US DOE and Mexico, CONACyT.

2:42PM JC.00007 Independent Benchmarking of a Hybrid Monte Carlo Cross Section Code. Nathan DeLauder, Lawrence Townsend, The University of Tennessee — Understanding the effects of high-energy neutron interactions with certain materials is of considerable interest to the field of space radiation protection. Due to the expected radiation environment, neutron production and interactions with spacecraft materials will result in neutrons that can cause significant biological risk to crewmembers. For investigating incident particle interactions with target materials, an existing statistical model code (ALICE2008) was used to compare our results with the usual Glauber model.

2:54PM JC.00008 Derivation of the Abrasion-Ablation Model Using Corrections to the Phase Function. Santosh Bhatt, Lawrence Townsend, The University of Tennessee — The analytical abrasion-ablation model has been used for the quantitative predictions of the neutron and light ion spectra from nucleus-nucleus and nucleon-nucleus collisions. The abrasion stage of the current model is based on the Glauber’s multiple scattering theory and applies the small angle approximation which assumes the longitudinal momentum transfer for the scattering amplitude to be small, where the expansion of the scattering amplitude is only considers first order terms. However the validity of the small angle approximations for the current model is not clear for light ions and nucleons. In this work, we have re-derived the phase functions, \( \chi \), for the calculation of nuclear cross-sections using a perturbation approach and expanded Fourier-Bessel arguments of scattering amplitude in terms of Legendre polynomials, thus eliminating the small angle approximation. We have computed the differential cross-section for various projectile-target data sets at different energies for different scattering angles and compared our results with the usual Glauber model.

Friday, October 21, 2011 1:30PM - 3:30PM –
Session JD Statistical Physics Far from Equilibrium

1:30PM JD.00001 The Emergence of Community Structure in Metacommunities. Per Arne Rikvold, Department of Physics, Florida State University — The role of space in determining species coexistence and community structure is well established. However, previous studies mainly focus on simple competition and predation systems, and the role of mutualistic interspecies interactions is not well understood. Here we use a spatially explicit metacommunity model, in which new species enter by a mutation process, to study the effect of fitness-dependent dispersal on the structure of communities with interactions comprising mutualism, competition, and exploitation [1,2]. We find that the diversity and the structure of the interaction network undergo a nonequilibrium phase transition with increasing dispersal rate. Low dispersion rate favors spontaneous emergence of many dissimilar, strongly mutualistic and species-poor local communities. Due to the local dissimilarities, the global diversity is high. High dispersion rate promotes local biodiversity and supports similar, species-rich local communities with a wide range of interactions. The strong similarity between neighboring local communities leads to reduced global diversity.


1Supported by U.S. NSF, SERC of Canada, and le Fond Qu´eb´ecois de la Recherche sur la Nature et les Technologies.
2:00PM JD.00002 Cyclically competing species: deterministic trajectories and stochastic evolution

MICHELE PLEMLING, Virginia Tech — Generalizing the cyclically competing three-species model (often referred to as the rock-paper-scissors game), we consider a simple system of population dynamics that involves four species. We discuss both well-mixed systems, i.e. without spatial structure, and spatial systems on one- and two-dimensional regular lattices. Unlike the three-species model, the four species form alliace pairs which resemble partnership in the game of Bridge. In a finite system with discrete stochastic dynamics, all but four of the absorbing states consist of coexistence of a partner-pair. For the system without spatial structure mean-field theory predicts complex time dependence of the system and that the surviving partner-pair is the one with the larger product of their strengths (rates of consumption). Beyond mean-field much richer behavior is revealed, including extinction probabilities and non-trivial distributions of the population ratio in the surviving pair. For the lattice systems, we discuss the growth of domains and the related extinction events, thereby confronting our results with those obtained for the three-species case.

1Supported by the US National Science Foundation through Grant DMR-0904999.

2:30PM JD.00003 Stochastic population oscillations in spatial predator-prey models

UWE C. TAUBER, Virginia Tech — It is well-established that including spatial structure and stochastic noise in models for predator-prey interactions invalidates the classical deterministic Lotka-Volterra picture of neutral population cycles. In contrast, stochastic models yield long-lived, but ultimately decaying erratic population oscillations, which can be understood through a resonant amplification mechanism for density fluctuations. In Monte Carlo simulations of spatial stochastic predator-prey systems, one observes striking complex spatio-temporal structures. These spreading activity fronts induce persistent correlations between predators and prey. In the presence of local particle density restrictions (finite prey carrying capacity), there exists an extinction threshold for the predator population. The accompanying continuous non-equilibrium phase transition is governed by the directed-percolation universality class. We employ field-theoretic methods based on the Doi-Peliti representation of the master equation for stochastic particle interaction models to (i) map the ensuing action in the vicinity of the absorbing state phase transition to Reggeon field theory, and (ii) to quantitatively address fluctuation-induced renormalizations of the population oscillation frequency, damping, and diffusion coefficients in the species coexistence phase. [See Preprint arXiv:1105.4242, and further refs. therein.]

3:00PM JD.00004 Accumulation of beneficial mutations in low dimensions

JAKUB OTWINOWSKI, Emory University — When beneficial mutations are relatively common, competition between multiple unfixxed mutations can reduce the rate of fixation in well-mixed asexual populations. We introduce a one-dimensional model with a steady accumulation of beneficial mutations. We find a transition between periodic selection and multiple-mutation regimes. In the multiple-mutation regime, the increase of fitness of a new-fx field much richer behavior is revealed, including extinction probabilities and non-trivial distributions of the population ratio in the surviving pair. For the lattice systems, we discuss the growth of domains and the related extinction events, thereby confronting our results with those obtained for the three-species case.

1Supported by the US National Science Foundation through Grant No. DMR-0812204.

Friday, October 21, 2011 3:45PM - 5:45PM

Session KA Superconductivity: 100th Anniversary

Crystal Ballroom A - Norman Mannella, University of Tennessee

3:45PM KA.00001 A New Piece in the High Tc Superconductivity Puzzle: Fe based Superconductors

ADRIANA MOREO, University of Tennessee and ORNL — An overview of the historic and current developments in superconductivity will be presented. The phenomenon of superconductivity was discovered almost 100 years ago and it is still one of the hottest research topics providing fascinating puzzles and challenges to both theoreticians and experimentalists. There was a lag of almost 50 years between the experimental discovery of (low Tc) superconductivity and the development of the BCS theory which explained the phenomenon in terms of pairs of electrons held together by the interaction with the phonons in the material. The quest to discover superconducting materials with higher Tc's continued quietly for many years until huge progress occurred in the 1980' when Tc's higher than 77K were observed in copper-oxide based materials. The study of these new materials generated tremendous advances in both experimental and theoretical methods and much is now known about their properties; but the mechanism, i.e., the "glue," that binds the electrons together is still unknown; it appears that phonons are unable to do the job and there is controversy on whether the magnetism present in these materials helps or hurts. Very recently, in 2008, high Tc was discovered in a new family of iron based materials. While they are similar to the cuprates in some ways, i.e., magnetism is present, there are many differences as well. This discovery provides a new chance to unveil the high-Tc mystery and the condensed matter community is intensely working on the subject.

1Supported by U.S. DOE, Office of Basic Energy Sciences, Materials Sciences and Engineering Division.

4:15PM KA.00002 High Temperature Superconductors: From Basic Research to High-Current Wires

DAVID CHRISTEN, Oak Ridge National Laboratory — In this talk, I will provide a perspective on the fundamental properties of the cuprate high-temperature superconductors (HTS), and how early and ongoing fundamental research has identified the strengths and weaknesses, and has ultimately led to the development of superconducting wires for power applications—the so-called "coated conductors." Early work on the properties of various classes of cuprate HTS materials revealed their emergent behavior as type-II superconductors, even though it was apparent that the underlying pairing mechanism is likely quite different than for conventional, electron-phonon coupled materials. From the perspective of this talk, important findings documenting the level of electronic anisotropy, basic length scales, etc., and the effects of thermal energies on vortex matter are described, especially as they relate to the ability to carry loss-free currents. It became apparent that a good supercurrent conduction wire is achieved only along well-aligned basal planes of the structure, and enhancement of those currents could be obtained by introduction of controlled nanostructures for flux pinning. From this work, the (RE)Ba2Cu3O7−δ emerged as the best material class for potential high-current wires, mainly because it was the least anisotropic from among those with transition temperature exceeding the boiling point of liquid nitrogen. Ultimately, much effort has been devoted to the control and optimization of nanostructural modifications to the materials, at a size range and spacing that should be tailored to match the magnetic vortex array. The description, success, and consequences of these efforts will be presented.

1Research sponsored by the U.S. DOE: Office of Electricity Delivery and Energy Reliability - Advanced Cables and Conductors, and the Materials Science and Engineering Division, Office of Basic Energy Science
Upper critical magnetic fields of unconventional superconductors are no longer the main parameters of merit for power applications, which can cuprates and the recently discovered Fe-based superconductors. One of the lessons of the last 20 years is that high critical temperatures and upper critical magnetic fields of unconventional superconductors are no longer the main parameters of merit for power applications, which can also be important for the ongoing quest for higher-\( T_c \) materials.

In this Talk, I describe the most recent progress in the field of iron-based superconductors. Using neutron scattering as a probe, we study the spin wave excitations in BaFe2As2 and RbFe1.6Se2, and its electron/hole doping evolution of the spin excitations. We find that the effective next nearest neighbor (NNN) exchange interactions for different families of materials are rather similar, thus demonstrating that the common features for superconductivity is associated with the NNN exchange interactions in these materials. These results suggest that spin excitations are the most promising candidate for electron pairing and superconductivity in iron-based superconductors, regardless of their original antiferromagnetic ordering status and electronic structure.

Using spectral matrix methods along with Monte Carlo methods to analyze and partition the Floridian and Italian high-voltage power grids, as well as the power distribution system for a conceptual all-electric naval vessel. We contrast the effects of approximating the generating capacity of generators according to degree of the generators versus using actual generating capacities.

Mechanical Engineering Department, University of New Mexico — Power grids are innately susceptible to electrical faults. Here we present various network-theoretical approaches to achieve intentional intelligent islanding of a power grid in order to limit cascading power failures in case such a fault occurs. The methods we use can partition networks into communities with local generating capacity. Here we discuss results of using spectral matrix methods along with Monte Carlo methods to analyze and partition the Floridian and Italian high-voltage power grids, as well as the power distribution system for a conceptual all-electric naval vessel. We contrast the effects of approximating the generating capacity of generators according to degree of the generators versus using actual generating capacities.

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**LA.00001 Network Theoretical Approach to Partitioning of Real Power Grids**. BRET ISRAELS, PER ARNE RIKVOLD, IJRAHIM ABOU HAMAD, Department of Physics, Florida State University, SVETLANA POROSEVA, Mechanical Engineering Department, University of New Mexico — Power grids are innately susceptible to electrical faults. Here we present various network-theoretical approaches to achieve intentional intelligent islanding of a power grid in order to limit cascading power failures in case such a fault occurs. The methods we use can partition networks into communities with local generating capacity. Here we discuss results of using spectral matrix methods along with Monte Carlo methods to analyze and partition the Floridian and Italian high-voltage power grids, as well as the power distribution system for a conceptual all-electric naval vessel. We contrast the effects of approximating the generating capacity of generators according to degree of the generators versus using actual generating capacities.

**LA.00002 Calculation of Stationary, Free Molecular Flux Distributions in General 3D Environments**. JESSE LABELLO, University of Tennessee Space Institute — This article presents an application of the angular coefficient method for diffuse reflection to calculate stationary molecular flux distributions in general three dimensional environments. The method of angular coefficients is reviewed and the integration of the method into Blender, a free, open-source, 3D modeling software package, is described. Some example calculations are compared to analytical and Direct Simulation Monte Carlo (DSMC) results with excellent agreement.

**LA.00003 A Muon Tomography Station with GEM Detectors for Nuclear Threat Detection**. MICHAEL STAIB, KONDO GNANVO, LEONARD GRASSO, MARCUS HOHLMANN, JUDSON LOCKE, Florida Institute of Technology, FILIPPO COSTA, SORIN MARTOIU, HANS MULLER, CERN — Muon tomography for homeland security aims at detecting well-shielded nuclear contraband in cargo and imaging it in 3D. The technique exploits multiple scattering of atmospheric cosmic ray muons, which is stronger in dense, high-Z nuclear materials, e.g. enriched uranium, than in low-Z and medium-Z shielding materials. We have constructed and operated a compact Muon Tomography Station (MTS) that tracks muons with six to ten 30 cm × 30 cm Triple Gas Electron Multiplier (GEM) detectors placed on the sides of a 27-liter cubic imaging volume. The 2D strip readouts of the GEMs achieve a spatial resolution of \( \sim 130 \mu m \) in both dimensions and the station is operated at a muon trigger rate of \( \sim 20 \) Hz. The 1,536 strips per GEM detector are read out with the first medium-size implementation of the Scalable Readout System (SRS) developed specifically for Micro-Pattern Gas Detectors by the RDSI collaboration at CERN. We discuss the performance of this MTS prototype and present experimental results on tomographic imaging of high-Z objects with and without shielding.

