75th Annual Meeting of the Southeastern Section of APS
Raleigh, North Carolina
http://www.aps.org/meetings/meeting.cfm?name=SES08
9:00AM BA.00002 Fundamental symmetry tests with ultracold neutrons , BRAD PLASTER, University of Kentucky — Ultracold neutrons (UCN) are neutrons with kinetic energies so low (less than 200–300 nano-eV) that they can be “bottled” with material surfaces or magnetic fields of a few Tesla. In this talk I will discuss the application of UCN to high-precision tests of the fundamental symmetries underlying the standard model, and also provide a preview of future physics opportunities utilizing UCN in the Southeast, particularly those to be staged at the Spallation Neutron Source.

9:30AM BA.00003 Neutrino oscillations: what do we know about $\theta_{13}$ , DAVID ERNST, Vanderbilt University — The phenomenon of neutrino oscillations is reviewed. A new analysis tool for the recent, more finely binned Super-K atmospheric data is outlined. This analysis incorporates the full three-neutrino oscillation probabilities, including the mixing angle $\theta_{13}$ to all orders, and a full three-neutrino treatment of the Earth’s MSW effect. Combined with the K2K, MINOS, and CHOOZ data, the upper bound on $\theta_{13}$ is found to arise from the Super-K atmospheric data, while the lower bound arises from CHOOZ. This is caused by the linear in $\theta_{13}$ terms which are of particular importance in the region $L/E > 10^7$ m/MeV where the sub-dominant expansion is not convergent. In addition, the enhancement of $\theta_{13}$ by the Earth MSW effect is found to be important for this result. The best fit value of $\theta_{13}$ is found to be (statistically insignificantly) negative and given by $\theta_{13} = -0.07^{+0.18}_{-0.11}$.

In collaboration with Jesus Escamilla, Vanderbilt University and David Latimer, University of Kentucky.

1Supported in part by the US Department of Energy.

10:00AM BA.00004 A New ECR Ion Source for Nuclear Astrophysics Studies , JOHN M. CESARATTO, UNC — Chapel Hill and TUNL — The Laboratory for Experimental Nuclear Astrophysics (LENA) is a low energy facility designed to study nuclear reactions of astrophysical interest at energies which are important for nucleosynthesis. In general, these reactions have extremely small cross sections, requiring intense beams and efficient detection systems. Recently, a new high intensity electron-cyclotron-resonance (ECR) ion source has been constructed (based on a design by Wills et al.[1]), which represents a substantial improvement in the capabilities of LENA. Beam is extracted from an ECR plasma excited at 2.45 GHz and confined by an array of permanent magnets. It has produced $^2$H$^+$ beams in excess of 1 mA on target over the energy range 100 - 200 keV, which greatly increases our ability to measure small cross sections. Initial measurements will focus on the $^{23}$Na(p,γ)$^{24}$Mg reaction, which is of interest in a variety of astrophysical scenarios. The present uncertainty in the rate of this reaction is the result of an unobserved resonance expected at $E_{\text{res}} = 144$ keV, which should be detectable using beams from the new ECR source. In collaboration with Arthur E. Champagne and Thomas B. Clegg, University of North Carolina, Chapel Hill and TUNL.


1Work partially supported by US DOE Grants No. DE-FG02-97ER41033 and DE-FG02-97ER41041.
will present microscopic (atomic) views on how the static polarizability of a cluster varies over a wide range of \( \nu \) diverging when a coupling constant and substance. The dependence on the separation between nearby chains within a cluster is also explored. The static polarizability depends also on material, at alternating sites along each chain, are chosen as cluster. The results of the present calculation show the effects of anisotropic shape (aspect ratio), finite size, may be calculated by considering each cluster as a point particle characterized by a static polarizability tensor. The static polarizability of a cluster is evaluated.

Enhancements of the mechanical or electrical properties are dependent on the formation of continuous networks of particle within the composite volume. This can produce a significant alteration in properties such as electrical conductivity, while retaining some of the processability associated with the neat polymer. Expands, the prevalence of composites with complex morphologies is increasing. Nanocomposite materials are desirable in that the addition of a nanoparticle attached to the ligand carry bulk of the magnetic moment. Studies, as a function of cluster size, also illustrate that magnetism resides only on the surface. Our result in a magnetic system where the 2p electrons in O and N, and 3p electrons in S sites are spin polarized. Furthermore, the sites nearest to the Zn atom ZnO bond length, hybridization between Zn 4s orbitals with N 2p or S 3p orbitals, and consequently the redistribution of charges between Zn and O atoms and correlation, and a cluster model for the nanoparticles. We show that N or S atoms of the ligand bind to the Zn sites. The accompanying changes in the density, QIAN WANG, PURU JENA, Virginia Commonwealth University — We provide the first theoretical understanding of the origin of magnetism in ligated ZnO nanoparticles as well as the structural properties of the ligated systems by using density functional theory and generalized gradient approximation for exchange and correlation, and a cluster model for the nanoparticles. We show that N or S atoms of the ligand bind to the Zn sites. The accompanying changes in the ZnO bond length, hybridization between Zn 4s orbitals with N 2p or S 3p orbitals, and consequently the redistribution of charges between Zn and O atoms result in a magnetic system where the 2p electrons in O and N, and 3p electrons in S sites are spin polarized. Furthermore, the sites nearest to the Zn atom attached to the ligand carry bulk of the magnetic moment. Studies, as a function of cluster size, also illustrate that magnetism resides only on the surface. Our results confirm that use of ligands can pave a new way for introducing magnetism in ZnO nanostructures, which can be used to develop magnetic sensors to detect N and S containing molecules.
10:18AM BB.00010 The Constrained Crystallization of Nylon-6. ANUHREE MOHAN, ALAN TONELLI, North Carolina State University — Non-covalently bonded crystalline inclusion compounds (ICs) have been formed by threading host cyclic structures, cyclodextrins (CDs) onto guest nylon 6 (N6) chains. When excess N6 is employed, non-stoichiometric (n-s)-N6-CD-ICs with partially uncovered and dangling N6 chains result. While the crystalline CD lattice is stable to ~300 °C, the uncovered and dangling, yet constrained, N6 chains may crystallize below or, as shown below, be molten above ~225 °C. We have been studying the constrained crystallization of the dangling N6 chains in (n-s)-N6-CD-ICs, with comparison to bulk N6 samples, as a function of N6 molecular weights, lengths of uncovered N6 chains, and the CD host used. In the IC channels formed with host α- and γ-CDs containing 6 and 8 glucose units, respectively, single and pairs of side-by-side N6 chains are threaded and included. In the α-CD-ICs the ~0.5 nm channels are separated by ~1.4 nm, while in the γ-CD-ICs the ~1 nm channels are ~1.7 nm apart, with each γ-CD channel including 2 N6 chains. N6 chains in the bulk and in the dense (n-s)-N6-CD-IC brushes show distinctly different kinetic and thermodynamic crystallization behaviors.

Thursday, October 30, 2008 8:30AM - 10:24AM – 
Session BC Biophysics I Holiday Inn Brownstone Lincoln

8:30AM BC.00001 Magnetomotive optical coherence tomography for elastography of small biosamples. AMY OLDENBURG, University of North Carolina at Chapel Hill — Optical coherence tomography (OCT) is a 3D micron-resolution imaging modality using the low-coherence properties of near-infrared light to render depth-resolved images typically a few millimeters into biological tissue. Visco-elasticity is an important parameter for detecting and staging various human diseases. We report a method for analyzing the visco-elastic properties of small tissue samples using magnetomotive OCT. Superparamagnetic nanoparticles (MNPs, ~20nm) are diffused into a tissue sample. Subsequently, an electromagnet is modulated with a chirped frequency waveform from 0-1kHz, providing a modulated force on the MNPs in the tissue. The mechanical response of the tissue is recorded using OCT at linears of 1-10kHz. Because OCT is a coherence imaging technique, sub-wavelength displacements are detected in the phase of the interferogram. The mechanical frequency response and associated phase lag fit a model for a damped harmonic oscillator, and results in homogeneous agarose cylinders can be interpreted in terms of Love’s solutions for longitudinal vibration modes. A rat mammary tumor biopsy was also analyzed with this technique during formaldehyde fixation, and a trend toward higher frequency correlates with stiffening of the tissue during the fixation process. In collaboration with Stephen Boppart, University of Illinois at Urbana-Champaign.

9:00AM BC.00002 Time-resolved Photoelectron Spectroscopy and the Photoprotective Properties of Adenine. NICK EVANS, University of Georgia, WILLIAM POTTER, AMANDA BRIQUILLETTE, SUSANNE ULLRICH, UGA — A system for fs time-resolved photoelectron and photon ion spectroscopy has recently been developed at the University of Georgia, Department of Physics and Astronomy, in order to study the photophysical properties of isolated biomolecular building blocks. Ultrafast electronic excited state deactivation processes are observed in these chromophores and contribute to their photostability under UV radiation. Time-resolved photoelectron spectroscopy (TRPES) provides a unique tool to investigate these processes as the two dimensional data comprises both spectral and dynamic information. The spectral data allows identification of participating electronically excited states while the dynamic data allows the states’ associated lifetimes to be extracted. Details of the experimental setup and technique will be presented in this talk as well as our initial results on the deactivation pathways in the DNA base adenine following excitation by wavelengths between 245 - 266 nm.

9:12AM BC.00003 High Throughput Magnetic Force System for Experiments in Polymer and Biological Physics.1, RICHARD SPERO, LEANDRA VICCI, JEREMY CRIBB, VINAY SWAMINATHAN, R. SUPERFINE. University of North Carolina at Chapel Hill — While technologies for micro- and nano-scale manipulation have expanded the fields of nano-mechanical and biological experimentation, these manipulation techniques are typically low-throughput. Techniques using microbeads (particles ~0.1 – 10μm) show promise for enabling high throughput mechanical measurements of these systems. We demonstrate instrumentaton to magnetically drive microbeads in a biocompatible, multi-well magnetic force system. It is based on commercial high throughput screening standards, and is scalable to 96 wells. The rheology of polymers and biomaterials can be studied, and cells can be cultured, in this Magnetic High Throughput System (MHTS). The MHTS can apply independently controlled forces to 16 specimen wells. Force calibrations demonstrate forces in excess of 1nN, predicted force saturation as a function of pole material, and powerlaw dependence of F ∼ r−1.4 ± 0.1. We also report our recent results in applying the MHTS to measure rheology of fibrin clots and cell mechanics.

1This work was supported by National Institute of Biomedical Imaging and Bioengineering grants P41-EB00205 and R01-EB000761.

9:24AM BC.00004 Observing ultrafast dynamics in gas-phase biomolecules.1, SUSANNE ULLRICH, N.L. EVANS, WILLIAM M. POTTER, University of Georgia — The UV photostability of biomolecules is determined by their excited state electronic relaxation mechanisms. To be effective, these mechanisms must operate on ultrafast timescales in order to dominate over competing photochemical processes that potentially lead to destruction of the biomolecule. Femtosecond time-resolved photoelectron spectroscopy (TRPES) provides unique capabilities for studying photoinduced processes in small polyatomic molecules. Changes in the PES, observed as the delay between the pump and probe pulses is scanned, can be potential lead to destruction of the biomolecule. Femtosecond time-resolved photoelectron spectroscopy (TRPES) provides unique capabilities for studying photoinduced processes in small polyatomic molecules. Changes in the PES, observed as the delay between the pump and probe pulses is scanned, can be associated with electronic configurational changes during the relaxation process. Analysis based on ionization correlations allows us to extract the electronic character of the excited states in addition to their lifetimes. TRPES has successfully been applied to the study of small biomolecular building blocks, such as the DNA base Adenine, however many challenges are faced when the interest in slightly larger biomolecular subunits, e.g. Adenosine. In this talk I will provide details on our newly constructed photoelectron photon spectrometer and discuss problems associated with evaporation of larger biomolecules.