**LA.00004 A New Viewpoint (The expanding universe, Dark energy and Dark matter)**. DANIEL CWELE — Just as the relativity paradox once threatened the validity of physics in Albert Einstein’s days, the cosmos paradox, the galaxy rotation paradox and the experimental invalidity of the theory of dark matter and dark energy threaten the stability and validity of physics today. These theories and ideas and many others, including the Big Bang theory, all depend almost entirely on the notion of the expanding universe, Edwin Hubble’s observations and reports and the observational inconsistencies of modern day theoretical Physics and Astrophysics on related subjects. However, much of the evidence collected in experimental Physics and Astronomy aimed at proving many of these ideas and theories is ambiguous, and can be used to prove other theories, given a different interpretation of its implications. The argument offered here is aimed at providing one such interpretation, attacking the present day theories of dark energy, dark matter and the Big Bang, and proposing a new Cosmological theory based on a modification of Isaac Newton’s laws and an expansion on Albert Einstein’s theories, without assuming any invalidity or questionability on present day cosmological data and astronomical observations.

**LA.00005 Dissociative Electron-Ion Recombination of the Protonated Interstellar Species Glycolaldehyde, Acetic Acid, and Methyl Formate**. PATRICK LAWSON, NIGEL ADAMS, University of Georgia — Recently, the prebiotic molecule and primitive sugar glycolaldehyde and its structural isomers acetic acid and the abundant methyl formate have been detected in the interstellar medium (ISM). Understanding the processes involving these molecules is vital to understanding the ISM, where stars are formed. The rate constants, \( \alpha \), for dissociative electron-ion recombination of protonated glycolaldehyde, \( (HCOOCH_2CHO)^+ \), and protonated methyl formate, \( (HCOOCH_2CH_2CHO)^+ \), have been determined at 300K in a variable temperature flowing afterglow using a Langmuir probe to determine the electron density. The \( \alpha \) at 300K are \( 3.2 \times 10^{-7} \text{ cm}^3 \text{s}^{-1} \) for protonated methyl formate and \( 7.5 \times 10^{-7} \text{ cm}^3 \text{s}^{-1} \) for protonated glycolaldehyde. The \( \alpha \) of protonated acetic acid could not be directly measured due to difficulty in producing the ion, but it appears to have a recombination rate constant, \( \alpha \), on the \( \sim 10^{-7} \text{ cm}^3 \text{s}^{-1} \) scale. Additional temperature dependence information was obtained. The astrochemical implications of the \( \alpha \) measurements and protonation routes are also discussed.

1 Research supported in part by the U.S. Department of Homeland Security under Grant No. 2007-DN-077-ER0006-02.
LA.00006 Towards Modeling Self-Consistent Core Collapse Supernovae, MEREK CHERTKOW, W. RAPHAEL HIX, Oak Ridge National Lab & University of Tennessee Knoxville, STEPHEN BRUENN, Florida Atlantic University, ERIC LENTZ, Oak Ridge National Lab, JOHN BLONDIN, North Carolina State University, O.E. BRONSON MESSEY, Oak Ridge National Lab, CHING-TSAL LEE, University of Tennessee Knoxville, ANTHONY MEZZACAPPA, Oak Ridge National Lab, PEDRO MARRONETTI, KONSTANTIN YAKUNIN, Florida Atlantic University — Core-collapse supernovae (CCSN) are multi-dimensional events and the codes we develop to model them must follow suit. Our group at the Oak Ridge National Lab has successfully generated self-consistent explosions in 2D of 12.25 solar mass stars using our code CHIMERA. This code is made up of three essentially independent parts designed to evolve the stellar gas hydrodynamics (VHI/MVH3), the “ray-by-ray-plus” multi-group neutrino transport (MGFLD-TRANS), and the nuclear kinetics (XNET). Incorporation of passive tracer particles, for post-processing nucleosynthesis, allows us to explore effects that stem from anisotropies, instabilities, and mixing. An extension of our alpha-nuclear network to 150 species, has enabled us to identify nuclear processes such as the nu-p process and better follow the neutronization during the explosion. These advances also allow us to investigate lower mass limit O-Ne-Mg CCSN and possible sites for the production of weak r-process elements. In this poster, we will present results of these efforts.

LA.00007 Trends in Ion-Electron Dissociative Recombination of Benzene Analogs, DAVID OSBORNE, NIGEL ADAMS, University of Georgia — The Kepler Spacecraft successfully identified five new planets within the Habitable zones of stars in our region of the Milky Way. In our own planetary system the Cassini Spacecraft obtained mass spectra of the atmosphere of Saturn’s moon Titan. To convert the mass spectra to molecular composition a great deal of kinetic rate data is required. These data are used to explain the processes by which small molecules form larger compounds within the Titan atmosphere. The models have indicated that larger ringed hydrocarbon species are present, like benzene. This makes the Titan atmosphere similar to the atmosphere of Early Earth and of interest to NASA. To help in the modeling, we have studied the kinetics of ion-electron recombination of various single ringed hydrocarbon analogs, like benzene. These data were obtained using a Variable Temperature Flowing Afterflow fitted with a Langmuir Probe to determine kinetic rates for ion-electron recombination. This technique was used for benzene analogs with varying degrees of nitrogen and methyl substitutions. From the data, it has been possible to determine trends which will reduce the amount of data needed in the modeling of the Titan atmosphere.

LA.00008 On-line Java Tools for Analyzing AGN Outflows, CARTER CHAMBERLAIN, Virginia Tech — We present six interactive programs created to aid in the analysis of outflows from Active Galactic Nuclei. 1. An interactive plot showing the ionic fraction versus the ionization parameter, for each ion of several elements and for different SEDs. 2. An interactive plot showing the excitation ratio versus electron number density for several elements. 3. A tool for finding the ionization parameter solution from the measured column densities. The user provides the measured ionic column densities and chooses an SED. Then the program displays the locus of possible models in a plot of Hydrogen column density versus ionization parameter. The program also calculates and overlays a chi-squared map for one- or two- ionization parameter solutions. 4. A spectral identification tool displays a spectrum, and allows the user to interactively identify the absorption features. This will give the redshift of each outflow and intervening system along the line of sight to the quasar. 5. Two calculators a) Calculate the velocity of an outflow given the systemic redshift and the absorber redshift. b) Convert GALEX flux to units of 10^{-15}ergs/s/cm^{2}/Å.

LA.00009 A statistical analysis of the environments of extragalactic water masers1, THOMAS REDPATH, James Madison University, ANCA CONSTANTIN, NATHAN DIDOMENICO, JAMES CORCORAN — Water megamasers provide crucial tools for accurate determinations of masses of black holes lurking in galaxy centers, and of extragalactic distances without the need for indirect cosmological assumptions. Current searches have detected masers in only 3 – 4% of the galaxies surveyed and require refinement of their survey criteria. Motivated by current models linking galaxy environment and black hole accretion and the possibility that maser activity correlates with black hole accretion, we undertook a study of the properties of the small-scale environments of galaxies hosting masers. Using samples of maser detections and non-detections provided by the Megamaser Cosmology Project together with SDSS DR7 photometric and spectroscopic observations we performed a comparative analysis of near-neighbor statistics that include distances to first and third neighbors, neighbor counts and color distributions for both flux and absolute magnitude limited volumes. We present results that provide potential constraints for maser surveys, which may increase their detection rate.

1This research is supported by the Thomas F. Jeffress and Kat Miller Jeffress Memorial Trust.

LA.00010 Radio Detection of Neutron Star Binary Mergers, BRANDON BEAR, Virginia Tech, BRETT CARDENA, DANA DISPOTO, JOANNA PAPADOPoulos, The College of New Jersey, MICHAEL KAVIC, Long Island University, JOHN SIMONETTI, Virginia Tech — Neutron star binary systems lose energy through gravitational radiation, and eventually merge. The gravitational radiation from the merger can be detected by the Laser Interferometer Gravitational-Wave Observatory (LIGO). It is expected that a transient radio pulse will also be produced during the merger event. Detection of such radio transients would allow for LIGO to search for signals within constrained time periods. We calculate the LWA-1 detection rate of transient events from neutron star binary mergers. We calculate the detection rate of transient events from neutron star binary mergers for the Long Wavelength Array and the Eight-meter-wavelength Transient Array.

LA.00011 Afterglow photometry and Modeling GRB 091018, APURVA OZA, UNC Chapel Hill — We focus on continuing the modeling of GRB (Gamma-ray Burst) 091018. Our data is mostly collected across 4 bands (BVRI) from PROMPT (Panchromatic Robotic Optical Monitoring and Polarimetry Telescopes) approximately 4.1 hours after the trigger. We have added NIR, UVOT, X-ray, and more optical points to our datasets. After rejecting the orginal assertion of dust evolution by linking extinction parameters with Galapagos (a software that employs genetic algorithms to output the best fit model with our circum-burst GRB parameters we have settled on a model with the circumburst density index k, at -1.75 (which is close to the wind-blown medium of k=-2). In addition to k, the results of our baseline fit indicate that the cooling break is above the data, and may be crossing the synchrotron peak during the early UVOT data. This cross-over will yield interesting results about the circumburst medium of a GRB at early times. Photometring GRBs live was also conducted along with instrumentation techniques.

1I acknowledge the support of NASA/NC Space grant
LA.00012 A Search for Astrophysical Meter Wavelength Radio Transients, SEAN CUTCHIN, JOHN SIMONETTI, Virginia Tech, MICHAEL KAVIC, Long Island University — Astrophysical phenomena such as exploding primordial black holes (PBHS), gamma-ray bursts (GRBs), compact object mergers, and supernovae are expected to produce a single pulse of electromagnetic radiation detectable in the low-frequency end of the radio spectrum. Detection of any of these pulses would be significant for the study of the objects themselves, their host environments, and the interstellar/intergalactic medium. Furthermore, a positive detection of an exploding PBH could be a signature of an extra spatial dimension, which would drastically alter our perception of spacetime. However, even without a PBH the observation of these events would be significant for solar and space physics.

LA.00013 Searching for Low-Frequency Radio Transients from Supernovae, JR-WEI TSAI, SEAN CUTCHIN, Virginia Tech, MANTHAN KOTHARI, CHRISTIAN SCHMITT, The College of New Jersey, MICHAEL KAVIC, Long Island University, JOHN SIMONETTI, Virginia Tech — Supernovae events may be accompanied by prompt emission of a low-frequency electromagnetic transient. These transient events are created by the interaction of a shock wave of charged particles created by SN core-collapse with a stars ambient magnetic field. Such events can be detected in a low-frequency radio array. Here we discuss an ongoing search for such events using two radio arrays: the Long Wavelength Array (LWA) and Eight-meter-wavelength Transient Array (ETA).

LA.00014 The Arcminute Morphology of the WIM Toward the Local Perseus Arm of the Galaxy, PHILLIP NELSON, Roanoke College, JOHN SIMONETTI, Virginia Tech, BRIAN DENNISON, UNC at Asheville — We used the Virginia Tech Spectral-Line Imaging Camera (SLIC) to image the warm ionized interstellar medium (WIM) toward the Local Perseus Arm. We obtained a series of images, each of which is 1°-wide, and has arcminute-resolution. The images show three basic types of structures — compact clouds with diameters greater than several degrees, those that are 1° or less in diameter, and extended filaments which span several degrees in length but have thicknesses of only a few tens of arcminutes. The data show that [S ii]/Hα ratios are, on average, nearly six times higher in the filaments than in the clouds, which indicates that emission from collisionally excited, singly-ionized S+ is the dominant emission source within the filaments. In clouds, the lower [S ii]/Hα values are evidence that the Hα recombination line of photoionized hydrogen dominates.

LA.00015 Mid-infrared Molecular Emission Studies from Energetic Materials using Laser-Induced Breakdown Spectroscopy, EI BROWN, UWE HOMMERICH, Hampton University, CLAYTON YANG, SUDHIR TRIVEDI, ALAN SAMUELS, PETER SNYDER — Laser-induced breakdown spectroscopy (LIBS) is a powerful diagnostic tool for detection of trace elements by monitoring the atomic and ionic emission from laser-induced plasmas. The laser-induced plasma was produced by focusing a 30 mJ pulsed Nd:YAG laser (1064 nm) to dissociate, atomize, and ionize target molecules. In this work, LIBS emissions in the mid-infrared (MIR) region were studied for potential applications in chemical, biological, and explosives (CBE) sensing. We report on the observation of MIR emissions from energetic materials (e.g., ammonium compounds) due to laser-induced breakdown processes. All samples showed LIBS-triggered oxygenated breakdown products as well as partially dissociated and recombination molecular species. More detailed results of the performed MIR LIBS studies on the energetic materials will be discussed at the conference.

LA.00016 Dianion formation from anion-alkali metal charge exchange reactions: TCNQ− + Na → TCNQ2− + Na+, BYRON SMITH, ROBERT COMPTON, SERGE OVCHINNIKOV, University of Tennessee, ANNE HOLM, STEEN NIELSEN, University of Aarhus — The interaction of an electron with an anion is characterized by a long-range coulomb repulsion and a short-range polarizability attraction giving rise to a coulomb barrier. The permanent addition of an extra electron to a negatively charged anion requires tunneling through the barrier or attachment of the electron over the top of this coulomb barrier followed by dissociation of the excess energy. Charge-exchange collisions of an anion with an alkali atom utilize the latter channel to produce permanent dianions with cross sections of ~1 Å². We have previously examined the reaction TCNQ− + Xe → TCNQ− + Xe and reported a delayed threshold and quantum phase interference effects in the charge exchange cross section[1] Employing sodium as the collision partner, the cross section is seen to increase with decreasing energy with a threshold below 180 eV (com). A few apparatus has been constructed to allow measurements down to energies below the expected threshold (~41 eV, laboratory energy based upon a 1 eV second electron affinity). This method has been used to study the reaction TCNQ− + Na → TCNQ2− + Na+ and will provide one of the first measurements of second electron affinities for molecular anions.


LA.00017 Upconversion Studies of Er3+ Doped into Low Phonon-Energy Hosts KPB2Cl5 and KPB2Br5 via 0.97 μm and 1.5 μm Laser Excitation1, A. BLUIETT, Elizabeth City State University, E. BROWN, U. HOMMERICH, Hampton University, S.B. TRIVEDI, Brimrose Corporation — A comparative study of the wavelength dependence of the Er3+ upconversion in low phonon-energy hosts KPB2Cl5 and KPB2Br5 will be presented. Initial measurements indicate that visible and infrared upconversion was generated under 0.97 μm and 1.5 μm laser excitation. Using time resolved emission, spectral absorption data the dominant upconversion mechanisms involving excited state absorption and/or energy transfer were investigated. In addition, special emphasis was geared toward a comparative study of the detrimental effects of upconversion under resonant pumping conditions (1.5 μm) for possible applications in the eye-safe wavelengths (1.5 – 1.6 μm) region.

1The work at Elizabeth City State University was supported by DoD grant W911NF-11-1-0226.

LA.00018 A study of the chiro-optical properties of Carvone, JASON LAMBERT, University of Tennessee — The intrinsic optical rotatory dispersion (ORD) and circular dichroism (CD) of the conformationally flexible carvone molecule has been investigated in 17 solvents and compared with results from calculations for the “free” (gas phase) molecule. The G3 method was used to determine the relative energies of the six conformers. The ORD of (R)-(−)-carvone at 589 nm was calculated using coupled cluster and density-functional methods, including temperature-dependent vibrational corrections. Vibrational corrections are significant and are primarily associated with normal modes of PBHS, from searches, would allow us to describe a method to carry out an diagnostic single dispersed pulse search, and apply it to data collected with ETA. Applying the single pulse search procedure to 30 hours worth ETA data yielded no compelling detections with S/N ≥ 6. However, with ≈ 8 hours of interference free data, we find an observational upper limit to the rate of exploding PBHS r ≥ 8 x 10⁻³ pc⁻² y⁻¹ for a PBH with a fireball Lorentz factor γ_f = 10⁴⁻³.
LA.00019 Collective excitations in a spinor condensate¹. JIANYING HAN, Physics Department, Hollins University; JQI — Bose Einstein Condensates (BECs) confined in a trap allow us to study the excitation between eigenfunctions of a given trap potential, which can be directly calculated from quantum mechanics. Here we study the spinor collective excitations, in other words, the collective excitations of different spin components. Specifically, the spinor collective modes in a 3D harmonic trap will be presented. Moreover, different types of collective excitations in this trap, collective mode mixing as well as their applications will be discussed.

¹It is a pleasure to acknowledge the laser cooling and trapping group at NIST.

LA.00020 Physical properties of unacetylated chromatin as examined by magnetic tweezers, KERRY MCGILL, North Georgia College & State University, DAVID DUNLAP, Emory University School of Medicine, JOHN LUCCHESI, Emory University — As the source of genetic material, DNA is involved in a variety of biological processes like transcription, cell replication, and more. In these processes, DNA is manipulated into different structures and is subjected to different levels of physical force on a molecular scale. When tension is applied to one hierarchical structure called chromatin, it appears to behave like a Hookian spring. The base component of chromatin is a nuclease, which is constructed when DNA coils around octamers of histone proteins. The histones can become acetylated—a chemical process in which an acetyl functional group attaches to amino acids of the histones, often lysines. Acetylation may loosen chromatin’s coils and therefore lower the amount of tension required to stretch the chromatin. Comparing the levels of tension required to stretch acetylated chromatin could reveal, directly, physical differences in the chromatin fiber that bear on the function of the DNA molecule. Work presented will be the investigation of unacetylated chromatin.

LA.00021 Superconducting Properties of Nb/Mo Bilayers¹, JAMES VELDHORST². PHILLIP BROUSSARD, Covenant College — We studied various electrical properties of Nb/Mo bilayer films at low temperatures as a function of layer proportions with series varying both Nb and Mo (eg. holding Nb constant at 30nm with Mo ranging from 10 to 40 nm). After growing multiple series of Nb/Mo bilayers on silicon substrates at different configurations through magnetron sputtering, the samples were cooled to ≈6K, where we explored their critical fields (\(H_{\text{c2}}\)) at low field strengths. Critical fields were measured using both resistive and inductive measurements on the samples under the influence of a magnetic field ranging from 0 to 120 Gauss. We also look at how the transition temperature of the films (\(T_c\)) vary with Nb and Mo layer thicknesses. We will compare our findings to the proximity effect theory for the \(T_c\) of thin film bilayers. We will also contrast the linear of our resistive \(H_{\text{c2}}\) vs T data fits with the non-linearity of our inductive \(H_{\text{c2}}\) vs T plots.

¹Equipment provided under NSF Grant DMR-0820025
²presently at Georgia Tech

LA.00022 Electrical characterization of Zn and ZnO nanowires grown on PEDOT:PSS conductive polymer thin films by physical vapor deposition¹. MATTHEW CHAMBERLIN, COSTEL CONSTANTIN, James Madison University — Physical vapor deposition (PVD) techniques offer tremendous possibilities for easy fabrication of nanostructure arrays for use in thin film electronics. In this study we examine inorganic/organic heterojunctions produced by growing conductive Zn and semiconductor ZnO nanowire arrays on organic conductive PEDOT:PSS polymer thin films using simple and cost-effective PVD methods. Understanding the electrical properties of these hybrid films are of particular interest for applications in organic electronics. However, traditional systems for measuring conductivity and resistivity of thin films by the Van Der Pauw method prove problematic when dealing with soft polymeric surfaces. We present here electrical studies of ZnO- and Zn-nanowire/PEDOT:PSS heterojunctions using a modified 2-point probe method constructed from inexpensive and easily available materials.

¹We would like to acknowledge the financial support from Research Corp. Dept. Development grant #7957.

LA.00023 Analysis of carbon nanotubes and graphene nanoribbons with folded racket shapes, ANDY BORUM, Engineering Science and Mechanics, Virginia Tech, RAYMOND PLAULT, Civil and Environmental Engineering, Virginia Tech, DAVID DILLARD, Engineering Science and Mechanics, Virginia Tech — When carbon nanotubes and graphene nanoribbons become long, they may self-fold and form tennis racket-like shapes. This phenomenon is analyzed in two ways by treating a nanotube or nanoribbon as an elastica. First, an approach from adhesion science is used, in which the two sides of the racket handle are assumed to be straight and bonded together with constant or no separation. New analytical results are obtained involving the shape, bending energy, and adhesion energy of the self-folded structures. These relations show that the dimensions of the racket loop are proportional to the square root of the flexural rigidity. The second analysis uses the Lennard-Jones potential to model the van der Waals forces between the two sides of the racket. A nanoribbon is considered, and the interatomic forces are integrated along the length and across the width of the nanoribbon. The resulting integro-differential equations are solved using the finite difference method. The racket handle is found to be in compression and the separation between the two sides of the racket handle decreases in the direction of the racket loop. The results for the Lennard-Jones model approximately satisfy the relationship between the dimensions and the flexural rigidity found using the adhesion model.

LA.00024 Electronic transport in semiconductors, ALEXANDER LARIN — The ultimate goal of this work is the Monte-Carlo simulation of electronic transport in semiconductors. As a special case, the effect of the adsorbed surface change on conductivity in the ambient air was investigated. The classical equation of electronic transport for semiconductors must be solved numerically since the analytical solution can be derived only for limited number of relatively simple cases. There are several numerical methods to describe the electronic transport in semiconductors. The One particle Monte Carlo simulation is widely used technique to obtain the exact solution for Boltzmann Transport Equation (BTE). During the simulation several assumptions were made: electron is a particle and its motion can be described by classical mechanics equations, the only interactions the electrons have are those with ions, the collisions/scattering of electrons with ions are elastic, and the outside electric field is uniform inside of the semiconductor device. The quantity of interest in the simulation is current density. The current density was calculated as an integrated result from contributions of individual paths of electrons as they travel from one ohmic contact to another. The simulation can also be used to predict the electronic transport under the influence of nonuniform electric and magnetic fields. The special case of oxygen adsorption was investigated in this work. It was found that an increase in the oxygen concentration in the ambient air can decrease the conductivity of some semiconductor materials.
LA.00025 Modeling of the pressurized xenon gamma ray scintillation detector. ROMNEY MEEK1, ALEXANDER BARZILOV, IVAN NOVIKOV, Western Kentucky University, Dept. of Physics and Astronomy — We are developing a high pressure xenon detector for photon measurements. Xenon produces electroluminescence (EL) scintillation emission that we use as the primary signal in our strategy to acquire information. The detector consists of a high pressure chamber, a thin radiation input window with the supporting grid of collimator ribs and electrode grids to create the electric field, and a photo sensor – the large area silicon avalanche photodiode. The electrode grids are made of thin wire. The modeling of the electric field is a crucial step in developing a working prototype. It has been previously shown that the uniform electric field divided by the number density of xenon gas needs to be above approximately 3 Td to give enough energy to ionize the xenon atoms, but less than 16 Td to prevent electron avalanches from occurring. The electric field was modeled using Comsol Multiphysics. This presentation discusses the results of electric field modeling for the detector (absorption, drift, and EL regions).

1Undergraduate Student

LA.00026 Neutron Photoproduction from $^{139}$La Using 12-15 MeV Linearly Polarized $\gamma$-Rays1. R.K. THRASHER, J. HAUVER, W.R. HENDERSON, C.S. WHISNANT, James Madison University, M.W. AHMED, H.J. KARWÓWSKI, J.M. MUELLER, L.S. MYERS, J. SILANO, J.R. TOMPKINS, H.R. WELLER, W.R. ZIMMERMAN, TUNL, B.J. DAVIS, D.M. MARKOFF, North Carolina Central University, M. SPRAKER, R.M. PRIOR, North Georgia College & State Univ., R.H. FRANCE, Georgia College — Data have been collected at the High Intensity $\gamma$-ray Source (HiRS) to investigate neutron emission from a $^{139}$La target with linearly polarized gamma rays at $E_\gamma$ = 12, 13, 14, and 15 MeV. Liquid scintillator detectors were placed at scattering angles of 55°, 90° and 125° above, below and to the left and right of the target. Six additional detectors were placed at angles of 72°, 107°, and 142° above and to the right of the target. The ratio of neutron yields parallel to the plane of polarization and perpendicular to the plane of polarization observed as a function of $E_n$, $E_\gamma$, and $\theta$ characterizes the response of the nucleus and may prove to be a useful observable in nuclear forensics. The results of the experiment will be discussed.

1Partial support provided by the DNDO through Academic Research Initiative grant 2010-DN-077-ARI046-02 and the NSF grant PHY-0969159.

LA.00027 Neutron Photoproduction from $^{nat}$Hg Using 11-15 MeV Linearly Polarized $\gamma$-Rays1. J. HAUVER, W.R. HENDERSON, R.K. THRASHER, C.S. WHISNANT, James Madison University, M.W. AHMED, H.J. KARWÓWSKI, J.M. MUELLER, L.S. MYERS, J. SILANO, J.R. TOMPKINS, H.R. WELLER, W.R. ZIMMERMAN, TUNL, B.J. DAVIS, D.M. MARKOFF, North Carolina Central University, M. SPRAKER, R.M. PRIOR, North Georgia College & State Univ., R.H. FRANCE, Georgia College — The linearly polarized photon beam at the High Intensity $\gamma$-ray Source (HiRS) was used to study neutron emission from a $^{nat}$Hg target at energies of 11, 12, 13, 14, and 15 MeV. Twelve liquid scintillator detectors were placed at polar angles of 55°, 90° and 125° at azimuthal angles of $\phi$ = 0°, 90°, 180°, 270°. Six more detectors were placed at polar angles of 72°, 107°, and 142° at $\phi$ = 0° and 90°. The ratio of neutron yields parallel to neutron yields perpendicular to the plane of polarization were determined as a function of $E_n$, $E_\gamma$, and $\theta$. Results will be discussed.