1partial support of this research from ACS-PRF#44110-G6.

9:36AM BC.00005 Novel Bioreactors to Study Forces on Bronchial Epithelial Cultures. JEROME CARPENTER1, MIKE MILLARD, MATTHEW COZON, RICHARD SUPERFINE2. University of North Carolina at Chapel Hill, VIRTUAL LUNG GROUP TEAM — Studying cells in a physiologically relevant environment is an important tool in understanding cell signaling and gene expression. Human bronchial epithelial cells (HBECS) are responsible for mucociliary clearance, which removes pathogens from the air we breathe. Recreating the in vivo conditions of HBECS is difficult; they are polarized and undergo a variety of forces. Polarization is required for organ-specific systems such as cilia motility and mucus regulation. We achieve polarization by growing cells on an electropopor nanoporous scaffold which we attach to a silastic annulus. Using this geometry we apply vacuum to the annulus and stretch the cells. This bioreactor allows us to study polarized HBECS as they experience cyclic strain similar to breathing. We’ve grown polarized cultures on the scaffold and are evaluating the scaffold’s mechanical properties. In a second bioreactor, we place the scaffold into a microfluidics channel to study the affect of shear stress on polarized cells. We also reproduce the branching structure found in the lungs to investigate the regulation of mucus as it ascends the airway tree.

1Curriculum in Applied Science and Engineering
2Department of Physics and Astronomy
9:48AM BC.00006 Magnetically driven nanorod transport through Matrigel in vitro, LAMAR MAIR1, RICHARD SUPERFINE2. University of North Carolina at Chapel Hill — The dense mesh of interwoven collagen and laminin sheets found in the extracellular matrix (ECM) presents a significant barrier for efficient and widespread delivery of particle-bound therapeutic drugs within the volume of a tumor. We use templated electroporation as an inexpensive means to creating highly uniform, calibrated, magnetic nanorods with process-defined dimensions. Specifically, we grow Cu/Ni multilayered rods and selectively etch Cu regions, successfully creating Ni nanorods with diameters ranging from 55 to 250nm. Novel to the field of micro- and nano-carrier research is our ability to observe single particles move through the ECM as AC or DC magnetic field gradients are applied. Using a microscope fitted with an in-house designed high throughput rheometer capable of applying magnetic field gradients to microliter-sized volumes we test the effect aspect ratio has on the efficiency of particle transport through Matrigel, as well as how the parameters of time-varying fields affect transport.

1Curriculum in Applied and Materials Sciences
2Department of Physics and Astronomy

10:00AM BC.00007 Analysis of Folded Geometry for Organic Solar Cells1. ARIC MEYER, JAEWOOK SEOK, HARALD ADE, North Carolina State University — Organic solar cells promise efficient clean affordable energy due to their potential for low cost, ease of production, and flexibility. Unfortunately practical implementation is prevented by lower power conversion efficiencies and shorter device lifetimes compared to inorganic photovoltaics. Many techniques are being investigated to improve the efficiency of organic solar cells beyond current limits of 5-6%. Recent work has demonstrated that folding a flat organic solar cell can be an effective way to improve power conversion efficiency; however, efficiency gains range from 20-100% depending on the details of the system. This theoretical work details the parameters affecting potential gains from a folded geometry. Results include guidelines for predicting which materials and device structures stand to benefit most from folding, and showing that some materials which cannot reach high efficiencies in a planar geometry can be competitive when in a folded solar cell.

1This work was supported by the U.S. Department of Energy (DE-FG02-98ER45737).

10:12AM BC.00008 Free energy calculations of short peptide chains using Adaptively Biased Molecular Dynamics, VADZIM KARPUSENKA, VOLODYMYR BABIN, CHRISTOPHER ROLAND, CELESTE SAGUI, North Carolina State University, CENTER FOR HIGH PERFORMANCE SIMULATIONS (CHIPS) AND DEPARTMENT OF PHYSICS TEAM — We performed a computational study of monomer peptides composed of methionine, alanine, leucine, glutamate, lysine (all amino acids with a helix-forming propensities); and proline, glycine tyrosine, serine, arginine (which all have poor helix-forming propensities). The free energy landscapes as a function of the handedness and radius of gyration have been calculated using the recently introduced Adaptively Biased Molecular Dynamics (ABMD) method, combined with replica exchange, multiple walkers, and post-processing Umbrella Correction (UC). Minima that correspond to some of the left- and right-handed 3_{10}, \alpha- and \pi-helices were identified by secondary structure assignment methods (DSSP, Stride). The resulting free energy surface (FES) and the subsequent steered molecular dynamics (SMD) simulation results are in agreement with the empirical evidence of preferred secondary structures for the peptide chains considered.

Thursday, October 30, 2008 10:45AM - 12:45PM
Session CA Granular Physics Holiday Inn Brownstone Roosevelt

10:45AM CA.00001 Jamming in Granular Systems1. BRIAN UTTER, James Madison University — Granular materials exist all around us, from the formation of sand dunes and collapse of seemingly stable grain silos, to the mixing of pharmaceuticals and other industrial materials. The behavior of these “fluids” though poorly understood. Their flow can be characterized by the continuous forming and breaking of a strong force network resisting flow. This jamming/unjamming behavior is typical of a variety of systems, including granular flows, and is influenced by factors such as grain packing fraction, applied shear stress, and the random kinetic energy of the particles. We present experiments on quasi-static shear and free-surface granular flows under the influence of external vibrations. By using photoelastic grains, we are able to measure particle trajectories and the local force network in these 2D flows. We find that during shear, sufficient shaking weakens the strong force network and reduces the amount of flow driven by sidewalls. We vibrate either the driving wall (sidewall forcing) or the entire shearing zone (bulk forcing). For sidewall forcing, flow behavior is controlled by vibration amplitude in particular and slipping of force chains at the boundary. In a rotating drum geometry, we find that small vibration leads to strengthening of the pile while larger vibrations induce failure as might be expected. This behavior is strongly history dependent and sufficient vibration erases the memory of the pile.

1We gratefully acknowledge support from Research Corporation (Cottrell College Science Award No. CCT145/7260) and DOD ASSURE Grant # DMR-0353773.

11:15AM CA.00002 Dense dry granular material under pure shear and shear reversal1. JIE ZHANG, Duke University, Department of Physics — We have performed 2D granular experiments under pure shear using bidisperse photo-elastic disks. Starting from a stress free state, a square box filled with granular particles is subject to shear with the area fixed. The forward shears involved various number of steps, leading to maximum strains between 0.1 and 0.3. Reverse shear was then applied. Depending on the packing fraction and the strain, the force chain network built prior to the shear reversal may be destroyed completely or partially destroyed. If the reverse shear is continuously applied, there is a force chain strengthening. Following each change of the system, contact forces of individual disks were measured. We also kept track of the displacement and rotation of every particle. I will present the results for the structure failure and reconstruction during shear reversals. I will also present results from a physical experiment and a DEM simulation. Particular attention is paid to the deformation and dissipation within a class of particle clusters found to be confined to the shear band, each comprising of a buckled force chain segment and its laterally supporting neighbors. The predominant mode of contact failure in a force chain undergoing buckling, and in the contacts with and within its laterally supporting neighbors, is frictional rolling.

1This work is supported by ARO grant W911NF-07-1-0313-00.

11:45AM CA.00003 Experimental investigation of state variables in a dense granular layer, FREDERIC LECHENAULT, North Carolina State University — Stationary states in dense granular systems lack a predictable statistical description, as kinetic theory approaches fail when the interactions significantly deviate from binary collisions. In particular, because of the degeneracy of geometric states due to friction forces, it has been argued that a comprehensive theory of such dense granular systems must incorporate additional state variables associated with constraint fluctuations. We investigate the relevance of various ensembles in a dense mixture of disks laid on a horizontal air table and driven into steady states by random kicks at the boundaries. We study how microscopically defined intensive parameters affect the macroscopic response of the system, and clarify the equilibration properties of these parameters. In collaboration with Karen Daniels, North Carolina State University.
alkyl side chains of polymers with various backbones. At high film densities, an additional, local relaxation occurs. This relaxation, which has been previously
dependent dielectric spectroscopy has been used to study molecular motion within two dimensional alkylsiloxane SAMs. Highly disordered SAMs of varying
density were grown, with the intention of maximizing the motion within the films. A cooperative relaxation is observed in films with an alkyl chain length greater
examples of glassy materials, where density is explicitly controllable and molecule-molecule interactions can be tuned. In this study, sensitive, temperature
detectors are used in numerous low background assay systems, including the MAJORANA experiment, and spatial reconstruction of radiation sources could be
the experiment based on those signals. The triggers that are provided by a specially built set of "Track-Finder" processors include triggers based on single CSC
operation this autumn and which opens a window onto physics at the TeV energy scale. After many years of preparation, the CMS detectors and electronics
provide proton-proton collisions at a center-of-mass energy of 10 TeV in 2008, and 14 TeV thereafter. The Compact Muon Solenoid (CMS) experiment is a
general-purpose experiment with excellent particle identification capability that is able to capitalize on the rich physics program of the LHC. The installation
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general-purpose experiment with excellent particle identification capability that is able to capitalize on the rich physics program of the LHC. The installation
1Energy nucleus + nucleus collisions in order to extend our understanding of QCD and the novel properties of nuclear matter under extreme conditions. ALICE
is the dedicated general purpose heavy ion experiment at the LHC which will measure the properties of the hot, dense nuclear matter produced in Pb + Pb
collisions at √s = 5.5 TeV, p + p collisions at √s = 14 TeV, and other collision systems. We describe the rich ALICE program of physics objectives and
future prospects, discuss the status of this year’s inaugural run with p + p collisions at √s = 10 TeV, and discuss key aspects of the detector design including
those experimental contributions from institutes associated with the APS Southeastern Section.
1Research sponsored by the Office of Nuclear Physics, U.S. Department of Energy.
10:45AM CB.00004 Performance of the Level-1 Muon Trigger for the CMS Endcap Muon System with Cosmic Rays and First LHC Beams , JOSEPH GARTNER, University of Florida, CMS COLLABORATION — We report on the performance of the level-1 muon trigger for the cathode strip chambers (CSCs) comprising the endcaps of the Compact Muon Solenoid (CMS) experiment. CMS is a general-purpose experiment designed to capitalize on the rich physics program of the Large Hadron Collider (LHC), which begins operation this autumn and which opens a window onto physics at the TeV energy scale. After many years of preparation, the CMS detectors and electronics have undergone a series of commissioning exercises involving the triggering and data acquisition of signals induced from cosmic ray muons, and most recently, first LHC beams. Here we report on the successful synchronization of signals from the 468 CSCs in the level-1 trigger path, and the successful triggering of the experiment based on those signals. The triggers that are provided by a specially built set of "Track-Finder" processors include triggers based on single CSC segments, tracks based on a coincidence of segments along a predefined road emanating from the beam collision point, and tracks parallel to the beam line that accept accelerator-induced halo muons. Evidence of the proper functioning of these triggers will be reported.
12:27PM CB.00005 Spatial Reconstruction of Co-60 Radiation Sources Using Goodness-of-Fit Tests on Spectra Obtained from an HPGe Detector , LENNY EVANS, University of North Carolina at Chapel Hill — HPGe detectors are used in numerous low background assay systems, including the MAJORANA experiment, and spatial reconstruction of radiation sources could be used to locate unwanted backgrounds. The effect of the position of a Co-60 point source on the shape of spectra was observed in both Monte Carlo and HPGe detector measurements. Spectra taken with the radiation source placed at different points on the face and side of the detector were compared in peak areas and were compared using the Kolmogorov-Smirnov goodness-of-fit test. We will discuss the position reconstruction accuracy of this statistical method.