1Partial support provided by the DNDO through Academic Research Initiative grant 2010-DN-077-ARI046-02 and the NSF grant PHY-0969159.

LA.00028 $^{nat}$Dy($\gamma$,n) Asymmetry Measurements with Linearly Polarized $\gamma$-rays between 11 and 15 MeV1. W.R. HENDERSON, R.K. THRASHER, J. HAUVER, C.S. WHISNANT, James Madison University, M.W. AHMED, H.J. KARWÓWSKI, J.M. MUELLER, L.S. MYERS, J. SILANO, J.R. TOMPKINS, H.R. WELLER, W.R. ZIMMERMAN, TUNL, B.J. DAVIS, D.M. MARKOFF, North Carolina Central University, M. SPRAKER, R.M. PRIOR, North Georgia College & State Univ., R.H. FRANCE, Georgia College — The $^{nat}$Dy($\gamma$,n) reaction was studied at TUNL’s High Intensity $\gamma$-ray Source (HiRS) using a linearly polarized photon beam at energies 11, 12, 13, 14, and 15 MeV. Measurements were made using liquid scintillator detectors at angles 55°, 72°, 90°, 107°, 125°, 142°. The ratio of neutrons detected parallel to the plane of polarization compared to perpendicular to the plane of polarization was measured as a function of $E_n$, $E_\gamma$, and $\theta$. This ratio may be useful for distinguishing different isotopes from one another, and $^{nat}$Dy is one among many isotopes measured to date. The experimental set-up is discussed, along with the data analysis procedure used to determine the ratio.

1Partial support provided by the DNDO through Academic Research Initiative grant 2010-DN-077-ARI046-02 and the NSF grant PHY-0969159.

LA.00029 Discovery of Isotopes1. CATHLEEN FRY, MICHAEL THOENENESSEN — Although a few thousand isotopes have been discovered, the limit existence is only known for the lightest elements. Unfortunately, there has not been a comprehensive compilation of all the discoveries. A project has been undertaken to find all of the first discovery papers. Claims of discoveries were investigated and verified, and first publications are listed at http://www.nscl.msu.edu/~la.00029 Discovery of Isotopes.

1This work was supported by the National Science Foundation under grants No. PHY06-06007 (NSCL) and PHY10- 62410 (REU).

LA.00030 Gravity’s Weak Force Link and other thoughts. RICH AQUILINA, APS — Gravity is by far the weakest of the known four forces. What if that is because it is the oldest of the forces and the most decayed of them? What if that is what caused the Big Bang? The decay of gravity could no longer hold the singularity (or other forces) in check. We know there is decay, it is known as the “Weak” force. The idea of decaying gravity would only serve to unite the “Weak” force and “Gravity.” What if this is the elusive connection between “Gravity” and the “Other Forces”? What if there have been other forces that are no longer with us because of decay or their own evolutionary process? What if these unknown decayed forces gave rise to newer and “stronger” forces or maybe even “weaker” ones? What if “particles” were actually a threshold of converged points of strings (like on a multi-dimensional graph), and the reason we can’t seem to find one for gravity is because the convergence threshold to manifest as a particle hasn’t been met, yet the strings and influence are still there.
SHyFT and Simple Counting Method, ERIN CHAMBERS, PAUL SHELDON, CMS COLLABORATION

Analysis over time. Herein we will report on these remote and in-situ studies of VPT characteristics and performance. Virginia (UVa) uses a 3.8 T large-bore superconducting solenoid magnet to simulate conditions at the LHC and to study the long term behavior of the Compact Muon Solenoid (CMS) at the LHC. Diamond is radiation hard, has a low thermal conductivity, and has a large bandgap. When a fast moving particle passes through the diamond, ionization occurs, leaving a trail of charge carriers in the diamond. By applying an external electric field, these secondary particles are induced to move towards the electrodes. The movement of these charge carriers induces a current, which can be measured. This is the detection mechanism for diamond detectors. A simulation of this detection mechanism was created using GEANT, a platform developed by CERN for simulating the passage of particles through materials. The program uses Monte Carlo methods to simulate the ionization process through the material. It is capable of tracking each secondary produced. By using this information and the Shockley-Ramo theorem, we are able to simulate the detection mechanism.

JOSEPH GOODELL, University of Virginia, CMS COLLABORATION — Gallium Arsenide (GaAs) photodetectors are a type of semiconducting photodetector that should be able to withstand much higher levels of radiation than commonly used silicon photomultipliers (SIPMs). At the University of Virginia we are characterizing GaAs devices as compared to SIPMs by studying the I/V curve in breakdown region, the breakdown voltage, dark noise, and response to photons. Measurements of single photon avalanche diodes (SPADs) and PMC (multiple SPAD chips) are being made focusing on the breakdown region for hardness tests. The SPADs and PMCs will be exposed to high levels of radiation in test beam environments so that post-irradiation performance can be characterized as well. Ultimately GaAs photodetectors could prove to be effective radiation-hard detectors with applications in high radiation environments like those found at the upgraded high-luminosity Large Hadron Collider (LHC).
LA.00039 First Neutrino Results from the NOvA Near Detector1, ZUKAI WANG, University of Virgina — The NOvA collaboration is building a long-baseline neutrino spectrometer optimized to study the appearance of electron neutrinos in a muon neutrino beam. A full-sized prototype of the Near Detector has been fabricated on the surface and is presently taking data with the Fermilab NUMI neutrino beam. A description of the Near Detector will be given and its performance will be shown.

1for the NOvA Collaboration

LA.00040 Identifying Electromagnetic Events in the Forward Hadron Calorimeter1, CHRISTOPHER FRYE, University of Central Florida — The Forward Hadron Calorimeter (HF) of the Compact Muon Solenoid (CMS) at the Large Hadron Collider (LHC) lies in a region not covered by an inner tracking system, and we can rely only on the shapes of showers that hit the HF to determine whether or not they are due to electromagnetic particles. We review the current method of distinguishing shower types in the HF, and we bring attention to a drawback that will become present as the luminosity of the LHC increases and creates a need for tighter shower-shape cuts. We provide a method to correct this drawback, and we analyze the effectiveness of various tight cuts at isolating signal from background.

1This project was completed in an REU program at the University of Minnesota funded by the NSF.

LA.00041 Open and Solved Elementary Questions in Astronomy, FLORENTIN SMARANDACHE, University of New Mexico — Some school scientific problems are posed: 1) Let’s consider a tunnel getting from one side to the other of a planet and passing through the planet center. An object is dropped into the tunnel. Is the object oscillating about the center as a pendulum? What happens if the tunnel gets from one to another side of the planet but doesn’t pass through the planet center, would the midpoint of the tunnel play a similar role as the planet center? How will Coriolis force influence this? 2) Is it possible to accelerate a photon (or another particle traveling at, let’s say, 0.999c) and thus to get a speed greater than c?

LA.00042 Periodicity of the Benjamin-Feir Instability and Linear Superposition, JUSTIN CUTRER, KEDRIC HAYES, JESSICA GRABER, Xavier University of Louisiana — Freak waves are waves of great height that appear out of nowhere from otherwise ordinary, if rough, seas. The steepness of these waves can cause an enormous amount of damage to ships and oil platforms. Understanding the cause of freak waves will help us to predict dangerous conditions, and engineer structures better able to withstand such waves. A number of mechanisms have been proposed as the source of freak waves, including linear focusing, refraction of waves through a current field, and nonlinear effects. The Benjamin-Feir instability solves the nonlinear Schrödinger equation when a carrier band of frequency ω0 is perturbed by sidebands of ω = ω0 ± Δω. These solutions are periodic, or “breather,” solutions under the condition that Δω < cωk/√2, where ka is the wave steepness determined by k, the wavenumber, and a, the wave amplitude. In this poster, we will compare the period of these breather solutions with the period of the envelope of the linear superposition of the same carrier wave and sideband perturbations using MatLab movies.

LA.00043 Acoustic measurement of the granular density of state, ELI OWENS, North Carolina State University, KAREN DANIELS — Measurements of the vibrational density of states (DOS) in glasses reveal that an excess number of low-frequency modes, as compared to the Debye scaling seen in crystalline materials, is associated with a loss of mechanical rigidity. An excess number of modes have also been observed experimentally in colloids and in simulations of idealized granular materials near the jamming point. However, there have not been any experimental measurements in an athermal granular system. We experimentally probe the material by mimicking thermal motion with acoustic waves, thereby allowing us to measure a DOS like quantity by analogy with conventional solid state techniques. Our system is made up of two dimensional photoelastic disks which allow visualization of the internal force structure, and a voice coil driver provides a white noise signal to excite a broad spectrum of vibrations. The sound is then detected with piezoelectric sensors embedded inside a subset of the particles. These measurements give us the particle velocities, from which we are able to compute a DOS by taking the Fourier transform of the velocity autocorrelation function. We measure this DOS as a function of the confining pressure and degree of disorder and find that the peak in the density of states shifts to higher frequency as the system pressure is increased.

LA.00044 Photon diffraction, JOHN HODGE, Blue Ridge CC — A particle model of light that exhibited wave–like behavior was proposed at SESAPS log. No. SES09-2009-000064. The model combined the Bohm interpretation with the Scalar Potential Model (SPM) of photons. The model simulation is expanded with a slight modification to allow for different color photons through a single slit experiment, Young’s experiment, and coherent light from large distances.

LA.00045 The Coffee and Cream Dilemma, BRANDON MINOR, GERALD FELDMAN, George Washington University — Many coffee drinkers take cream with their coffee and often wonder whether to add the cream earlier or later. With the objective of keeping their coffee as hot as possible over a moderate time period (10-15 minutes), this is a question that most of them can never answer definitively. We investigated this problem empirically using hot and cold water, with special emphasis on the calorimetry of the mixture. Assuming a coffee:cream (hot:cold) ratio of 3:1, we began with two identical styrofoam coffee cups containing hot water and then added cold water at t = 200 s in one cup and t = 700 s in the other cup. Using Vernier temperature probes to simultaneously track the temperature change during the cool-down period of the water in both cups over Δt = 1000 s, we obtained a real-time graphical account of which process achieved the higher temperature over this time period. In addition, the effect of evaporation was explored by comparing trials with and without a lid on the coffee cup. The application of Newton’s Law of Cooling, as compared to the graphical temperature data acquired, will leave no doubt as to the best strategy for adding cool cream to hot coffee.

LA.00046 Characterization of large-scale velocity fluctuations in the Princeton MRI experiment1, W. LOVE, Virginia Polytechnic Institute and State University, A. ROACH, E. SPENCE, P. SLOBODA, H. JI, Princeton Plasma Physics Laboratory — The Princeton MRI Experiment is a modified Taylor-Couette device that uses GainSn as its working fluid. An Ultrasonic Doppler Velocimetry (UDV) system allows the measurement of internal fluid velocities. Starting from both hydrodynamically stable and unstable background flow states, prior work has demonstrated the existence of large-scale, large-amplitude, coherent, nonaxisymmetric velocity fluctuations when a sufficiently strong magnetic field is applied. Characterizations of these oscillations are made by looking at the dominant fluctuations in the azimuthal and radial velocity field components and matching these features to different model velocity profiles. These profiles are calculated by starting with a model azimuthal and radial flow and calculating the vertical term in the continuity equation. The relative magnitudes of the calculated azimuthal and radial flows are compared to experimental UDV data to determine the validity of the model. Additional calculated properties such as final velocity current density profiles will be presented.

1This work was supported by the Department of Energy’s SULI program and the Princeton Plasma Physics Laboratory.
LA.00047 Emission Spectroscopy of RF Helicon Heated Plasmas1, TIM YOUNKIN, University of Tennessee Knoxville, T.M. BIEWER, R.H. GOULDING, D.L. HILLS, R. ISLER — In order to study plasma-material interfaces under high power and particle flux, large linear machines are being constructed that can effectively simulate conditions that will be found in fusion-grade toroidal devices such as ITER and DEMO. A 15 cm diameter, 1.5 m long linear machine has been built at ORNL using a new helicon antenna designed for input powers up to 100 kW, producing a plasma that will be used to bombard material targets. Visible spectroscopy has been used to measure emission line spectra of the helicon heated plasma from 200 nm to 1100 nm at low resolution. The spectrometer is thoroughly calibrated for wavelength and intensity in order to determine electron density and temperature using the ratios of spectral line intensities. A variety of gas species have been heated, including hydrogen, deuterium and helium. Residual amounts of foreign materials can be monitored near the plasma-wall interface. Results on how magnetic field scans, probe scans, and power scans affect the plasma will be analyzed and presented.

1This work was supported by the US. D.O.E. contracts DE-AC05-00OR22725 and DE-AC05-06OR23100.

LA.00048 Two definitions for genders, PHILLIP SHIN — By my definition, man and woman are the same fact to say. So man and woman have the same thinking and same existence. But when I say again for man and woman, they are different for sex as the two different persons. They are different each two persons. As an example, by quantum, sex and color is different (the same existence and also different kind with quantum way-push and pull at the same time), also they are the same as they are our ID (hormones) and also dream matter. The same way, I hope we go to heaven and god will say you are the truth like it to be after the end of the world. I wish man and woman are different as it is more fun.

LA.00049 Magnetization Dynamics in Magnetic Nanoparticle Chains, SUVOJIT GHOSH, ISHWAR PURI, Department of Engineering Science and Mechanics, Virginia Tech — Magnetic nanoparticles (MNPs) exhibit superparamagnetism when the energy changes due to thermal fluctuations (∼ k_BT) are comparable to or larger than the anisotropy potential barrier KV. Thermal fluctuations produce frequent magnetization reversals in such a situation causing the net MNP magnetization to approach zero. If thermal oscillations are relatively small, the odds of magnetization reversal diminish significantly implying that an MNP is permanently magnetized. In this study we explore the influence of the magnetostatic coupling of moments in neighboring MNPs in an idealized two-particle system. The anisotropic nature of such coupling adds to the magnetocrystalline anisotropy to augment the potential barrier for magnetization reversal. A two-particle system of MNPs therefore has a more stable magnetization than an isolated particle. This is analyzed by a scaling analysis of the interaction energies concerned. Numerical simulations of magnetization dynamics of MNPs using a stochastic form of the Landau-Lifshitz-Gilbert equation confirm the hypothesis. The phenomena is explored to determine a range of radii within which an MNP exhibits superparamagnetism in isolation while forming permanently magnetized chains upon self-assembly.

LA.00050 It may be possible to use Capillary Action as a Cooling method, RICHARD KRISKE, University of Minnesota — It is well known that it takes no work for water to rise in a Capillary tube. It only takes work for the water to be removed from the top of the tube. It may be possible for this water to be removed using individual photons of the size needed to break the water to water hydrogen bond. This bond is often broken in evaporation of water from surfaces. As this bond is broken at the top of the Capillary tube the water makes a phase transition and makes room for another water molecule to move up the column. The phase transition cools the column and another molecule moves up the column with no work being done. There is a net energy loss in this system, and the entire system is cooled. This may be one of the mechanisms that plants use to cool themselves and the soil around the plant. This mechanism may be used to explain the slight temperature regulating effect of plants and the areas around large plant populations. Photons of other sizes may also be used in this mechanism if there are the proper molecules (Chlorophyll for instance) in a chain reaction linked to this mechanism. This chimney like effect could also be used as a precise balancing method to transport materials based on mass and chemical composition, like a chromatograph. The “Einstein Refrigerator” can be viewed as a similar idea.

LA.00051 Acoustic Radiation from Smart Foam for Various Foam Geometries, NISHKALA SHIVAKUMAR, NC School of Science and Mathematics and NC A&T State University — Smart foam is an emerging active-chromatograph. The “Einstein Refrigerator” can be viewed as a similar idea. A chimney like effect could also be used as a precise balancing method to transport materials based on mass and chemical composition, like a chromatograph. The “Einstein Refrigerator” can be viewed as a similar idea.

LA.00052 Use of Spray Adhesives for the Manufacture of 3-D Capillary Origami Microstructures, MITHI DE LOS REYES, NC School of Science and Mathematics — The method of “capillary origami”—using the surface tension of an evaporating water droplet to fold a flexible membrane into a 3-D polyhedron, as investigated by Py et al.—has shown promise as a way to create fully 3-D microstructures. However, the origami re-opens past a critical evaporation point, and previous attempts to prevent this re-opening have proven to be expensive and time-consuming. We therefore investigated the use of various spray adhesives in keeping these origami microstructures closed. Three characteristics were measured: efficiency, tackiness, and strength of the adhesive. Measurements of these three characteristics point to 3M Super 77 Spray Adhesive as an optimal adhesive for spray microstructures. Furthermore, we designed a new method to measure adhesive strength by using an analytical balance to measure force applied by a micrometer to a microstructure. We also developed novel procedures to create uniformly-sized microstructures and to accelerate the folding process, all of which improve upon the original capillary origami method. These novel procedures, combined with measurements that indicate 3M Super 77 as an optimum adhesive, suggest a potential method for the mass-manufacture of truly 3-D microstructures. Py, Charlotte, et al. “Capillary origami: Spontaneous wrapping of a droplet with an elastic sheet.” Physical Review Letters. 98.156103 (2007)

LA.00053 e/m Experiment Analysis Refinement1, MICHAEL HARMON, BRYCE PRIU1T, KEVIN VELASQUEZ, RICH SCHELPE, Erskine College — Thomson’s e/m experiment is widely popular in undergraduate courses to help gain an understanding of the properties of the electron. Our results using a standard apparatus, however, reveal significant systematic errors. We examine possible reasons for the discrepancy with the aim of modeling effects that were not included in the original analysis. We conclude that the energy loss of the electron beam as it travels through the helium and the distortion of the beam radius measurement by the curved glass of the tube are the two factors which dominate the discrepancy.

1Funded by Erskine College Faculty Development.
State University, STEFANO SACANNA, DAVID PINE, New York University, NEW YORK UNIVERSITY COLLABORATION

The lock and key models using Pac-man particles is an alternative identification mechanism for directing the assembly of combined structures. The system was guided by Fischer's lock- and key principle which consisted of colloidal spheres as keys and monodisperse colloidal particles with a spherical cavity as locks that bind. What makes this so specific is the fact that the assembly is controlled by how closely the size of a spherical colloidal key particle matches the radius of the spherical cavity of the lock particle. Viscosity measurements were also looked at because nano-particles are known to change the resistance of the fluid.

1 NSF-MRSEC
2 MRSEC

LA.00054 Pac-Man: Lock and Key Colloid Particles1, ASHLEY TAYLOR, LEI ZHANG, Winston Salem State University, STEFANO SACANNA, DAVID PINE, New York University, NEW YORK UNIVERSITY COLLABORATION2 — The lock and key models using Pac-man particles is an alternative identification mechanism for directing the assembly of combined structures. The system was guided by Fischer’s lock- and key principle which consisted of colloidal spheres as keys and monodisperse colloidal particles with a spherical cavity as locks that bind. What makes this so specific is the fact that the assembly is controlled by how closely the size of a spherical colloidal key particle matches the radius of the spherical cavity of the lock particle. Viscosity measurements were also looked at because nano-particles are known to change the resistance of the fluid.

Saturday, October 22, 2011 8:30AM - 10:00AM —
Session NB Particle Physics II

Crystal Ballroom A - Laurie McNeil, UNC Chapel Hill

8:30AM NA.00001 Scientific user facilities at Oak Ridge National Laboratory: New research capabilities and opportunities1, JAMES ROBERTO, Oak Ridge National Laboratory — Over the past decade, Oak Ridge National Laboratory (ORNL) has transformed its research infrastructure, particularly in the areas of neutron scattering, nanoscale science and technology, and high-performance computing. New facilities, including the Spallation Neutron Source, Center for Nanophase Materials Sciences, and Leadership Computing Facility, have been constructed that provide world-leading capabilities in neutron science, condensed matter and materials physics, and computational physics. In addition, many existing physics-related facilities have been upgraded with new capabilities, including new instruments and a high-intensity cold neutron source at the High Flux Isotope Reactor. These facilities are operated for the scientific community and are available to qualified users based on competitive peer-reviewed proposals. User facilities at ORNL currently welcome more than 2,500 researchers each year, mostly from universities. These facilities, many of which are unique in the world, will be reviewed including current and planned research capabilities, availability and operational performance, access procedures, and recent research results. Particular attention will be given to new neutron scattering capabilities, nanoscale science, and petascale simulation and modeling. In addition, user facilities provide a portal into ORNL that can enhance the development of research collaborations. The spectrum of partnership opportunities with ORNL will be described including collaborations, joint faculty, and graduate research and education.

1 ORNL is operated for the U.S. Department of Energy by UT-Battelle, LLC, under contract DE-AC05-00OR22725.

9:00AM NA.00002 Grand Challenges in Science and the Opportunities Afforded by DOE's New X-ray Laser Project1, GWYN WILLIAMS, Jefferson Lab — The National Academy of Sciences, Department of Energy Office of Science and National Science Foundation have recently defined a set of scientific “Grand Challenges” for the 21st Century. DOE's interest is a secure and sustainable energy future in a clean environment. Addressing many of the challenges will require an X-ray laser - a coherent ultra-bright light source whose wavelength is of atomic dimensions. The machine will cost $1-2B, and will be based on technology developed at Jefferson Lab. In this talk we will address the science motivating the X-ray laser, will describe the physics and nature of the source itself, and talk about JLab's Free Electron Laser program and Virginia’s potential role in this project.

1 Notice: Authored by Jefferson Science Associates, LLC under U.S. DOE Contract No. DE-AC05-06OR23177. The U.S. Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce this manuscript for U.S. Government purposes.

9:30AM NA.00003 Kimballton Underground Research Facility2, R. BRUCE VOGELAAR, Virginia Tech — A new deep underground research facility is open and operating only 30 minutes from the Virginia Tech campus. It is located in an operating limestone mine, and has drive-in access (eg: roll-back truck, motor coach), over 50 miles of drifts (all 40’ x 20’ x 100’; the current lab is 35’x100’x22’), and is located where there is a 1700’ overburden. The laboratory was built in 2007 and offers fiber optic internet, LN2, 480/220/110 V power, ample water, filtered air, 55 F constant temp, low Rn levels, low rock background activity, and a muon flux of only ~0.004 muons per square meter, per second, per steradian. There are currently six projects using the facility: mini-LENS - Low Energy Neutrino Spectroscopy (Virginia Tech, Louisiana State University, BNL); Neutron Spectrometer (University of Maryland, NIST); Double Beta Decay to Excited States (Duke University); HPGe Low-Background Screening (North Carolina State University, University of North Carolina, Virginia Tech); MALBEK - Majorana neutrinoless double beta decay (University of North Carolina); Ar-39 Depleted Argon (Princeton University). I will summarize the current program, and exciting plans for the future.

Saturday, October 22, 2011 8:30AM - 10:06AM —
Session NA Opportunities at National Labs and User Facilities in the SESAPS Area

Crystal Ballroom B - Craig Group, University of Virginia

8:30AM NA.00001 Scientific user facilities at Oak Ridge National Laboratory: New research capabilities and opportunities1, JAMES ROBERTO, Oak Ridge National Laboratory — Over the past decade, Oak Ridge National Laboratory (ORNL) has transformed its research infrastructure, particularly in the areas of neutron scattering, nanoscale science and technology, and high-performance computing. New facilities, including the Spallation Neutron Source, Center for Nanophase Materials Sciences, and Leadership Computing Facility, have been constructed that provide world-leading capabilities in neutron science, condensed matter and materials physics, and computational physics. In addition, many existing physics-related facilities have been upgraded with new capabilities, including new instruments and a high-intensity cold neutron source at the High Flux Isotope Reactor. These facilities are operated for the scientific community and are available to qualified users based on competitive peer-reviewed proposals. User facilities at ORNL currently welcome more than 2,500 researchers each year, mostly from universities. These facilities, many of which are unique in the world, will be reviewed including current and planned research capabilities, availability and operational performance, access procedures, and recent research results. Particular attention will be given to new neutron scattering capabilities, nanoscale science, and petascale simulation and modeling. In addition, user facilities provide a portal into ORNL that can enhance the development of research collaborations. The spectrum of partnership opportunities with ORNL will be described including collaborations, joint faculty, and graduate research and education.

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9:30AM NA.00003 Kimballton Underground Research Facility2, R. BRUCE VOGELAAR, Virginia Tech — A new deep underground research facility is open and operating only 30 minutes from the Virginia Tech campus. It is located in an operating limestone mine, and has drive-in access (eg: roll-back truck, motor coach), over 50 miles of drifts (all 40’ x 20’ x 100’; the current lab is 35’x100’x22’), and is located where there is a 1700’ overburden. The laboratory was built in 2007 and offers fiber optic internet, LN2, 480/220/110 V power, ample water, filtered air, 55 F constant temp, low Rn levels, low rock background activity, and a muon flux of only ~0.004 muons per square meter, per second, per steradian. There are currently six projects using the facility: mini-LENS - Low Energy Neutrino Spectroscopy (Virginia Tech, Louisiana State University, BNL); Neutron Spectrometer (University of Maryland, NIST); Double Beta Decay to Excited States (Duke University); HPGe Low-Background Screening (North Carolina State University, University of North Carolina, Virginia Tech); MALBEK - Majorana neutrinoless double beta decay (University of North Carolina); Ar-39 Depleted Argon (Princeton University). I will summarize the current program, and exciting plans for the future.
8:30AM NB.00001 Search for a Fourth Generation $t'$ Quark via $Wb$ Decays into a Lepton Plus Jets Final State in 7 TeV pp Collisions

CHARLES JENKINS, University of South Alabama, CMS COLLABORATION — The CMS Experiment at the LHC is currently observing 7 TeV center of mass energy pp collisions. One of the many beyond the standard model searches being conducted by CMS is for evidence of a fourth generation top-like quark ($t'$). If this object exists, it is expected to decay as: $t' \rightarrow W b$. In pp collisions the top-like quark would be produced with its anti-quark ($pp \rightarrow t't'\rightarrow W\bar{W}b\bar{b}$). This search looks for this decay where one of the W bosons decays leptonically ($W\rightarrow\ell\nu$) and the other hadronically ($W\rightarrow q\bar{q}$). This analysis studies two channels: muon+jets and electron+jets. Results from a sample of 684 pb-1 muon+jets and 573 pb-1 electrons+jets will be presented.