Thursday, October 30, 2008 10:45AM - 12:39PM –
Session CB Particle Physics: Large Hadron Collider
Holiday Inn Brownstone Washington

10:45AM CB.00001 The ATLAS Experiment at the CERN Large Hadron Collider , A.T. GOSHAW, Duke University — This year marks the culmination of the two decades of design and construction required to bring the Large Hadron Collider (LHC) and associated experiments into operation. The LHC will provide proton-proton collisions at energies far higher than other accelerators. Six experiments have been constructed to detect the particles produced from these proton-proton collisions, and these experiments will investigate the structure of matter at a new level of sensitivity. In this talk, I will describe the detector referred to as ATLAS and summarize its measurement capabilities. I will then review the potential of the ATLAS experiment for discovering new types of matter and additional forces beyond those described by the Standard Model of elementary particle physics.

11:15AM CB.00003 The Status and Prospects of the CMS Experiment at the LHC , DARIN ACOSTA, University of Florida — The start-up of the Large Hadron Collider (LHC) this autumn opens a window onto physics at the TeV energy scale, allowing for studies on the nature of electroweak symmetry breaking and possibly the discovery of new particles and symmetries. A popular extension of the Standard Model of particle physics is Supersymmetry, which proposes an entire new family of particles with opposite spin statistics to the known particles; but other proposals to solve some of the fine-tuning and ad hoc ingredients to the Standard Model include new gauge interactions and extra spatial dimensions. The LHC will provide proton-proton collisions at a center-of-mass energy of 10 TeV in 2008, and 14 TeV thereafter. The Compact Muon Solenoid (CMS) experiment is a general-purpose experiment with excellent particle identification capability that is able to capitalize on the rich physics program of the LHC. The installation of all major detector components is complete, and an extensive commissioning program with cosmic ray muons has taken place over the last year and will continue with first LHC beams. This report will review the current status of the experiment, the performance of its detectors, and the status and prospects for measurements and discoveries in the first year of LHC operations.

11:45AM CB.00004 The ALICE Experiment at CERN1 , KENNETH READ, Oak Ridge National Laboratory and University of Tennessee — The ALICE Experiment at the CERN Large Hadron Collider (LHC) is commencing a comprehensive program of measurements of high energy nucleus + nucleus collisions in order to extend our understanding of QCD and the novel properties of nuclear matter under extreme conditions. ALICE is the dedicated general purpose heavy ion experiment at the LHC which will measure the properties of the hot, dense nuclear matter produced in Pb + Pb collisions at √s = 5.5 TeV, p + p collisions at √s = 14 TeV, and other collision systems. We describe the rich ALICE program of physics objectives and future prospects, discuss the status of this year’s inaugural run with p + p collisions at √s = 10 TeV, and discuss key aspects of the detector design including those experimental contributions from institutes associated with the APS Southeastern Section.

Thursday, October 30, 2008 10:45AM - 12:45PM –
Session CC Materials I
Holiday Inn Brownstone Washington

10:45AM CC.00001 Dynamics of two dimensional alkylsiloxane self assembled monolayers1 , MARY SCOTT, DERRICK STEVENS, JASON BOCHINSKI, LAURA CLARKE, North Carolina State University Dept of Physics — Self assembled monolayers (SAMs) are commonly implemented as a method to easily and permanently modify surface properties. For many existing applications, SAMs are considered essentially static systems; however, motion within disordered SAMs is of interest to the thin film community, and such systems could be studied as simplified examples of grafted materials, where density is explicitly controllable and molecule-molecule interactions can be tuned. In this study, sensitive, temperature dependent dielectric spectroscopy has been used to study molecular motion within two dimensional alkylsiloxane SAMs. Highly disordered SAMs of varying density were grown, with the intention of maximizing the motion within the film. A cooperative relaxation is observed in films with an alkyl chain length greater than three carbons long. This interacting motion has similar dynamics to a previously reported polyethylene-like glass transition occurring in phase segregated alkyl side chains of polymers with various backbones. At high film densities, an additional, local relaxation occurs. This relaxation, which has been previously observed in three dimensional SAMs, is attributed to sub-chain rotation.

1NSF grant 04-03871
10:57AM CC.00002 Shockley-type Surface State Modification for Enantiopure vs. Racemic Tartaric Acid on Ag(111), NANCY SANTAGATA, PENGSHUN LUO, BRYCE DAVIS, THOMAS PEARL, North Carolina State University — Shockley-type surface states exist on several metal surfaces and are characterized by electron confinement by the vacuum barrier on one side and a band gap in the bulk on the other. We will report the observation of Shockley-type surface state energy shifts as a signature of adsorbate structure for tartaric acid (C4H6O6) on Ag(111). The adsorption of both enantiopure and racemic tartaric acid in the submonolayer regime was studied with low temperature scanning tunneling microscopy (STM) and spectroscopy (STS) and modeled with density functional theory (DFT). We find that the surface state, which is occupied on the clean Ag(111) surface (67 meV below the Fermi level), experiences a positive energy shift and becomes unoccupied after the adsorption of both forms of tartaric acid. The magnitude of the shift differs, however, for films composed of either enantiopure or racemic domains, and we attribute these relative shifts to unique adsorbate units. DFT is used to confirm the molecular-level adsorbate arrangements that lead to the experimentally observed behavior.

10:57AM CC.00003 Magnetic and magnetotransport properties of organic trilayers of alkanethiol self-assembled monolayers sandwiched between ferromagnetic thin films, WILLIAM RICE, PAUL HOERTZ, JEREMY NISKALA, JEFF HALLER, MIKE FENG, WEI YOU, FRANK TSUI, University of North Carolina at Chapel Hill — Magnetic and magnetotransport properties of organic spin valve structures have been studied. The organic trilayer spin valve structure consists of a self-assembled monolayer (SAM) of alkanethiol and a conducting polymer layer sandwiched between two ferromagnetic metal contacts, a Ni film as the bottom contact and a Co film as the top contact. Each trilayer is confined in a square well-like structure (approximately 40 microns across) surrounded by 500nm thick photoreisot to provide both electrical isolation and mechanical support for 4-terminal vertical transport measurements. The SAM was formed on the Ni surface on the bottom of the well. The conducting polymer layer was spin coated on top of the SAM prior to the deposition of the Co film. Magnetooptic Kerr Effect (MOKE) measurements show independent switching of the ferromagnetic layers at approximately 50 and 100 Gauss. Electrical transport measurements were carried out as a function of bias voltage, temperature and field, in order to explore spin-dependent transport through the organic interlayer.

11:10AM CC.00004 Advanced spectroscopy and imaging studies of multiferroicity in YMnO3 and BiFeO3, RELJA VASIC, MARC ULRICH, JACK ROWE, JERRY LUCOVSKY, JOSEPH FONTACUBERTA, XAVIER MARTI, JUREK SADOWSKI, HAI DONG ZHOU, JAMES BROOKS, CHRIS WIEBE, NCSU TEAM, CSIC COLLABORATION, NHMFL COLLABORATION — There has been recent research interest in a number of magnetic ferroelectrics, including YMnO3, a hexagonal perovskite that is antiferromagnetic [Neel temperature (TN) between 70 and 130 K] and ferroelectric [Curie temperature (TC) between 570 and 990 K] in the ground state and perovskite BiFeO3 which is ferroelectric (TC ~ 1103 K) and antiferromagnetic (TN ~ 643 K), exhibiting weak magnetism at room temperature due to a residual moment from a canted spin structure. These systems can be understood by competition between local interactions on several ion sites. We report synchrotron based spectroscopy and low-energy electron microscopy (LEEM) imaging studies of sample surface and bulk for magnetoelectric coupling and spin ordering in multiferroic heterostructures and single crystals. Preliminary results indicate the importance of oxygen vacancies in ferroic properties in thin films of YMnO3. Photoemission and x-ray absorption spectroscopy of electronic structure indicate relations between strain and crystallographic structure of epitaxial thin films grown on different substrates. The goal of this study is better understanding the interface effects and spin ordering in multiferroic heterostructures vs single crystals.

11:21AM CC.00006 Onset of ferrielectricity and the hidden nature of nanoscale polarization in ferroelectric thin films, MATIAS NUNEZ, MARCO BUONGIORNO NARDELLI, North Carolina State University — Using calculations from first principles we have elucidated the nanoscale organization and local polarization in ferroelectric thin films between metallic contacts. We discovered a ferrielectric pattern of polarization in what was originally thought to be a simple ferroelectric domain. Applying the layer polarization concept (Wu et al., Phys. Rev. Lett. 97, 107602 (2006)), we analyzed the polarization profile for different film thicknesses. The results (M. Nunez and M. B. Nardelli, Phys. Rev. Letters, to be published) unveil a peculiar spatial pattern where individual atomic layers acquire uncompensated opposing dipoles in what was originally thought to be a simple ferroelectric domain. This ferrielectric behavior arises as consequence of the complex energetic competition between the interface effects, the depolarization field, and the mutual interaction of the layer dipoles. Moreover, as the thickness of the film is varied, we show that the system undergoes a ferroelectric-to-ferrielectric phase transition at a critical thickness. These results are interpreted using a simple classical model where the interface effects are explicitly taken into account. We propose a method in order to carefully tune the spatial polarization pattern of the film (M. Nunez and M. B. Nardelli, Appl. Phys. Lett. 92, 1 (2008)).

11:33AM CC.00005 Magnetism of {Cr10Cu2}: A story of the interplay between experiment and theory, LARRY ENGELHARDT, Francis Marion University, Florence, SC — It is a common view that theoretical results are irrelevant without experimentation and experimental results cannot be understood without theories. However, it is often the case that research in physics falls strictly under the heading of “theory” or “experiment” with limited communication between the two. Our recent analysis of a particular magnetic molecule, {Cr10Cu2}, provides a striking example to the contrary: X-ray diffraction measurements allowed us to formulate a general theoretical model; magnetic susceptibility measurements were used to refine the model; the model provided low temperature predictions; these predictions were verified experimentally; certain features of these measurements provided additional new insights about the theory; in turn, the theory gave a better understanding of the experimental technique itself, and this led to additional predictions for future experiments. (Background information about each of the quantities that have been measured and/or calculated will be provided.)

11:45AM CC.00007 Shockley-type Surface State Modification for Enantiopure vs. Racemic Tartaric Acid on Ag(111), NANCY SANTAGATA, PENGSHUN LUO, BRYCE DAVIS, THOMAS PEARL, North Carolina State University — Shockley-type surface states exist on several metal surfaces and are characterized by electron confinement by the vacuum barrier on one side and a band gap in the bulk on the other. We will report the observation of Shockley-type surface state energy shifts as a signature of adsorbate structure for tartaric acid (C4H6O6) on Ag(111). The adsorption of both enantiopure and racemic tartaric acid in the submonolayer regime was studied with low temperature scanning tunneling microscopy (STM) and spectroscopy (STS) and modeled with density functional theory (DFT). We find that the surface state, which is occupied on the clean Ag(111) surface (67 meV below the Fermi level), experiences a positive energy shift and becomes unoccupied after the adsorption of both forms of tartaric acid. The magnitude of the shift differs, however, for films composed of either enantiopure or racemic domains, and we attribute these relative shifts to unique adsorbate units. DFT is used to confirm the molecular-level adsorbate arrangements that lead to the experimentally observed behavior.