1This work is supported in part by DoE Grant DE-FG02-96ER40970

8:42AM NB.00002 Techniques for Higgs Hunting at D0

HUONG NGUYEN, University of Virginia, D-ZERO COLLABORATION — This talk will discuss several techniques employed to increase sensitivities in searches for the standard model Higgs boson at the D0 Experiment, including kinematic fits, matrix element methods, and kinematically motivated divisions of data. Examples from recent data analysis work will be presented.

8:54AM NB.00003 Angular Distribution of $Z^0$ Bosons in $Z^0$+Jet Events

LUIS LEBOLO, Florida International University, CMS COLLABORATION — The $Z^0$ boson center-of-mass angular distribution is measured in proton-proton collisions at $\sqrt{s} = 7$ TeV, at the CERN LHC. The advantage of studying the angular distribution is that the partonic cross section is solely a function of $\hat{s}$ and $\cos \theta$; it does not depend on the details of the parton distribution functions. The data sample, recorded with the CMS detector, corresponds to an integrated luminosity of approximately 36 pb$^{-1}$. Events in which there is a $Z^0$ and at least one jet, with a transverse momentum threshold of 20 GeV and absolute rapidity less than 2.5, are selected for this analysis. Only the $Z^0$'s muon decay channel is studied. Within experimental and theoretical uncertainties, the measured angular distribution is in agreement with next-to-leading order perturbative QCD predictions. This analysis extends the phase space available to previous Tevatron studies by probing larger values of $\phi$ and center-of-mass rapidities.

9:06AM NB.00004 Identifying Electromagnetic Events in the Forward Hadron Calorimeter

CHRISTOPHER FRYE, University of Central Florida — The Forward Hadron Calorimeter (HF) of the Compact Muon Solenoid (CMS) at the Large Hadron Collider (LHC) lies in a region not covered by an inner tracking system, and we can rely only on the shapes of showers that hit the HF to determine whether or not they are due to electromagnetic particles. We review the current method of distinguishing shower types in the HF, and we bring attention to a drawback that will become present as the luminosity of the LHC increases and creates a need for tighter shower-shape cuts. We provide a method to correct this drawback, and we analyze the effectiveness of various tight cuts at isolating signal from background.

1This project was completed in an REU program at the University of Minnesota funded by the NSF.

9:18AM NB.00005 Precision Measurement of anti-$B_{0bar}$→$D^{*+}$ Lepton Neutrino Branching Fraction

CHRISTOPHER BUCHANAN, SHANNON EYNON, RAFL IQMUSIEH, ROMULUS GODANG, University of South Alabama — We present a precision measurement of the exclusive anti-$B_0$ meson decays to $D^{*+}$, lepton, and anti-neutrino using 476 million $B$-meson anti-$B$-meson pairs. The data sample collected with the BABAR detector at the PEP-II asymmetric-energy B-Factory at SLAC National Accelerator Laboratory. The anti-$B_0$ mesons are reconstructed using a partial reconstruction in which the $D^{*+}$ four-momentum is inferred from the slow pion. This allows for a much higher statistical precision on this branching fraction. We use a single and double tag method to measure this important branching fraction.

1This work was supported by the U.S. Department of Energy under No. DE-FG02-96ER40970

9:30AM NB.00006 CP Violation in B Decays at BABAR

ROMULUS GODANG, University of South Alabama, BABAR COLLABORATION — We report on the study of the decay $B_+ \rightarrow D_0(D_{0bar}) K_+$ where the $D_0$ or $D_{0bar}$ meson decaying to Kpipi and Kpipi0, with the Atwood Dunietz and Soni (ADS) and Gronau, London, and Wyler (GLW) methods. We measure the ratios $R_{+}$, $R_{-}$, and $R_{R}$ since the processes $B_+ \rightarrow D_{0bar} K_+$ and $B_+ \rightarrow D_{0} K_+$ are proportional to $V_{cb}$ and $V_{ub}$, respectively, are sensitive to $R_B$ and to the weak phase angle gamma.

4:42AM NB.00007 Measurement of the Branching Fraction of $Y(4S)$ to Neutral B Pairs

RAFL IQMUSIEH, CHRISTOPHER BUCHANAN, SHANNON EYNON, ROMULUS GODANG, University of South Alabama — We measure a model independent measurement of the branching fraction of $Upsilon(4S)$ to neutral B pairs. We use a sample of 476 million $B$-meson anti-$B$-meson pairs collected at the Upsilon(4S) resonance with the BABAR detector at the PEP-II asymmetric-energy B-Factory at SLAC National Accelerator Laboratory. The B mesons are reconstructed through the channel of anti-$B_0$ decays to $D^{*+}$ lepton, anti-neutrino using a partial reconstruction method. Our result does not depend on any branching fraction, the reconstruction efficiency, and the ratio of the charged and neutral B meson. This measurement is an important input for normalizing many $B$ mesons decay.

1This work was supported by the U.S. Department of Energy under grant No. DE-FG02-96ER40970

9:54AM NB.00008 Angular Distribution of Photons in γ+Jet Events

VANESSA GAULTNEY, Florida International University, CMS COLLABORATION — The angular distribution of prompt photons in events with at least one jet in the center-of-mass frame for pp collisions at $\sqrt{s} = 7$ TeV is presented. A template method is used to distinguish between signal and the dominant background from jets fragmenting into neutral mesons. Measuring the angular distribution is a direct probe of the partonic cross section for prompt photon production and is free of the parton distribution functions that are normally associated with an inclusive cross section measurement typically used for next-to-leading order predictions. The $|\phi|$ distribution in the center-of-mass frame ranging from 0-2.1 ($|\cos\theta|$ 0-0.97) is examined and compared to next-to-leading order QCD predictions, the highest angular limit reached since the last measurement of angular distributions nearly a decade ago.
Saturday, October 22, 2011 8:30AM - 10:30AM – Session ND Astronomy Crystal Ballroom DE - Leo Piilonen, Virginia Polytechnic Institute and State University

8:30AM ND.00001 Gravitational Wave Astronomy and Astrophysics: A Status Report1, PETER SHAWHAN, University of Maryland, for the LIGO Scientific Collaboration and Virgo Collaboration — The LIGO, GEO and Virgo gravitational wave detectors have collected a few years of data with good sensitivity and have carried out searches for several types of gravitational-wave signals. I will highlight a few search results obtained so far which shed light on plausible astrophysical sources. The detectors are currently undergoing major upgrades and will run again as Advanced LIGO and Advanced Virgo beginning around 2015. I will describe several areas of astrophysics which will be opened up by the future data.

1The speaker is grateful for the support of the National Science Foundation under grants PHY-0757957 and PHY-1068549.
9:00AM ND.00002 A Multi-Messenger Search for Radio Transients and Gravitational Waves, MICHAEL KAVIC, Long Island University — The sensitivity of gravitational waves searches could be improved by coincident observation of electromagnetic signals from expected gravitational wave sources. One possibility is using low-frequency radio transients to trigger and constrain searches for gravitational wave signals. Both are all-sky observations with a number of common sources, and low frequency observations are able to provide spatial and temporal constraints to the search for gravitational wave signals. There is also the added benefit that coincident low-frequency radio and gravitational spectra will allow for more in-depth study of astrophysical events and processes than otherwise possible. In this talk I will layout the case for using low-frequency radio observations to trigger and constrain searches for coincident gravitational wave signals. Common sources and potential ways the joint observation of low-frequency radio and gravitational waves can enhance our understanding of the physics behind these sources will be addressed.

9:30AM ND.00003 A Precision Test for an Extra Spatial Dimension Using Black-Hole—Pulsar Binary Systems, JOHN SIMONETTI, Virginia Tech — Given the difficulties in testing current frontier physics ideas in earth-based experiments, we might profitably look to the cosmos for observational tests. I will discuss observations that could set a limit on the size of a warped extra spatial dimension in the braneworld scenario. The observations would be similar to those that provided evidence of gravitational radiation by the binary pulsar B1913+16. In the presence of a warped extra spatial dimension a stellar mass black hole will evaporate at a sufficiently high rate to produce an observable orbital effect in a black-hole—pulsar binary system. For some masses and orbital parameters the binary components will outspiral, the opposite of the behavior due to energy loss by gravitational radiation alone. Observations of a black-hole—pulsar system could set considerably better limits on size of the extra dimension in these braneworld models than could be determined by torsion-balance gravity experiments in the foreseeable future.

10:00AM ND.00004 Kinetic Luminosity of Quasar Outflows and its Implications to AGN Feedback, NAHUM ARAV, Virginia Tech — Sub-relativistic outflows are seen as blueshifted absorption troughs in the spectra of roughly one third of all quasars. I will describe how we determine the mass flux and kinetic luminosity of these outflows and show that the derived values suggest that absorption outflows may be a main agent of AGN feedback scenarios.

Saturday, October 22, 2011 10:45AM - 11:21AM –

10:45AM PA.00001 LabVIEW ALPHA Immersion at Reed College, R. SETH SMITH, Francis Marion University — During the summer of 2011, ALPHA (Advanced Physics Laboratory Association) hosted a series of laboratory immersion experiences in which faculty could spend several days working closely with a mentor on an advanced undergraduate experiment. The goal of this program is to foster wider implementation of these experiments at the undergraduate level. One of these immersions took place at Reed College and focused on the use of LabVIEW software in undergraduate physics laboratories. This was an extremely valuable laboratory. The immersion experience and the LabVIEW projects will be described.

10:57AM PA.00002 What is the purpose of undergraduate physics labs?*, WILLIAM SAMS, North Carolina State University, MICHAEL PAESLER, CLIFF CHAFIN — In recent years, enrollment in undergraduate physics courses at NC State has grown significantly, especially in introductory physics. Since most of these courses involve a laboratory component, the increased enrollment is leading to a shortage of laboratory space. Starting this spring NC State will implement kit labs in calculus-based mechanics labs. These kits will make it possible for students to have laboratory experiences outside of the standard lab rooms, decreasing space demands. During the implementation the kit labs will be evaluated with an instrument developed for this purpose. This paper discusses the first step of designing this instrument, determining what the specific goals and purposes of the labs are. Literature reviews have led to focus on three primary areas where students should make gains during lab: content knowledge, scientific process, and affect. Physics faculty members were surveyed to identify specific areas considered important for our labs. Using results from our survey and published literature we have developed a specific set of goals for our labs, and we are using this to guide the development of our assessment instrument.

*NC State DELTA Large Course Redesign Pilot Grant

11:09AM PA.00003 Remote Sensing: Radio Frequency Detection for High School Physics Students, DANIEL HUGGETT, MICHAEL JEANDRON, LARRY MADDOX, SANICHIRO YOSHIDA, Southeastern Louisiana University — In an effort to give high school students experience in real world science applications, we have partnered with Loranger High School in Loranger, LA to mentor 9 senior physics students in radio frequency electromagnetic detection. The effort consists of two projects: Mapping of 60 Hz noise around the Laser Interferometer Gravitational Wave Observatory (LIGO), and the construction of a 20 MHz radio telescope for observations of the Sun and Jupiter (Radio Jove, NASA). The results of the LIGO mapping will aid in strategies to reduce the 60 Hz line noise in the LIGO noise spectrum. The Radio Jove project will introduce students to the field of radio astronomy and give them better insight into the dynamic nature of large solar system objects. Both groups will work together in the early stages as they learn the basics of electromagnetic transmission and detection. The groups will document and report their progress regularly. The students will work under the supervision of three undergraduate mentors. Our program is designed to give them theoretical and practical knowledge in radiation and electronics. The students will learn how to design and test receiver in the lab and field settings.

*Undergraduate Presenter
2Undergraduate

Saturday, October 22, 2011 10:45AM - 12:57PM –
Session PB Statistical and Nonlinear Physics II Crystal Ballroom B - Uwe Tauber, Virginia Polytechnic Institute and State University
10:45AM PB.00001 Effect of Diffusion on Size Distribution Dynamics of Desorption in KMC Simulations of a Lattice-Gas Model of Pulsed Electrodeposition. TJIPTO JUVONO, Florida State University — We have studied the effect of diffusion during the desorption phase in pulsed electrodeposition in a square lattice-gas model using Kinetic Monte Carlo simulations. The effect of diffusion on correlation length and size distribution during the desorption were studied. During the process, the correlation length increased up to a maximum and then decreased. We found that diffusion increase correlation length by small percentage in the regime where correlation length is decreasing, and increase it more significantly when the correlation length is increasing. By studying size distributions we found that diffusion tends to shrink large clusters and grow or create medium clusters. When the clusters grow or creation by diffusion is small, the increase of correlation length by diffusion is small and large otherwise.

10:57AM PB.00002 Effect of the size distributions of magnetic nanoparticles on metastability across dynamic phase boundary. YOH YAMAMOTO, KYUNGWHA PARK, Virginia Tech — Recent experiments showed that magnetic nanoparticles have distributions of sizes and shapes, and that the distributions greatly influence static and dynamic properties of the nanoparticles. Therefore, it is critical to understand their properties as functions of the distributions. Previously, we studied an effect of particle size distributions on metastability in magnetization relaxation, using a spin $S = 1$ Blume-Capel model, in the single-droplet regime where a critical droplet comprises a single flipped spin. The particle size distributions were simulated using distributions of magnetic anisotropy parameter $D$ with spins fixed. We found that the lifetime of the metastable state is governed by the smallest particle or the particle with the smallest value of $D$ in a given system. In this work, we present the effect of size distributions on metastability in the region where the values of $D$ are distributed across the phase boundary between different critical droplets for constant $D$. Interesting phenomena may occur in this region because particles with low values of $D$ expect different critical droplets from particles with high values of $D$ in a given distribution of $D$. We examine magnetization relaxation in this region using kinetic Monte Carlo simulations for the spin $S = 1$ Blume-Capel model.

11:09AM PB.00003 Non-equilibrium phases of the two-dimensional Ising model in contact with two heat baths1. LINJUN LI, MICHEL PLEIMLING, Virginia Tech — The equilibrium phase diagram of the two-dimensional Ising model in contact with a single heat bath is well understood. We here study the properties of the two-dimensional Ising model with conserved dynamics where the two halves of the system are in contact with different heat baths. Using Monte Carlo simulations, we identify three different phases for this non-equilibrium system, as a function of the aspect ratio of the lattice and of the temperatures. The first phase is characterized by the complete disorder of the particles, while the second phase is characterized by the complete order of the particles. The third phase is the most interesting one as it displays stripes with widths that depend on the system parameters. The full phase diagram of our non-equilibrium system is determined through the study of the structure factor.

1Supported in part by the US National Science Foundation through Grant DMR-0904999.

11:21AM PB.00004 Langevin Molecular Dynamics of Driven Magnetic Flux Lines1, ULRICH DOBRAMYSL, MICHEL PLEIMLING, UWE C. TÄUBER, Department of Physics, Virginia Tech — The characterization of type-II superconducting materials and their technological applications in external magnetic fields require a thorough understanding of the stationary and dynamical properties of vortex matter. The competition of repulsive interactions and attractive material defects renders the physics of externally driven magnetic flux lines very rich. We study the non-equilibrium steady states as well as transient relaxation properties of driven vortex lines in the presence of randomly distributed point pinning centers. We model the vortices as interacting elastic lines and employ a Langevin Molecular Dynamics (LMD) algorithm to extract steady-state and non-stationary time-dependent behavior. We compare the efficiency and accuracy of LMD to previously obtained Metropolis Monte Carlo steady-state force-velocity and gyration radius data. In future work we intend investigate the transient two-time height-height correlation and response functions.

1Research supported through the US Department of Energy (DOE-BES), grant no. DE-FG02-09ER46613.

11:33AM PB.00005 An Approximation to the Periodic Solution of a Differential Equation of Abel. RONALD E. MICKENS, Clark Atlanta University — The Abel equation, in canonical form, is $y' = \sin t - y^3$ (*) and corresponds to the singular ($\varepsilon \to 0$) limit of the nonlinear, forced oscillator $\varepsilon y'' + y' + y^3 = \sin t, \varepsilon > 0$. (**) Equation (*) has the property that it has a unique periodic solution defined on $(-\infty, \infty)$. Further, as $t$ increases, all solutions are attracted into the strip $|y| < 1$ and any two different solutions $y_1(t)$ and $y_2(t)$ satisfy the condition

$$\lim_{t \to \infty} [y_1(t) - y_2(t)] = 0, \quad (**)$$

$t \to \infty$ and for $t$ negatively decreasing, each solution, except for the periodic solution, becomes unbounded.

Our purpose is to calculate an approximation to the unique periodic solution of Eq. (*) using the method of harmonic balance. We also determine an estimation for the blow-up time of the non-periodic solutions.

11:45AM PB.00006 An Averaged-Separation of Variable Solution to the Burger Equation. KALE OYEDEJI, Morehouse College, RONALD E. MICKENS, Clark Atlanta University — The Burger Partial Differential Equation (PDE) provides a nonlinear model that incorporates several of the important properties of fluid behavior. However, no general solution to it is known for given arbitrary initial and/or boundary conditions. We propose a “new” method for determining approximations for the solutions. Our method combines the separation of variables technique, combined with an averaging over the space variable. A test of this procedure is made for the following problem, where \( u = u(x,t) \):

\[
0 \leq x \leq 1, \ t > 0,
\]

\[
u(0,t) = 0, \ u(1,t) = 0, \]

\[
u(x,0) = x(1-x),
\]

\[
\frac{\partial u}{\partial t} + uu_x = Du_{xx},
\]

where \( D \) is a non-negative parameter. The validity of the calculated solution is made by comparing it to an exact analytic solution, as well as an accurate numerical solution for the special case where \( D = 0 \).

11:57AM PB.00007 A two-Lane model with anomalous slow dynamics\(^1\), DAN LINFORD, TREVOR RICHARDS, MICHELE PLEIMLING, Virginia Tech — It is known that in one-dimensional equilibrium systems with short range interactions a phase transition cannot exist at finite, non-zero temperatures. However, far from equilibrium, one-dimensional systems with local interactions can exhibit a phase transition. The ABC model, a three species model defined on a chain characterized by non-symmetric exchanges between particles, is known to possess a non-equilibrium phase transition. This model exhibits anomalous slow dynamics that we investigate in some detail using two-time quantities. In addition we discuss an extension of this model to a case where this single lane is coupled to a one-dimensional particle bath. This coupling yields an additional phase transition that we discuss in some detail.

\(^1\)Supported in part by the US National Science Foundation through Grant DMR-0904999.

12:09PM PB.00008 Degree-based graph construction and sampling\(^1\), HYUNJU KIM, Virginia Tech — Network representation and modeling has been one of the most comprehensive ways to study many complex systems. However, the network describing the system frequently has to be built from incomplete connectivity data, a typical case being degree-based graph construction, when only the sequence of node degrees is available. In this presentation I will introduce problems and results related to the construction of all the possible graphs and sampling from the class of graphs with fixed degree-sequence. Firstly, for graph construction, I will present necessary and sufficient conditions for a sequence of integers to be realized as a simple graph’s degree sequence under the condition that a specific set of connections from an arbitrary node are avoided. Secondly, by using this result, I will show how to provide an efficient, polynomial time algorithm that generates graph samples with a given degree sequence. Unlike other existing algorithms, this method always produces statistically independent samples, without back-tracking or rejections. Also, the algorithm provides the weight associated with each sample, allowing graph observables to be measured uniformly over the graph ensemble.

\(^1\)Supported in part by the NSF BCS-0826958, DTRA HDTTRA 201473-35045, NSF DMR-0908286 and NSF DMR-1005417

12:21PM PB.00009 A simple model for studying interacting networks\(^1\), WENJIA LIU, SHIVAKUMAR JOLAD, BEATE SCHMITTMAANN, R.K.P. ZIA, Virginia Tech — The characteristics of single networks, whether physical, biological or social, are well known. However, many of these networks function not only in isolation, but also coupled to each other. So far, little is known about such “interacting networks.” Here, we consider two coupled systems, modeling social networks with a preferred number of friends. We first report on the (statistical) properties of the stationary state of a single network, which consists of a fixed set of nodes and a stochastically varying set of links (generated according to a preferred degree, \( k \)). Next, we investigate the effects of coupling two such networks (with different \( k \)) by various means. Findings using both analytic and simulation techniques will be presented and potential consequences for real networks will be discussed.

\(^1\)Supported in part by NSF-DMR-0705152 and 1005417

12:33PM PB.00010 Image Charge Optimization for the Reaction Field by Matching to an Electrostatic Force Tensor, WEI SONG, DONALD JACOBS — A new image charge solvation model has recently been developed, which consists of a spherical cavity of explicit solvent embedded in a continuum dielectric medium. Inside the cavity, the dielectric constant is 1 and outside the cavity is set to 80. Although the discontinuity from 1 to 80 at the cavity interface creates large artifacts near the boundary, MD simulation using this model yields accurate results by incorporating a buffer layer containing imaged water. We generalized the model to reflect a continuously changing dielectric profile at the boundary, and optimized image charges for the reaction field based on electrostatic forces to minimize the buffer layer volume and reproduce the electrostatic force field associated with the dielectric properties of the provided solvent. However, MD simulation suggests that the new model is unstable. Previously, we also showed that the reaction field has an order of magnitude stronger influence on the electrostatic torque compared to force on solvent water molecules. Therefore, we optimize the image charges in a different way, using a force tensor defined by a grid of dipoles, which places more constraints on the system.

12:45PM PB.00011 Unusual criticality in a generalized XY model, YIFEI SHI, University of Virginia — We study the generalized XY model in two dimension, which has a term proportional to \( \cos(2\theta) \) in addition to the normal XY Hamiltonian. This corresponds to having half vortices connected by solitons, as well as integer vortices. From both renormalization group analysis and Monte Carlo simulation using the worm algorithm, we find that the phase diagram includes Kosterlitz-Thouless transitions of half and integer vortices, together with an Ising transition. Remarkably, part of the Ising line is a direct transition from the quasi-long-ranged ordered state to the disordered state.

Saturday, October 22, 2011 10:45AM - 1:21PM –
Session PC Condensed Matter Physics/Nanophysics II Crystal Ballroom C - Wilfredo Otano Rivera, University of Puerto Rico-Cayey
10:45AM PC.00001 Determination of the Current Voltage Signatures of NanoGUMBOS1. KALYAN KANAKAMEDALA, SERGIO DE ROOY, SUSMITA DAS, Louisiana State University, BILAL EL-ZAHAB, Massachusetts Institute of Technology, ISIAH WARNER, THEDA DANIELS-RACE, Louisiana State University — Tantamount to the realization of next generation nanoscale devices is the synthesis and characterization of new electronic materials. GUMBOS, or a Group of Uniform Materials Based on Organic Salts, represent a first-time synthesis of nanoscale material composed of ionic liquid species in the frozen (solid) state whose electronic characteristics are indicative of potential future application to device electronics. Using a Keithley 4200 semiconductor characterization system, we have examined the nanoscale conductivity and current-voltage (I-V) characteristics of GUMBOS nanowires under both aqueous and "dry" conditions. Just as nanoGUMBOS are new materials in the realm of ionic liquid research, our I-V measurements are a first-time characterization of this species of nanostructures.

1This work was supported by the Louisiana Board of Regents and the National Science Foundation (CHE-0911118).

10:57AM PC.00002 Characterization of NanoGUMBOS Using Conductive Probe Atomic Force Microscopy1. NAVEEN JAGADISH, SERGIO DE ROOY, ATIYA JORDAN, ASHLEIGH WRIGHT, SUSMITA DAS, Louisiana State University — In our work on hybrid (organic-inorganic) electronic materials (HEMs), we have developed a reasonably facile method for characterizing GUMBOS or a Group of Uniform Materials Based on Organic Salts. In addition to the versatility of traditional ionic liquids (i.e.-solubility, melting point, viscosity), nanoGUMBOS are functionalizable to exhibit properties such as fluorescence, magnetic susceptability, and even antimicrobial activity. However, given our interest in the electrical properties of HEMs, we have made first-time measurements of nanoGUMBOS, using CP-APM, in order to deduce their room temperature current-voltage characteristics. In conjunction with the nanoscale imaging of AFM alone, we have observed both the morphology and conductivity of these unique materials. Our results bode well for combining GUMBOS with substrates of more traditional materials, such as metals or semiconductors, to serve as the basis for future HEMs-based devices.

1This work was supported by the Louisiana Board of Regents and the National Science Foundation (CHE-0911118).