11:57AM CC.00007 ABSTRACT WITHDRAWN —
12:21PM CC.00009 Epitaxial graphene growth on several SiC surface orientations at high and ultrahigh vacuum pressure. ANDREAS SANDIN, ZHENGANG WANG, XIANHUA KONG, J.E. (JACK) ROWE, NC State University — We use Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM) methods on several SiC surface orientations and have measured an Auger Electron Spectroscopy (AES) signature confirming the formation of graphene at high (∼10−7 torr) and ultrahigh (∼10−10 torr) vacuum pressure. In addition, low energy electron diffraction (LEED) and ex situ AFM have been used in situ to characterize the graphene layers. Sample preparation and characterization both in situ and ex situ is an important prerequisite for a uniform graphene film. A chemical mechanical polish of the initial SiC gives atomically flat surfaces with SiC bilayer-step heights. In situ direct current annealing at ∼900 C is performed to remove the native oxide and further prolonged annealing activates step flow growth of graphene on SiC. The decomposition of Si on bare SiC is shown to be more rapid at higher pressures possibly due to residual gases such as CO and H2O while having much less effect on the 6×6 root3 surface reconstruction due to its inert properties. AES is combined with STM to characterize the surface morphology combined with LEED to image surface graphene layer transformations. The half-cell stacking-fault symmetry appears to be preferred on the Si polar face as reported by others and gives the most uniform graphene growth.

12:33PM CC.00100 Epitaxial and stoichiometric effects on structural and chemical ordering in Heusler alloys. BRIAN A. COLLINS, LIANG HE, FRANK TSUI, University of North Carolina at Chapel Hill, YUNCHENG ZHONG, YONG S. CHU, Argonne National Laboratory — The Heusler alloys of Co2MnGe and Co2MnSi have been predicted to be half-metallic, where the minority spin density of states shows a gap at the Fermi Level. However, half-metallicity has not yet been realized owing to its expected sensitivity to atomic disorders associated with off-stoichiometry and epitaxial constraints. Combinatorial epitaxial films of Co2 MnGe and Co2 MnSi have been grown on Ge (111) substrates in and around the Heusler stoichiometry using molecular beam epitaxy. The structural and chemical ordering of the films has been examined using synchrotron x-ray microbeam techniques, including x-ray diffraction and energy dependent anomalous diffraction. A comprehensive model has been developed for anomalous diffraction, allowing for detection and quantification of various disorders even at small amounts, including site-dependent vacancies and elemental site swapping. The x-ray experiments reveal that the ordering is very sensitive to the Co:Mn atomic ratio and that epitaxial strain can cause a shift in the composition of highest structural ordering away from the Heusler stoichiometry, accompanied by increased chemical disorders. These findings have made it possible to explore spin dependent states as a function of structural and chemical ordering.

Session DA Forefront Materials Physics I Holiday Inn Brownstone Roosevelt

1:30PM DA.00001 Generation, Modulation and Electrical Detection of Spin Currents in Silicon in Lateral Transport†, BEREND JONKER, Naval Research Laboratory — The electron’s spin angular momentum is one of several alternative state variables under consideration on the International Technology Roadmap for Semiconductors. Electrical injection / transport of spin-polarized carriers is prerequisite for developing such an approach. While significant progress has been realized in GaAs, little has been made in Si. Electrical injection of spin-polarized electrons is demonstrated in Fe/AI2O3/Si (001) n-i-p structures by measuring the circular polarization of the electroluminescence (EL). The EL polarization tracks the Fe magnetization, confirming spin injection into the Si, and reflects Fe majority spin, consistent with the common delta-l symmetry of the Fe and Si bands. The Si spin polarization is at least 30% at 5K, with significant polarization extending to at least 125K. These results are confirmed in Fe/AI2O3/Si/AlGaAs/GaAs quantum well structures – the GaAs EL shows that spin injection occurs despite poor crystalline quality of Si epilayers on GaAs, the 0.3 eV Si/AlGaAs CB offset, and air exposure of the interfaces. Lateral transport structures and non-local detection techniques are used to create a pure spin current which flows separately from the spin-polarized charge current. This spin diffusion current is sensitive to the relative magnetizations of the injecting and detecting contacts, and can be modulated by a perpendicular magnetic field (Hanle effect) which causes precession in the transport channel. The generation of spin currents, coherent spin precession and electrical detection using magnetic tunnel barrier contacts and a simple lateral device geometry compatible with “back-end” silicon processing will facilitate development of silicon-based spintronic devices. Refs: Nature Physics 3, 542 (2007); Appl. Phys. Lett 91, 212109 (2007).

†This work was supported by ONR and core NRL programs.

2:00PM DA.00002 Mode locking of electron spin coherence in singly charged quantum dots, ALEXANDER EFROS, Naval Research Laboratory — Fast dephasing of electron spins in an ensemble of quantum dots is detrimental for applications in quantum-information processing. We show that dephasing can be overcome by using a periodic train of light pulses to synchronize the phases of the precessing spins, and demonstrate this effect in an ensemble of singly charged (In,Ga)As/GaAs quantum dots. A periodic train of circularly polarized light pulses from a mode-locked laser synchronizes the precession of the spins to the laser repetition rate, transferring the mode-locking into the spin system. The mode-locking technique allows us to measure the single-spin coherence time to be 3 microseconds, which is four orders of magnitude longer than the ensemble dephasing time of 400 picoseconds. The technique also offers the possibility of achieving all-optical coherent manipulation of spin ensembles, in which electron spins can be clocked by two trains of pump pulses with a fixed temporal delay. The nuclei in these experiments act constructively, leading to the nuclear-induced frequency-focusing effect, which moves the electron-spin precession into dephasing-free subspace.

2:30PM DA.00003 From computational materials science to nanoscale device physics, AVIK GHOSH, Dept. of Electrical and Computer Engineering, University of Virginia — I will outline formal, computational and device level challenges for modeling and simulation of nanoelectronic devices and systems. Formal challenges involve developing the basic equations for quantum transport in the presence of strong many-body correlations (Coulomb Blockade), incoherent scattering (phonons) and time-dependent effects at the nano-micro interface (hysteretic switching and random telegraph noise). Computational challenges involve translating these equations into quantitative, predictive models, particularly at surfaces and interfaces, where we need practical semi-empirical descriptions with transferable parameters to handle hybrid regions. In addition, we need multiscaling and embedding techniques to merge these models with more detailed “ab-initio” descriptions of chemically significant moieties. Finally, Device level challenges involve identifying fundamental limits of existing device paradigms, such as molecular FETs, as well as exploring novel device operational principles. I will touch upon the fundamental issues that arise in context of each challenge, and possible means of solving them. I will then apply these ideas to a specific device architecture, namely, an ordered array of quantum dots grown on the surface of a nanoscale silicon transistor. All of the challenges identified above manifest themselves prominently in this geometry that operates at the nano-micro interface. Specifically, I will discuss how the strongly correlated electrons in the nanoscale dots “talk” to their weakly interacting macroscopic counterparts, how the interfacial electronic structure captures both long-range band correlations and short-ranged chemical correlations, and how the tunable coupling with the localized dot degrees of freedom can lead to novel physics, such as the experimentally observed blocking and unblocking of a nanotube current by correlated interactions between multiple oxide traps.
3:00PM DA.00004 Temperature-dependent study of vibration and polymorphism of oligoacenes and their derivatives, ZHONGQIAO REN, LAURIE MCNEIL. Department of Physics and Astronomy, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599-3255, USA, CHRISTIAN KLOC, Nanyang Technological University, School of Materials Sciences and Engineering, Singapore — Raman measurements have been performed on a series of oligoacenes and their derivatives (anthracene, tetracene, pentacene and diphenyl-anthracene, rubrene) in a wide temperature range (50-300K). It has been observed that different phases co-exist in several of these crystals depending on sample preparation and history, and that transitions between polymorphs can be observed as a function of temperature. Comparisons among crystals with similar molecular structure will be made to clarify the changes in the inter- and intra-molecular modes as the structure changes with temperature. Simulated calculations of the inter-molecular modes between multiple molecules, and the intra-molecular modes of the isolated molecules will also be presented.

3:12PM DA.00005 Band Engineering in C/BN Nanoribbons and Stacks, JEFFREY MULLEN, MARCO BUONGIORNO NARDELLI, North Carolina State University — Using electronic structure calculations from first principles we have studied the electronic characteristics of graphene/BN sheets in planar “super-striped” and layered stacks geometries. Similarly to Hydrogen-terminated graphene nanoribbons, C/BN super-stripes and stacks show a variation of band gaps. Moreover, the bonding with BN introduces confinement effects that can be potentially exploited to enhance the electronic transport properties of these systems. We have characterized these effects by evaluating the band offsets and the electrostatic potential profile across the structures.

Thursday, October 30, 2008 1:30PM - 3:30PM
Session DB Forefront Astrophysics Holiday Inn Brownstone Washington

1:30PM DB.00001 Gamma-Ray Bursts and their jets, DAVIDE LAZZATI, NCSU — Gamma-Ray Bursts are the brightest explosions in the present universe. We observe them as brief flashes of high-energy photons appearing randomly in the sky, followed by a tail of longer wavelengths emission lasting several months. They are associated to the final evolutionary stages of massive stars, and are thought to be powered by the formation of a black hole of several solar masses. I will review their properties and discuss the results of numerical simulations of their outflows, the role of magnetic fields and the nature of their spectral evolution.

2:00PM DB.00002 The Skynet Robotic Telescope Network, DANEIL REICHERT, University of North Carolina — Over its first three years of operation, the Skynet Robotic Telescope Network has taken over 1 million images for approximately 20,000 users. To date the network consists of telescopes in Chile, North Carolina, Italy, Colorado, and California. I will describe Skynet and demo one of its telescopes.

2:30PM DB.00003 GRB Studies with GLAST, CHARLES MEEGAN, NASA/MSFC — The Gamma Ray Large Area Space Telescope (GLAST), launched on June 11, 2008, is NASA’s most recent observatory dedicated to gamma ray astronomy. GLAST comprises two science instruments, the Large Area Telescope (LAT) and the GLAST Burst Monitor (GBM). The LAT is a pair telescope with unprecedented sensitivity on the energy range from 30 MeV to >100 GeV. GBM is an array of 14 scintillation detectors that will observe GRBs in the 8 keV to 30 MeV energy band. I will describe the GLAST capabilities for GRB studies and show some early results.

3:00PM DB.00004 The Supernova-GRB Connection, ROGER CHEVALIER, University of Virginia — I will discuss the relation between supernovae and gamma-ray bursts, with an emphasis on nearby events.

Thursday, October 30, 2008 1:30PM - 3:18PM
Session DC Biophysics II Holiday Inn Brownstone Lincoln

1:30PM DC.00001 Dynamics of Individual cilia to external loading- A simple one dimensional picture, VINAY SWAMINATHAN, Curriculum in Applied Sciences and Engineering, UNC- Chapel Hill, DAVID HILL, Cystic Fibrosis/Pulmonary Research and Treatment Center, UNC- Chapel Hill, R. SUPERFINE, Department of Physics and Astronomy, UNC- Chapel Hill, THE VIRTUAL LUNG PROJECT TEAM — From being called the cellular janitors to swinging debauchers, cilia have captured the fascinations of researchers for over 200 years. In cystic fibrosis and chronic obstructive pulmonary disease where the cilia loses it’s function, the protective mucus layer in the lung thickens and mucociliary clearance breaks down, leading to an increased risk of lung infections. The mechanistic understanding of mucus clearance depends on a quantitative assessment of the axoneme dynamics and the maximum force the cilia are capable of generating and imparting to the mucus layer. Similar to the situation in molecular motors, detailed quantitative measurements of dynamics under applied load conditions are expected to be essential in developing predictive models. Based on our measurements of the dynamics of individual ciliary motion in the human bronchial epithelial cell under the application of an applied load, we present a simple one dimensional model for the axoneme dynamics and quantify the axoneme stiffness, the internal force generated by the axoneme, the stall force and show how the dynamics sheds insight on the time dependence of the internal force generation. The internal force generated by the axoneme is related to the ability of cilia to propel fluids and to their potential role in force sensing.

1:42PM DC.00002 Directed Fluid Transport with Biomimetic “Silia” Arrays, A.R. SHIELDS, B.A. EVANS, B.L. CARSTENS, M.R. FALVO, S. WASHBURN, R. SUPERFINE, Dept. of Physics - UNC - Chapel Hill — We present results on the long-range, directed fluid transport produced by the collective beating of arrays of biomimetic “silia.” Silia are arrays of free-standing nanorods roughly the size of biological cilia, which we fabricate from a polymer-magnetic nanoparticle composite material. With external permanent magnets we actuate our silia such that their motion mimics the beating of biological cilia. Biological cilia have evolved to produce microscale fluid transport and are increasingly being recognized as critical components in a wide range of biological systems. However, despite much effort cilia generated fluid flows remain an area of active study. In the last decade, cilia-driven fluid flow in the embryonic node of vertebrates has been implicated as the initial left-right symmetry breaking event in these embryos. With silia we generate directional fluid transport by mimicking the tilted conical beating of these nodal cilia and seek to answer open questions about the nature of particle advection in such a system. By seeding fluorescent microparticles into the fluid we have noted the existence of two distinct flow regimes. The fluid flow is directional and coherent above the tips of the silia, while between the silia tips and floor particle motion is complicated and suggestive of chaotic advection.
2:54PM DC.00003 A Novel Silicone-Magnetite Composite Material Used in the Fabrication of Biomimetic Cilia. B.L. CARSTENS, Department of Physics and Astronomy, University of North Carolina at Chapel Hill, B.A. EVANS, Department of Physics, Elon University, A.R. SHIELDS, Department of Physics and Astronomy, University of North Carolina at Chapel Hill, J. SU, North Carolina School of Science and Mathematics, S. WASHBURN, M.R. FALVO, R. SUPERFINE, Department of Physics and Astronomy, University of North Carolina at Chapel Hill — We have developed a novel polymer-magnetite composite that we use to fabricate arrays of magnetically actuable biomimetic cilia. Biomimetic cilia are flexible nanorods 750 nm in diameter and 25 microns tall. They generate fluid flows similar to those produced by biological cilia. Polymer-magnetic nanoparticle materials such as ours are becoming increasingly useful in biomedical applications and microelectromechanical systems (MEMS). Comprised of magnetite (Fe3O4), the nanoparticles have a diameter of 5-7 nm and are complexed with a silicone copolymer and crosslinked into a flexible, magnetic solid. Amine groups make up 6-7 percent of the silicone copolymer, providing a simple means of functionalization. We present a detailed mechanical and magnetic analysis of our bulk crosslinked material. The high-aspect ratio biomimetic cilia we create with this magnetite-copolymer complex may have applications in microfluidic mixing, biofouling, and MEMS.

2:06PM DC.00004 In-situ AFM measurement of single fibrin fiber stiffness before and after addition of Factor XIII. JOHN HOUSER, E. TIMOTHY O’BRIEN, Department of Physics and Astronomy, University of North Carolina at Chapel Hill, SUSAN T. LORD, Department of Pathology and Laboratory Medicine, University of North Carolina at Chapel Hill, RICHARD SUPERFINE, MICHAEL R. FALVO, Department of Physics and Astronomy, University of North Carolina at Chapel Hill — Fibrin fibers are the main structural component of blood clots. Ligation of fibrin by native Factor XIII (FXIII) serves to fine tune the mechanical properties of the clot. Mechanical alteration is important because a clot must be stiff enough to resist forces from blood flow but compliant enough to prevent embolism (fracture). Cone and Plate measurements of fibrin gels, which represent the vast majority of mechanical measurements on fibrin, show that FXIII increases clot stiffness. More recently, measurements on individual fibrin fibers show that they exhibit remarkable extensibility, breaking at strains up to 300%. As of yet, the origin of this extensibility is not fully understood. The different responses of ligated and unligated fibrin fibers can give us clues as to it’s mechanism of extension. We use a combined fluorescence/atomic force microscopy setup to measure the mechanical properties of fibrin fibers. We found up to a 3.5-fold increase in fiber stiffness after addition of FXIII. We also show stiffening of individual fibrin fibers after crosslinking by gluteraldehyde.

2:18PM DC.00005 The role of single fiber strain stiffening in fibrin networks1. NATHAN HUDSON, UNC-CH Department of Physics and Astronomy, DANIEL MILLARD, Department of Biomedical Engineering at Georgia Tech University, JOHN HOUSER, E. TIMOTHY O’BRIEN, UNC-CH Department of Physics and Astronomy, SUSAN LORD, UNC-CH Department of Pathology and Laboratory Medicine, RICHARD SUPERFINE, MICHAEL R. FALVO, UNC-CH Department of Physics and Astronomy — The mechanical properties of fibrin networks, the primary structural component of blood clots, are of great interest both from a biophysics and biomedical perspective. We take a novel approach to studying fibrin network mechanical properties using a combination fluorescence/atomic force microscope system to quantitatively manipulate and visualize the network. Many biological gels exhibit non-linear elasticity known as strain stiffening, but the origins of this behavior are not well understood. We hypothesized that the strain stiffening of individual fibers plays a role in the response of the overall network, and the data indicate that some of the individual fibers within a network do strain stiffen and distribute strain to less strained fiber segments. Each network pulled was also compared to a linear spring model of the same geometry. Preliminary analysis showing a difference between the strain distributions in the model and the actual network will be presented.

2:30PM DC.00006 Observation of molecular rings formed from DNA deposited on Au(111). PENGSHUN LUO, Department of Physics, North Carolina State University, MICHAEL S. WOODY, Department of Physics and Astronomy, University of North Carolina, Chapel Hill, NORMAN L. BEEMELMANS, Department of Chemistry, North Carolina State University, THOMAS P. PEARL, Department of Physics, North Carolina State University — Beside its biological functions, DNA has been used as a building block for biological sensors and a template for electronic nanostructures. These applications require a deep understanding of how DNA molecules organize on particular surfaces as well as the electronic properties of an individual DNA molecule. Using scanning tunneling microscopy (STM) and atomic force microscopy (AFM), we have successfully characterized DNA deposited on Au(111) of various strand lengths and sequences. Here we report the observation of ring-like structures formed on the Au(111) surface by adsorption of 45 bp long, double stranded DNA. To understand the nature of these structures, deposition parameters such as DNA concentration, exposure time, and buffer solution were varied. In an attempt to gain more insight into the structures, a computer model was constructed based on electrostatic interaction between the DNA molecules. This model provides additional information about the composition and formation mechanisms of the ring structures.

2:42PM DC.00007 An investigation of the structural transitions between different forms of DNA using the Adaptively Biased (ABMD) and Steered Molecular Dynamics Methods. MAHMoud MORADI, VOLODYMyr BABBIN, CHRISTOPHER ROLAND, CHIPS and Department of Physics, North Carolina State University, THOMAS A. DARDEN, National Institute of Environmental Health Sciences (NIEHS), CELESTE SAGUI, CHIPS and Department of Physics, North Carolina State University — Left-handed A-DNA and B-DNA along with right-handed Z-DNA, are believed to be the three main biologically active double-helix structures associated with DNA. The free energy differences associated with the A to B-DNA, and B to Z-DNA transitions in an implicit solvent environment have been investigated using the recently developed Adaptively Biased Molecular Dynamics (ABMD) method, with the RMSD as the collective variable associated with the former transition, and handedness and radius of gyration as the collective variables associated with the latter. The ABMD method belongs to the general category of umbrella sampling methods with a time-dependent potential — when combined with replica exchange, multiple walkers and umbrella correction runs — allows for the efficient and accurate determination of the free energy maps. In turn, these free energy maps allow for an estimation of the transition pathways and barriers connecting the different helical structures, which are discussed for polyproline in vacuo, in implicit water, and the organic solvents hexane and propanol.
3:06PM DC.00009 Stochastic energetics of a Brownian motor driven by position dependent temperature\textsuperscript{1}, RONALD BENJAMIN, RYOICHI KAWAI, University of Alabama at Birmingham — We study the energetics of a Brownian motor driven by position dependent temperature, also known as the Büttiker-Landauer motor. Overdamped models fail to predict the energetics when temperature is spatially inhomogeneous. Its found that the irreversible heat transfer via kinetic energy diverges as $\sqrt{\gamma}$ (M being the mass of the Brownian particle) and cannot be accounted for by the overdamped model. The motor can never attain Carnot efficiency as evidenced by our results obtained from numerical solution of the Langevin equation and first principles molecular dynamics simulation. We also show that the motor can be converted into a refrigerator and find that the Coefficient of Performance (COP) of the refrigerator is far below the Carnot COP. Onsager symmetry relationship which links the motor to the refrigerator is confirmed in the presence of inhomogeneous temperature. Mechanisms to enhance the motor efficiency and refrigerator COP are also discussed.

\textsuperscript{1}I would like to acknowledge financial support from the Graduate Assistantship Fellowship Program of the University of Alabama at Birmingham.

Thursday, October 30, 2008 3:45PM - 5:45PM – Session EA Nuclear Physics I Holiday Inn Brownstone Roosevelt

3:45PM EA.00001 Measurement of the \textsuperscript{3}H(n,np)n Cross Section in the SCRE Configuration\textsuperscript{1}, A. COUTURE, T. CLEGG, UNC-Chapel Hill, B. COWE, D. MARKOFF, L. CUMBERBATCH, NCCU, C. HOWELL, A. COWELL, J. ESTERLINE, B. FALLIN, Duke, R. PEDRONI, NCA&T — To try to understand differences between earlier measurements and theoretical predictions, we are currently measuring the \textsuperscript{3}H(n,np)n cross section at both 19 and 16 MeV in the Symmetric Constant Relative Energy (SCRE) configuration \textsuperscript{1}. In the neutron-deuteron (nd) breakup reaction, the SCRE configuration occurs when, in the center of mass frame, the three outgoing nucleons all have the same energy and their final momenta all lie in the same plane separated by 120 degrees. We are measuring two special cases of this configuration; one where the plane contains the incident beam, another where the plane is perpendicular to the incident beam. The neutron beam is produced by the \textsuperscript{2}H(d,n)\textsuperscript{3}He reaction. The breakup reaction target consists of a CD\textsubscript{2} foil located in a scattering chamber with two charged particle detection arms, each containing an E-ΔE telescope. We are detecting the proton and one of the neutrons in coincidence. Experimental details and the status of our experimental measurements will be described. \textsuperscript{[1]} W. Glockle, et al., Physics Reports 274 (1996) 107.

\textsuperscript{1}Work partially supported by US DOE Grants No. DE-FG02-97ER41033 and DE-FG02-97ER41041.

3:57PM EA.00002 An Investigation of the \textsuperscript{48}Ca(γ,n) Cross Section between 9.5 and 15.3 MeV\textsuperscript{1}, J.R. TOMPKINS, C.W. ARNOLD, H.J. KARWOWSKI, G. RICH, UNC-Chapel Hill and Triangle U. Nuclear Lab (TUNL), L.G. SOBOTKA, Washington U., C.R. HOWELL, Duke U. and TUNL — A 2.7 g \textsuperscript{48}Ca target enriched to 92.4% was probed using an incident γ-ray beam of ∼2% energy resolution generated at the TUNL High Intensity γ-Ray Source (HIγS). Prior to the experiment, no direct measurements had been made using a quasi-monoenergetic γ-ray beam. Cross sections for the (γ,n) reaction, normalized to the known D(γ,n) reaction cross sections, were measured to a precision of less than ±6% at 34 different energies between 9.5 and 15.3 MeV using a \textsuperscript{3}He proportional counter for neutron detection. The γ-ray energies span the region from the neutron emission threshold, across previously identified M1 strength, and up the low-energy edge of the E1 Giant Dipole Resonance. Neutron emission dominates the region though a few excited states in the daughter nucleus are populated. The experimental data will be presented as will the initial interpretation of this excitation function.