11:09AM PC.00003 Negative coefficient of thermal expansion in (epoxy resin)/(zirconium tungstate) nanocomposites. ERICH SEE, Virginia Tech Department of Physics, MC 0435, 910 Drifldell Drive, Blacksburg, VA 24061. VLADIMIR KOCHERGIN, LAUREN NEELY, MADRAKHIM ZAYETNIKOV, MicroXact, Inc. 2000 Kort Drive, Suite 1207, Blacksburg, VA 24060. GIANLUIGI GIOVATI, Jefferson Lab, 1200 Jefferson Avenue, MS 58, Suite 17, Newport News, VA 23606. HANS ROBINSON, Virginia Tech Department of Physics, MC 0435, 910 Drifldell Drive, Blacksburg, VA 24061 — The α-phase of zirconium tungstate (ZrW2O8) has the remarkable property that its coefficient of thermal expansion (CTE) takes on a nearly constant negative value throughout its entire range of thermal stability (0 – 1050 K). Composites of ZrW2O8 nanoparticles and polymer resins have a reduced CTE compared to the pure polymer, but previous work has been restricted to measurements near room temperature. We show that the CTE of such composites can take on increasingly negative values as the temperature is lowered to cryogenic values. We used this phenomenon to fabricate a metal-free all-optical cryogenic temperature sensor by coating a fiber optic Bragg grating with the nanocomposite. This sensor has a sensitivity at 2 K that is at least six time better than any previous fiber-optic temperature sensor at this temperature.

11:21AM PC.00004 Towed-grid system for production and calorimetric study of homogenous quantum turbulence1. ROMAN CIPARIN, KYLLE THOMPSON, GARY G. IHAS, University of Florida — The decay of quantum turbulence is not fully understood in superfluid helium at milikelvin temperatures where the viscous normal component is absent. Vibrating grid experiments performed perseveringly produced inhomogeneous turbulence, making the results hard to interpret. We have developed experimental methods to produce homogeneous isotropic turbulence by pulling a grid at a variable constant velocity through superfluid 4He. While using the calorimetric technique to measure the energy dissipation, the Meissner effect was employed to eliminate all heat sources except from turbulent decay. A controlled divergent magnetic field provides the lift to a hollow cylindrical superconducting actuator to which the grid is attached. Position sensing is performed by measuring the inductance change of a coil when a superconductor, similar to that of the actuator, is moved inside it. This position sensing technique proved to be reliable under varying temperatures and magnetic fields, making it perfect for use in the towed-grid experiment where a rise in temperature emerges from turbulent decay. Additionally, the reproducible dependency of the grid’s position on the applied magnetic field enables complete control of the actuator’s motion.

1Work partially supported by NSF Grant DMR-1007937.

11:33AM PC.00005 Radiative Polaritons in Thin Oxide Films with Experimental and Simulated Dispersion Relations . ANITA VINCENT-JOHNSON, Dept. of Physics, James Madison University, JAMES HAMMONDS JR., Dept. of Mechanical Engineering, Howard University, GIOVANNA SCAREL, Dept. of Physics, James Madison University — Our research focuses on polaritons, or infrared (IR) phonon-phonon coupling in ionic materials, as a way to capture IR radiation from the solar spectrum. Radiative polaritons (RP) have the unique property that their phase velocity is faster than the speed of light. We wish to prove that the polaritons present in thin oxide films are RP’s with the traits predicted by theory. Therefore, in this work we study simulated and experimental IR spectra of Al2O3 films grown by atomic layer deposition (ALD) on Al. Since RP’s are characterized by a complex frequency $\omega$, we have derived from IR spectra the real part, $\text{Re}(\omega)$, as the peak centroid, and the imaginary part, $\text{Im}(\omega)$, as the peak’s width. Dispersion relations were obtained by plotting $\text{Re}(\omega)$ vs. $\text{Im}(\omega)$ and by fitting various models to the experimental data. The agreement between simulated and experimental data and between our data and theory allow us to conclude that RP’s are present in thin oxide films.
11:57AM PC.00007 Time-dependent hydrogen annealing of Mg-doped GaN. USTUN SUNAY, MARY ZVANUT, JAMIYANAA DASHDORJ, University of Alabama at Birmingham — Unintentional doping by hydrogen is a concern for industrial growth of p-type GaN which is important in creating blue LEDs and high frequency devices. Using electron paramagnetic resonance (EPR) we investigated hydrogen passivation in p-type nitrides. Samples included conventional GaN and Al_{x}Ga_{1-x}N(x=0.12,0.28) grown by chemical vapor deposition (CVD) with 1×10^{19} cm^{-3} Mg and GaN grown by Metal Modulation Epitaxy (MME) yielding 1.5×10^{20} cm^{-3} Mg. The Mg signal was observed during isothermal anneals in N2:H2 (92%:7%). The Mg EPR signal unexpectedly increased below 600°C in GaN, but not Mg-doped GaN observed in AlGaN. The MME Mg EPR signal began decreasing after 10 min at 400°C, while the Mg intensity of AlGaN did not start reducing until 500°C. As expected the Mg EPR signal in the CVD GaN quenched at 700°C, as did the signal in AlGaN. However, the intensity of the Mg signal in MME samples was eliminated after only 20 min at 500°C. The different temperature dependence suggests that hydrogen diffusion is affected by increased Mg concentration. These studies are integral for the advancement of p-type GaN.

1This work is funded by NSF. We thank A. Allerman, Sandy National Lab and M. Moseley and W.A. Doolittle, Ga Tech, for the samples.

12:09PM PC.00008 First-principles study of surface states of topological insulators1, KYUNGWHA PARK, Virginia Tech — Recently, three-dimensional topological insulators (TIs) with time reversal symmetry draw attention due to their unique quantum properties and device applications. Strong spin-orbit coupling in TIs induces metallic surface states within bulk band gaps. It has been known that Bi_{2}Te_{3}, Bi_{2}Se_{3}, and Sb_{2}Te_{3} are TIs possessing a single Dirac cone in the dispersion of the surface states at a given surface. The surface states of TIs play a critical role in proposed novel physical phenomena and applications. We investigate the surface states of thin films of Bi_{2}Te_{3}(111) and Bi_{2}Se_{3}(111) using density-functional theory including spin-orbit coupling. We identify the surface states of the TI films from calculated band structures using the decay length of the surface states and electron density plots. We also present the electronic properties of the surface states of the films.

1Supported by NSF DMR-0804665

12:21PM PC.00009 Electronic Structure Determination of the Thermoelectric CuRh_{1-x}Mg_{x}O_{2} using Soft X-Ray Spectroscopies, ERIC MARTIN, PAOLO VILMERCATI, CHRISTINE CHENEY, Dept. of Physics and Astronomy, The University of Tennessee, TAKAO SASAGAWA, Materials and Structures Laboratory, Tokyo Institute of Technology, NORMAN MANNELLA, Dept. of Physics and Astronomy, The University of Tennessee — Magnesium-doped rhodium oxides with formula unit CuRh_{1-x}Mg_{x}O_{2} and delafossite-type structure exhibit a high thermoelectric figure of merit at elevated temperatures. The electronic structure of CuRh_{1-x}Mg_{x}O_{2} has been studied with x-ray emission spectroscopy (XES), x-ray absorption spectroscopy (XAS), and photoemission spectroscopy (PES). The data reveal that the states at the Fermi level are Rh-derived. Measurements carried out by changing the orientation of the linear photon polarization further indicate that the Rh states have a more localized character along the c-axis, consistent with the layered crystal structure. Given the similarity of the electronic configurations of Co and Rh, these data provide solid experimental evidence that the orbital degrees of freedom of the d^{9} ionic configuration of the states rooted in transport are key for explaining the thermoelectric properties of oxide materials.

12:33PM PC.00010 Energy Band Gap Behavior as a Function of Optical Electronegativity for Semiconducting and Insulating Binary Oxides1, KRISTEN DAGENAIS, University of Maryland, Baltimore County, MATTHEW CHAMBERLIN, COSTEL CONSTÂNTIN, James Madison University — A relationship between energy band gap and electronegativity has long been understood to exist. However, defining the relationship between the two for binary oxide systems has proven difficult. Many scientists tried to model the band gap as a function of Pauling electronegativity values, but we show that by using a new concept called “optical electronegativity” one can obtain much better predictions regarding band gaps of new oxide. Interestingly we found that the behavior of oxides varies across depending on the chemical group the cation is from. With that knowledge, we developed two equations to describe the alkali earth metal and poor metal oxide. By using our models, we are able to predict the band gap of radium oxide at 5.36 eV. With that knowledge, we developed two equations to describe the alkali earth metal and poor metal oxide. The electronic properties of the surface states of the films.

1Supported by financial support:DOD-ASSURE/NSF-REU grant # DMR-0851367, and Research Corp. Dept. Development grant #7957.

12:45PM PC.00011 ABSTRACT WITHDRAWN —

12:57PM PC.00012 Microstructural investigations of 0.2% carbon content steel, SAJJAD TOLLABIMAZRAEHNO, KURT HINGERL, Johannes Kepler University — The effect of thermal annealing to get different phases on low carbon steel was investigated. Steel sheets (0.2 wt. % C) of 900 m thickness were heat treated to produce different structures. All the samples have the same starting point, transformation to coarse austenite at 900 degree Celsius. The nano indentation results revealed that samples have different hardness. By making conventional SEM micrographs, focus ion beam maps, and Electron backscatter diffraction (EBSD) the microstructural development and grain boundary variation of transformed phases martensite, bainite, tempered martensite and different combination of these phases were studied.

1We would like to acknowledge the following agencies for financial support:DOD-ASSURE/NSF-REU grant # DMR-0851367, and Research Corp. Dept. Development grant #7957.

1undergraduate student
2present address:Tokyo Denki University

12:09PM PC.00013 Optical interferometric assessment of thin-film adhesion to substrate, SUSHOVIT ADHIKARI1, KENJI GOMI2, SANICHIRO YOSHIDA, Southeastern Louisiana University — A Michelson interferometer has been assembled to evaluate the adhesion strength of thin-film coating on silicon wafers. Two gold coated silicon wafer specimens were configured as the two end mirrors of the interferometer. The end mirrors are slightly tilted so that vertical interferometric fringes (dark strips) are formed behind the beam splitter. An acoustic transducer is attached to the silicon substrate of each wafer so that the gold coated surface oscillates in the direction of the optical axis. One wafer is driven at a time. As the coated surface oscillates, the vertical fringes oscillate horizontally, where the amplitude of the oscillation varies depending on the adhesion strength. Two specimens, one with oxygen-plasma pre-coating treatment and the other with no pre-coating treatment, have been tested. Empirically, the former is known to be stronger in adhesion than the latter. When the specimen of the weaker adhesion is driven in a range of 10 – 17 kHz, the fringes become blurry, indicating that displacement is greater. Analysis of the fringe patterns in the spatial frequency domain has enabled us to differentiate the displacement quantitatively.
10:45AM PD.00001 The impact of Higgs boson searches at the Tevatron in the LHC era, CRAIG GROUP, University of Virginia and Fermilab — The Tevatron’s long program of colliding protons and anti-protons at a center-of-mass energy of 1.96 TeV will end in September of this year (2011). I will describe the ongoing efforts of the CDF and DØ collaborations to conclude their search for the Higgs boson and make predictions on their sensitivity with the complete dataset. The sensitivity of the LHC experiments at CERN is quickly surpassing the Tevatron in most new physics searches; however, in some efforts—such as some low-mass Higgs boson searches—the Tevatron results will remain competitive for quite some time. I will focus the talk on the complementarity of the information that will be provided by the Tevatron and LHC experiments and will explain why both are important in understanding the nature of a low mass Higgs boson if it is discovered in the next few years.

11:15AM PD.00002 ATLAS in 2011: Status and Prospects, DICK GREENWOOD, Louisiana Tech University — The ATLAS Experiment at the Large Hadron Collider (LHC) began taking data at a center of mass energy of 7 TeV in spring 2010. What have we learned from ATLAS since SESAPS 2010? In my talk, I present the status of our measurements thus far, relate these results to predictions of the Standard Model and of theories beyond the Standard Model, and conclude with our prospects for making interesting discoveries in the future.

11:45AM PD.00003 Recent Results from 7 GeV proton-proton running at CMS, WILL JOHNS, Vanderbilt University (CMS experiment) — The Compact Muon Solenoid (CMS) experiment at CERN’s Large Hadron Collider (LHC) has been collecting and analyzing proton-proton collisions at 7 TeV. CMS has collected more than 2 fb$^{-1}$ of collision data, including smaller samples at lower energies of 0.9 TeV and 2.36 TeV. These samples allow precision measurements of Standard Model processes and probing for new physics. The results presented will show good detector performance as well as some of the recent physics results from CMS.

12:15PM PD.00004 Naturalness of electroweak symmetry breaking in the LHC era, TAKEMICHI OKUI, Florida State University — I will provide a concise, coherent overview of electroweak symmetry breaking from a modern perspective and in light of the latest LHC data, focusing on the mechanisms of electroweak symmetry breaking that are natural, i.e., without significant fine-tuning.