\textsuperscript{1}This work was supported in part by USDOE Grant #’s DE-FG52-06NA26155 and DE-FG02-87ER-40316 as well as NSF/DHS Grant # CBET-0736123.


4:09PM EA.00003 Experience with the UNC Polarized \textsuperscript{3}He Target\textsuperscript{1}, TIMOTHY DANIELS, THOMAS CLEGG, ALEX COUTURE, CHARLES ARNOLD, University of North Carolina at Chapel Hill and Triangle Universities Nuclear Laboratory — We discuss our experience with the UNC polarized \textsuperscript{3}He target\textsuperscript{[2]} to collect for p+\textsuperscript{3}He spin-correlation coefficients below 6 MeV. The use of a compact, enclosed external polarizer was convenient in a general-purpose accelerator target room, but made optimization and improvement difficult. The target initially used spin-exchange with Rb to achieve ∼30% polarization in 24hr with a T1 of 36hr, before the original optical pumping cell was destroyed. The wide variation in performance, both individually and over time, of the 10 replacement cells we fabricated included the deterioration of T1 in individual cases after optical pumping and reversing the magnetic holding field, but no clear difference between GE-180 and Pyrex cells. The best replacement cell yielded ∼20% polarization with a 15hr T1. Cells using a mixture of Rb and K gave similar results\textsuperscript{[3]} though they reached saturation polarization in ∼12hrs. A frequency-narrowed 30W diode laser\textsuperscript{[4]} produced similar results to those of the 60W broadband diode laser.

\textsuperscript{1}Work supported in part by USDOE grant #DE-FG02-97ER41041.


4:21PM EA.00004 The β decays of \textsuperscript{75,77}Cu\textsuperscript{1}, S.V. ILYUSHKIN, J.A. WINGER, Miss. St., K.P. RYKACZEWSKI, C.J. CROSS, D. STRACENER, ORNL, R. GRZYWACZ, S.N. LIDDICK, I. DARBY, S. PADGETT, U. Tenn., J.C. BATCHELDER, UNIRIB, E.F. ZGANJAR, LSU — The newly designed Low-energy Radioactive Ion Beam Spectroscopy Station (LeRIBSS) at the HRIBF was implemented in order to study properties of neutron-rich nuclei. Isotopes of interest are produced by proton-induced fission in a uranium carbide target. Ions are separated using the high-resolution injector magnet and delivered to LeRIBSS, which consists of a universal detector support and a new fast moving tape collector. Using negative ions and adjusting the high-resolution magnet slits and field allowed us to obtain high purity beams with good rate. In particular a rate of about 3000 pps was reached for \textsuperscript{75}Cu. Results of beta and beta-delayed neutron decay studies of \textsuperscript{75,77}Cu will be discussed. Funded by DOE grant DE-FG02- 96ER41006.

\textsuperscript{1}This work supported by NASA Grant NNX08AM65A

4:33PM EA.00005 Nuclear Fragmentation Model Evaluation\textsuperscript{1}, RYAN NORMAN, University of Tennessee-Knoxville, STEVE BLATTNIG, NASA Langley Research Center — The semiempirical nuclear abrasion-ablation model NUCFRG2 was recently updated to include the qualitative even-odd effect for fragment charge production seen in experiments and the addition of alpha cluster knockout. In this talk, we present a comparison of the updated NUCFRG2 model cross sections with recent experimental cross sections and give a discussion of the results.

\textsuperscript{1}This work supported by NASA Grant NNX08AM65A
4:45PM EA.00006 Light Ion Production Improvements in the NUCFRG2 Semiempirical Nuclear Fragmentation Model: Preliminary Results†, SIRIKUL SIRPRISAN, RYAN NORMAN, LAWRENCE TOWNSEND, University of Tennessee — The nuclear interaction model used in the space radiation transport/shielding codes developed at NASA Langley Research Center is the NUCFRG2 semiempirical model. Previous versions of this model used simple approximations to generate yields of light ion fragments (Z = 1.2). In an attempt to improve the accuracy of the light ion yields, a coalescence formalism is incorporated into NUCFRG2. In this work, the modifications to the NUCFRG2 model are described and preliminary results for light ion yields presented.

†Research support from NASA Langley Research Center is gratefully acknowledged.

4:57PM EA.00007 Modeling and Design of a Gadolinium Based Neutron Detector†, DAVID TICHERY, JEROMY TOMPKINS, HUGON KARWOWSKI, UNC-Chapel Hill — The goal is to measure the partial cross sections for (γ, xn) and (γ, f) on the actinides with the ultimate objective of developing and refining a method for the γ-ray interrogation of fissionable material. These measurements require the construction of a highly segmented neutron detector to record multiple neutrons emitted following photodisintegration and fission. Each detector segment will use a gadolinium-loaded liquid organic scintillator optically coupled to a photomultiplier tube. Gadolinium has one of the highest thermal neutron capture cross sections (49 keV), therefore its presence in the detector will greatly enhance neutron detection efficiency. A prototype detector of 3 L volume has been constructed and modeled using Geant4, a Monte Carlo based program‡. The detector model and conclusions developed from it along with the results from testing the prototype detector will be presented.

†This work was supported in part by USDOE Grant No. DE-FG52-06NA26155 and NSF/DHS Grant No. CBET-0736123.

5:09PM EA.00008 Isotopic shifts in light Kr nuclei and evidence of N=36 magicity near the rp-process path, J.K. SHARMA, Physics Department, St. Johns College, Agra-282002, India, M.M. SHARMA, Physics Department, Kuwait University, Kuwait 13060 — Neutron-deficient Kr isotopes play an important role in the rp-process nucleosynthesis. The isotope 72Kr has been described variously as a waiting-point nucleus. We have examined the experimental data on isotopic shifts in light Kr nuclei close to the proton drip line within the framework of the relativistic mean-field theory. Using the Lagrangian model with the vector self-coupling of neu meson, it is shown that 72Kr is oblate in its ground-state, which exhibits a shape-coexistence with a prolate shape. It is shown that the negative isotopic shift for 72Kr provides an evidence for a neutron shell closure at N = 36. This is affirmed by the presence of a shell gap in the single-particle spectrum in the deformed space. This lends credence to the isotope 72Kr as being a waiting-point nucleus in the rp-process path.


5:21PM EA.00009 High Spin States in \(^{139,140,142}\text{Cs}\), SHAOHUA LIU, J.H. HAMILTON, A.V. RAMAYYA, J.K. HWANG, Vanderbilt University, Y.X. LUO, J.O. RASMUSSEN, Lawrence Berkeley National Laboratory, S.J. ZHU, Tsinghua University — The high spin excited states of neutron-rich nuclei \(^{139,140,142}\text{Cs}\) are investigated from a study of the prompt γ rays emitted in spontaneous fission of \(^{252}\text{Cf}\) with the Gammasphere detector array. Eight new γ transitions and a new side band in \(^{139}\text{Cs}\) are observed here. Seven new γ transitions, involving two new levels at lower spins and one at high spins, in \(^{140}\text{Cs}\) are identified. The level scheme of \(^{140}\text{Cs}\) is rebuilt and eleven new γ transitions, one new side band and four low energy transitions in \(^{142}\text{Cs}\) are observed here. Angular correlation measurements are planned to confirm or assign the spins of levels in these three nuclei. Theoretical calculations are needed to interpret the new spin excitations of \(^{140,142}\text{Cs}\).

5:33PM EA.00010 Nonlinear Tunneling and Nuclear Decay, CHRISTA LABADORF, EUGENE CHAFFIN, Bob Jones University — Recent astrophysical data have indicated a possible variation of the proton-electron mass ratio \(\mu = m_p/m_e\). Attributing the variation to a change in the strength of the nuclear force, we take into account nonlinear interactions, such as those originally proposed in 1955 by Johnson and Teller, and examine the resulting change in nuclear half lives. Our Mathematica calculations show the effect of the nonlinear terms by solving the three-dimensional nonlinear Schrödinger equation in a model applied to a typical nucleus. We match the radial wavefunction and its derivative for the interior of the nucleus to the Coulomb wavefunctions on the exterior of the nucleus in a generalization of the procedure originally used by Pieronne and Marquez, 1978, but without the nonlinear interactions. The results indicate that the nonlinear interactions, in cases where the number of nodes in the radial wavefunction is poised on a change from one value to another, can cause a large change in half-life for a small change in the strength of the nuclear force.

Thursday, October 30, 2008 3:45PM - 5:45PM – Session EB Forefront Atmospheric Physics and Geophysics Holiday Inn Brownstone Washington

3:45PM EB.00001 NOAA Interdisciplinary Scientific Environmental Technology Cooperative Science Center†, SOLOMON BILILIGN, North Carolina A&T State University — ISETCSC is led by North Carolina Agricultural & Technical State University in collaboration with thirty one scientists and engineers in nine academic departments in seven academic partnering institutions. The focus of the ISET Cooperative Science Center (ISETCSC) is to conduct research on sensor science and sensor technology for oceanic and atmospheric applications; perform analysis of global observing systems that include numerical and physical research and analysis of hurricanes; and, develop information technology tools for data fusion, data mining and geospatial modeling and analysis. In collaboration with Keith Schimmel and Abdollah Homaiifar, North Carolina A&T State University; Frederick Semazzi, North Carolina State University; and Samir Ahmed, City University of New York.

†This work is supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.
4:15PM EB.00002 Recent Advances and Future Challenges in Hurricane Prediction, YUH-LANG LIN, N.C. A&T State University — Recent advances and future challenges in hurricane prediction reviewed. More skillful hurricane prediction is needed due to the societal impacts, which include a high percentage of population living along coastal areas, costly evacuation, evacuation numbers depending on hurricane size and intensity, and the effects of global warming. In order to make skillful hurricane prediction, one has to understand the origin of hurricanes, such as that the precursors of eastern Atlantic major hurricanes are originated from African easterly waves and the embedded mesoscale convective systems over the Eastern tropical Atlantic. In this paper, we review the recent advances in hurricane forecast, numerical weather prediction techniques, models used for hurricane prediction, hurricane track prediction, hurricane intensity and rainfall prediction, and seasonal hurricane forecast. Finally, the potential impacts of global warming on hurricane frequency and intensity are discussed. This work is supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.

4:45PM EB.00003 Simulation of the Climate of Africa Based on the Hydrodynamical System of Equations Governing Atmospheric Flow, FREDERICK SEMAZZI, North Carolina State University — Application of the laws of physics is the cornerstone in the development of computer simulation models used for the study and prediction of climate. They involve application of the laws of thermodynamics, fluid dynamics, acoustics, and optics physics, among others. The typical basic formulation of climate models consists of a closed system of time-dependant non-linear partial differential equations, discretized with appropriate numerical forms, executed on high powered gigaflop computer systems, and supported by terabyte disk storage systems. Specific application of a climate computer simulation model and prediction of recent record drought conditions in Africa is discussed. Climatic and hydrologic projection results for the year 2071 through 2100 derived from the computer model show that regional climate will be warmer except for a few areas and major rainfall shifts are expected to occur. As a consequence the levels of large lakes in Eastern Africa will increase. In particular Lake Victoria (source of the Nile) is projected to increase in height by 2 meters thus increasing the potential for hydroelectric power generation for domestic and industrial consumption. These results will contribute to improved planning and management of multi-billion dollar climate-sensitive social-economic functions in Africa.

5:15PM EB.00004 Research and career opportunities in the geophysical sciences for physics students, ANDREW NYBLADE, Penn State University — The field of geophysics involves using most branches of physics to investigate the physical structure and process that characterize the solid and fluid parts of our planet. Major advances in geophysics have come about from physicists crossing disciplinary boundaries and using their skills and knowledge to address first-order problems about the nature and structure of our planet and how the planet has changed over time. Indeed, some of the largest scientific breakthroughs in geophysics have come from physicists. As a way to introduce students to the field of geophysics and to provide them with information about research and career opportunities in geophysics, this talk will focus on one area of geophysics, seismology. This is an area of geophysics that has not only been instrumental in advancing our understanding of solid Earth structure and processes, but one that also has an applied side used for oil, gas and mineral exploration, as well as for environmental work. Examples of research projects involving seismic wave propagation and tomographic imaging will be presented, along the short descriptions of career opportunities in industry, government and academic institutions. In collaboration with Solomon Billign, North Carolina A&T State University.

Thursday, October 30, 2008 3:45PM - 5:57PM
Session EC Applied Physics I Holiday Inn Brownstone Lincoln

3:45PM EC.00001 Information Extraction from Congested Molecular Spectra by Modulation Spectroscopy, MOHAMMAD KHAN, KARAN MOHAN, AMIN DHARAMSI, Old Dominion University — Wavelength Modulation Spectroscopy (WMS) of molecular species is quantified utilizing concepts of entropy and information content. The optimal harmonic detection order (i.e. the one for which maximum information can be extracted, in a noise environment) is found by theoretical considerations and then verified by experiment. The method developed, which can be used for precise measurements of molecular collision dynamics encoded in the absorption lineshape profile, is applied to resolution of very weak (spin-forbidden, magnetic dipole driven) overlapping lines of disparate oscillator strengths in molecular Oxygen A-Band. The complexity of the structure (turning points and zero crossings) of WMS provides an ultra sensitive probe, sensitive to small perturbations in the lineshape profile. For particular experimental limitations and noise environments, finite amounts of information can be transmitted by the probe interacting with the information source (the lineshape) to the detection apparatus. This information reaches a maximum value at an optimum detection order. The theory developed is applied to experimental measurements of four overlapping transitions in Oxygen A-band. It is shown that detection at harmonics greater than the commonly-used second are optimal in this case.

3:57PM EC.00002 Regimes of resonance Raman utility: studies in diluted liquid benzene, CHRISTOPHER CHADWICK, HANS HALLEN, North Carolina State University, ADAM WILLITSFORD, C. RUSSELL PHILBRICK, Pennsylvania State University — Resonance Raman yields huge increases in cross section as the excitation laser is tuned through an absorption band. Unfortunately, the measured signal levels do not always correspondingly increase. We use a tunable laser source to investigate this phenomenon with three different concentrations of liquid benzene in heptane as well as pure liquid benzene. Resonant Raman signal enhancement yields a significant signal output even as the number of scattering agents is reduced. The enhancement gains of the signal to noise for resonant Raman can be applied to enable spectrographic information where the signal level of non-resonant Raman is not measurable. While Raman scattering intensities are largely dependent on the number of scattering agents in the non-resonant case, when probing electronic absorption features in a species with the excitation light, enhancement yields a significant signal output even as the number of scattering agents is reduced. The enhancement gains of the signal to noise for resonant probing are superior in low concentrations and tiny interaction volumes. This enhancement characteristic has broad application for materials identification in trace species such as remote sensing and tiny sampling volumes such as near-field optical microscopy.

4:09PM EC.00003 EPR Study of SiC Defects Related to Device Processing, SARAH THOMAS, MARY ELLEN ZVANUT, University of Alabama at Birmingham — SiC is a promising replacement for Si in future high power, high temperature electronic devices. The surface of SiC is particularly important to MOSFETs, where the active region is on the surface. Previous research, which used electron paramagnetic resonance (EPR) spectroscopy to study electronically active defects in SiC, suggested that a defect, likely a broken C-Si bond, was created by oxidation. Our research focuses on identifying the cause and location of defects in as-grown SiC substrates using EPR. Samples underwent isochronal anneals from 400 to 1000 °C in high purity dry (0.9 ppm) N2 and O2. Room temperature EPR spectra showed two signals, one broad (10 G) and one narrow (4 G). Because the results from the N2 and O2 anneals were similar, we conclude that the defects are not affected by the reaction with oxygen. That the heat of annealing decreases the broad EPR signal suggests the defect is removed, rather than passivated. During the talk we will discuss the heat treatment results, as well as the location of the defects, as discovered through reactive ion etching and forming gas anneals.
The adhesion of Au on polymer surfaces is weak because of the inert nature of Au and the non-polarity of the hydrocarbon surface of the polymer. We seek to fabricate multifunctional devices in which vacuum deposited gold thin films will be used in electrical contacts and optical reflectors.

4:45PM EC.00006 Characterization of polar molecular species adsorbed on LiNbO$_3$ surfaces$^1$

SATAYAVEDA BHARATH$^2$, THOMAS PEARL$^3$, North Carolina State University — In order to explore the mechanisms of adsorption on ferroelectric surfaces, single crystalline lithium niobate (LiNbO$_3$; LN), ‘Z-cut’ along the (0001) plane, has been prepared and characterized and subsequently exposed to a polar molecule. 4-n-octyl-4′-cyanobiphenyl (8CB) liquid crystal was chosen as our model system. Low-energy electron diffraction, atomic force microscopy, surface contact angle measurement, and X-ray photoelectron spectroscopy were used to characterize the surface of LN as well as the nature of the films grown on the surface. Atomiically flat LN surfaces were prepared as a support for monolayer thick, 8CB molecular domains. Preferential attachment for positive domains was indicated by ellipsometry, and X-ray photoelectron spectroscopy were used to characterize the surface of LN as well as the nature of the films grown on the surface. As the pH of the solution was increased, the 8CB molecules were preferentially adsorbed on the LN surface.

4:57PM EC.00007 Sequestration and selective oxidation of carbon monoxide on graphene edges

SUJATA PAUL, NC State University, ERIK E. SANTISO, MIT, MARCO B. NARDELLI, NC State University — The versatility of carbon nanostructures makes them attractive as possible catalytic materials, as they can be synthesized in various shapes and chemically modified by doping, functionalization, and the creation of defects in the nanostructure. In this work, we consider the carbon-mediated partial sequestration and selective oxidation of carbon monoxide (CO), an important problem in environmental chemistry and energy conversion. Using first principle calculations we study the key reactions of CO with the various surfaces, including the suspender, in constant contact with each other during growth through gas-phase diffusion, and that deposition occurs via a precursor that involves both Ga and P. We propose a model for GaP growth based on the formation mechanism of this precursor.
5:33PM EC.00010 Multimedia ellipsometry of (aminomethylaminoethyl)phenethyltrimethoxysilane (PEDA) layers. JEREMY PETERS, HANS HALLEN, NC State University — A novel ellipsometric characterization method is described for determining the layer thickness and refractive index of substrates functionalized using (aminomethylaminoethyl)phenethyltrimethoxysilane (PEDA) self assembled monolayers (SAMs). Since traditional ellipsometry cannot independently determine the thickness and index of very thin layers, we have developed an ellipsometric apparatus that measures films in liquid solvents, and an analytical procedure that combines the two parameters three-layer models in these solvent media to enable measurement of both values. Two types of ellipsometry analysis procedures are shown. We illustrate an analysis of thin layer deposition on a simple substrate using PEDA on Si growth vs. time and solution. For more complex substrates, which require measurement before and after SAM layer growth, we show results for a PEDA/oxide/Si multilayer system. Since the refractive index of the layer is a function of the density of the molecules on the substrate, multimedia ellipsometry can determine whether the changes of the ellipsometric parameters are due to density or overgrowth effects.

5:45PM EC.00011 Optimization of a Prototype Atomic Clock Based on Coherent Population Trapping1. EUGENIY MIKHAILOV, NATHAN BELCHER, IRINA NOVIKOVA, The College of William & Mary — We developed and constructed a VCSEL-based laser system to study various configurations of coherent population trapping resonances (CPT) in hot Rb vapor, relevant for miniature CPT-based atomic clocks. We also locked an external crystal oscillator to CPT resonance; best observed fractional stability is $6 \times 10^{-12}$ at 400s. In addition to its research value, our apparatus can be easily adopted as a advance undergraduate experiment, since it uses primarily off-the-shelf electronic and optical components.

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Friday, October 31, 2008 8:30AM - 10:24AM –
Session GA Forefront Particle Physics Holiday Inn Brownstone Washington

8:30AM GA.00001 Neutrinos – Going to extremes. JOHN F. WILKERSON, University of North Carolina — Like the Southeastern Section of the APS, neutrinos are also septuagenarians, having been "born" in 1930 as a means of solving the apparent violation of energy and angular momentum in nuclear beta-decay. Because of their elusive nature, we have had a limited grasp of their intrinsic properties. However, in the past decade our understanding of neutrinos and their role in the universe has undergone a remarkable transformation. We have discovered that neutrinos morph from one species to another as they journey through matter and space. And based on these observations we know that neutrinos are not massless particles, but have tiny masses, being at least 250,000 times lighter than electrons. Yet even with such diminutive masses, neutrinos play important roles in shaping the largest scales of the cosmos. Today much remains unknown about neutrino properties. What do neutrinos "weigh" — we still do not know their absolute masses. Are neutrinos and anti-neutrinos indistinguishable from one another (Majorana particles), indicating lepton number violation? Might neutrinos account for the matter – antimatter asymmetry observed in the universe? Future neutrino experiments aim to address these questions, but the extreme nature of neutrinos presents daunting experimental challenges. The consequences of deciphering neutrino properties will be profound, guiding us to the formation of a new "standard model" of fundamental particle interactions, impacting our models of astrophysics and cosmology, and perhaps holding the key to understanding our existence.

9:00AM GA.00002 Accelerator-based Neutrino Physics at Fermilab. EDMOND DUKES, University of Virginia — The discovery of neutrino mass has excited great interest in elucidating the properties of neutrinos and their role in nature. Experiments around the world take advantage of solar, atmospheric, reactor, and accelerator sources of neutrinos. Accelerator-based sources are particularly convenient since their parameters can be tuned to optimize the measurement in question. At Fermilab an extensive neutrino program includes the MiniBooNE, SciBooNE, and MINOS experiments. Two major new experiments, MINERVA and NOvA, are being constructed, plans for a high-intensity neutrino source to DUSEL are underway, and an R&D effort towards a large liquid argon detector is being pursued. The NOvA experiment intends to search for electron neutrino appearance using a massive surface detector 811 km from Fermilab. In addition to measuring the last unknown mixing angle, theta(13), NOvA has the possibility of seeing matter-antimatter asymmetries in neutrinos and resolving the ordering of the neutrino mass states.

9:30AM GA.00003 Plans and Prospects at Fermilab. SUSAN BLESSING, Florida State University — I will give an overview of work being done by the DØ and CDF collaborations in anticipation of searches for new physics planned by the LHC collaborations.

10:00AM GA.00004 The T2K Long Baseline Neutrino Beam Experiment. JOSHUA ALBERT, Duke University, T2K COLLABORATION — T2K is a long baseline neutrino beam experiment scheduled to begin operation in 2009. The energy of the $\nu_e$ beam from JPARC and the distance (295 km) to the far detector (Super-Kamiokande) have been chosen to maximize sensitivity to $\nu_\mu$ appearance through neutrino oscillation. The expected sensitivity is an order of magnitude better than current experiments. Observation of $\nu_\mu \rightarrow \nu_e$ oscillations in the T2K beam would provide a non-zero measurement of $\theta_{13}$.

10:12AM GA.00005 Prospects for a Low Threshold Neutrino Experiment at the SNS. DIANE MARKOFF, NC Central University, CLEAR COLLABORATION — A low-threshold neutrino scattering experiment at a high-intensity stopped-pion neutrino source has the potential to measure coherent neutral current neutrino-nucleus elastic scattering. Coherent scattering is a vital process for driving stellar explosion mechanisms which are as yet poorly understood in supernova evolution, and may provide a means to detect neutrino bursts from nearby supernova. The coherent scattering interaction rate can be very precisely calculated in the Standard Model, therefore comparison to measurements provides for another means to test the Standard Model and an opportunity to search for non-standard neutrino interactions. A promising prospect for the measurement of this process is a proposed noble-liquid-based experiment, dubbed CLEAR (Coherent Low-Energy A(Nuclear) Recoils), at the Spallation Neutron Source located at ORNL in Tennessee. This talk will describe the CLEAR proposal and its physics reach.

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Friday, October 31, 2008 8:30AM - 10:30AM –
Session GB Forefront Materials Physics II Holiday Inn Brownstone Roosevelt

1This research is supported by Jeffress Research grant J-847, National Science Foundation and the College of William & Mary.

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5:33PM EC.00010 Multimedia ellipsometry of (aminomethylaminoethyl)phenethyltrimethoxysilane (PEDA) layers.

5:45PM EC.00011 Optimization of a Prototype Atomic Clock Based on Coherent Population Trapping.
8:30AM GB.00001 Plasmon Polariton Excitation and Enhancement of the Magneto-optical Activity. ROSA ALEJANDRA LUKASZEN, College of William and Mary — Light can be localized and manipulated in metallic and metallo-dielectric nanoparticle arrays and/or thin film structures via Plasmon Polariton excitation. This phenomenon is very sensitive to slight changes in the dielectric constant at the surface and it has been successfully applied to bio-sensing. [1] During the Plasmon excitation the associated electric field is strongly enhanced near the dielectric-metal interface. [2] and this can also enhance magneto-optical activity in magnetic layers and/or nanomagnets. We have studied this effect in Au/Co/Au tri-layered structures, and we measured the reflectivity (R) under an alternating magnetic field and found that the surface Plasmon excitation itself depends on the applied magnetic field because of the magnetic field dependence of its wave vector. We have achieved remarkably high $\Delta R/R$ modulated performance, in excess of 150% at moderate magnetic fields externally applied, when excited in Kretschmann configuration [3].


9:00AM GB.00002 Electrophoretic Deposition of Thin Films of Nanoparticles. JAMES DICKERSON, Vanderbilt University — Nanoparticles have attracted considerable interest recently due to their size-dependent, quantum confinement characteristics, which make them attractive for a variety of optical, magnetic, and electronic devices. For nanoparticles to be employed in an array of commercial and industrial applications, a technique for the facile, site-selective assembly of homogeneous, densely packed, defect-free thin films must be realized. Widely used methods for casting nanoparticle (NP) constituents into films have recognized limitations, including the inability to achieve both large-scale ordering of the nanoparticles and robust chemical and structural properties. NP deposition schemes also require an understanding of both the NP dynamics in suspension and the interactions that govern nanoparticle-substrate and nanoparticle-nanoparticle binding. Although research has been conducted on the assembly of nanoparticles with a distribution of surface charge states, little has been done on the assembly of like-charged nanoparticles. The only NP deposition scheme that considers the physical characteristics of the NPs in the film formation and incorporates the most favorable attributes of NP deposition is electrophoretic deposition (EPD). Recent progress in the NP EPD will be the emphasis of this presentation. Highlighted are the recent discoveries of the size dependence of the thickness of iron oxide NP films and the fabrication of free-standing NP films.

9:30AM GB.00003 Photonic Structuring of Bulk Heterojunction Organic Solar Cells. RENE LOPEZ, Physics and Astronomy Dept., Univ. 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 nanostructuring 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 solar cell. We also calculate the local excitation 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 nanofabrication method to show this approach can be used to produce improved large-area nanostructured P3HT:PCBM solar cells. In collaboration with John Tumbleston, Physics and Astronomy Department, University of North Carolina at Chapel Hill, and Doo-Hyun Ko and Edward Samulski, Chemistry Department, University of North Carolina at Chapel Hill.

10:00AM GB.00004 Bulk crystal growth of scintillators materials for gamma ray detectors. MOHAN AGGARWAL, Department of Physics, Alabama A&M University, Normal, AL 35762 — Within the past few years, it has been demonstrated that several new rare earth halide scintillation detector crystals such as cerium doped lanthanum bromide (LaBr$_3$:Ce) have high output and improved energy deposit to light linearity and thus they can substantially enhance the performance of the next generation of gamma ray detectors. These detectors have a variety of applications in NASA hard x-ray and gamma ray missions, high energy physics, home land security and medical imaging applications. This cerium doped lanthanum bromide crystal has ~1100% the light output of BGO, resulting in better energy resolution than conventional scintillators. This is equivalent to 60000 photons per MeV of deposited energy. This new series of scintillator materials promise to usher a breakthrough in the field, if sufficiently large and clear crystals of this material can be grown. These halides however are highly hygroscopic and hence pose some difficulty in growing crystals. Efforts are being made to grow this and other materials in this family of crystals and successful results have been achieved. An overview of the challenges encountered during the synthesis and melt crystal growth of these rare earth halide scintillators shall be presented.

This work was supported under the NSF HBCU-RISE program HRD-0531183 and NASA Administrator’s Fellowship Program.

Friday, October 31, 2008 8:30AM - 10:30AM — Session GC Mathematical Physics and Physics Education Holiday Inn Brownstone Lincoln

8:30AM GC.00001 Eigenvalue Spacings in the Asymmetric Infinite Square Well. TODD TIMBERLAKE, MOLLY NELSON, Berry College — The distribution of eigenvalue spacings is an important tool in the study of quantum chaos. Quantum systems with chaotic classical counterparts exhibit eigenvalue spacings that follow random matrix statistics, while those with integrable counterparts generally follow Poisson statistics. One-dimensional quantum wells, which are always integrable under Newtonian mechanics, are expected to display uniform eigenvalue spacings (after unfolding). We will show that the asymmetric infinite square well (an infinite square well with a step) does not fit this expectation. The spacings between eigenvalues above the step height are not uniform after unfolding, but gradually approach uniformity at higher energies. Semiclassical analysis reveals that the departure from uniformity is due to the existence of non-Newtonian periodic orbits that reflect from the step even though their energies are above the step height. The sequence of eigenvalue spacings also displays some unusual features that are related to resonances in the classical (non-Newtonian) dynamics.

1Currently enrolled at the Georgia Institute of Technology

8:42AM GC.00002 Nonassociative decomposition of angular momentum operator using complex octonions. JENS KOEPLINGER, 105 E Avondale, Greensboro, NC 27403, USA, VLADIMIR DZHUNUSHALIEV, Dept. Phys. and Microel. Engineer., Kyrgyz-Russian Slavic University, Bishkek, Kyrgyz Republic — Non-associative octonion algebra has been proposed [e.g., V. Dzhunushaliev, J. Math. Phys. 49, 042108 (2008); arXiv:0712.1647] for description of a hidden structure in operator quantum mechanics, which contains traditional observables, as well as unobservable quantities that cannot be measured in principle. The approach allows to decompose the supersymmetric momentum operator, and also the angular momentum operator, as a bilinear combination of some (non-associative) operators [V. Dzhunushaliev, arXiv:0805.3221]. This talk presents the finding of a linear decomposition of the angular momentum operator, with use of complex octonion numbers. Potential implications and next steps will be outlined.
8:54AM GC.00003 Information Content in Antenna Radiation Patterns, KARAN MOHAN, M. AMIR KHAN, AMIN DHARMSI, Old Dominion University — We discuss the application of Shannon’s Information Theory to the quantification of information lost in practical measurements of radiation patterns of antenna arrays. The radiation pattern of a uniform linear one-dimensional phased array of N dipole elements, with inter-element spacing of d and inter-element phase of ψ is given by
\[ P_N(\theta, \phi) = P_{\text{ind}} \sum_{n=-\infty}^{\infty} I_n \exp(i(kd_n \sin \theta \sin \phi + \psi_n)) \]
where \( P_{\text{ind}} \) is the radiation pattern of an individual dipole element, \( I_0 \) is the intensity and k is the wavenumber. The probability density function, in space, of emitted photons is therefore given by
\[ P_N(\theta, \phi) = P_{\text{ind}}(\theta, \phi) \int P_{\text{ind}}(\theta, \phi) \sin \theta d\theta d\phi. \]

The entropy of this distribution is
\[ H = -\int P_N(\theta, \phi) \ln P_N(\theta, \phi) d\theta d\phi. \]

The information obtained about any change in the array is therefore \( \Delta H = |H_f - H_i| \) where \( H_f \) and \( H_i \) correspond to the entropies of the final and initial distributions. This expression leads to a quantitative formulation for the information lost due to imprecision in detectors used to measure radiation patterns. The theoretical approach developed allows one to measure any changes in the antenna array that may occur in an optimal manner, given limitations such as noise, a finite number of detectors of finite precision, or access only to a limited section of the surrounding space.

9:06AM GC.00004 Closed Analytic Solution for the Potential and Equations of Motion in the Presence of a Gravitating Oblate Spheroid, WILLIAM ATKINSON, The Boeing Company — A closed analytic solution for the potential due to a gravitating solid oblate spheroid, derived in oblate spheroidal coordinates in this paper, is shown to be much simpler than those obtained either in cylindrical coordinates (MacMillan) or in spherical coordinates (McCullough). The derivation in oblate spheroidal coordinates is also much simpler to follow than those of the MacMillan or McCullough. The potential solution is applied in exacting a closed solution for the equations of motion for an object rolling on the surface of the spheroid subjected only to the gravitational force component tangential to the surface of the spheroid. The exact solution was made possible by the fact that the force can be represented as separable functions of the coordinates only in oblate spheroidal coordinates. The derivation is a good demonstration of the use of curvilinear coordinates to problems in classical mechanics, potential theory, and mathematical physics for both undergraduate and graduate students.

9:18AM GC.00005 Semi-classical Determination of the Energy Levels of a \( x^{4/3} \) Potential, KALE OYEDEJI, Morehouse College, RONALD MICKENS, Clark Atlanta University — Given a classical solution to a 1-dim in space system, for which all the solutions are periodic, the application of the modified Bohr-Sommerfeld quantization condition [1] allows a determination of semi-classical estimates for the energy levels of the associated quantum system. We consider a \( x^{4/3} \) potential and use the methods of harmonic balance and iteration to calculate accurate approximations to the classical periodic solutions [2]. With these results, a general semi-classical energy spectrum can be determined. To judge the accuracy/validity of these calculations, we use a simple functional form for the ground state wave function in a variational calculation of the associated energy and compare this value with our semi-classical result.


9:30AM GC.00006 A Theoretical Estimate for the Frequency of the TNL Oscillator \( x + x^{1/3} = 0 \), DORIAN WILKENSON, RONALD MICKENS, Clark Atlanta University — Truly nonlinear (TNL) oscillators have the property of having no linear approximation at the fixed-point of the modeling differential equation [1]. For a conservative oscillator this means that the fixed-point is a nonlinear center. Another feature of TNL oscillators is that none of the standard perturbation expansion procedures can be applied to calculate analytical approximations to the periodic or oscillator solutions [2]. Using the initial conditions \( x(0) = A \) and \( \dot{x}(0) = 0 \), we calculate the frequency \( \omega(A) \) of the equation given in the title for small, \( 0 < A < 1 \), and large \( A \gg 1 \), amplitudes. From these expressions a composite function, \( \omega(A) \), is found such that these two special limits hold. This function should provide an accurate estimate of the frequency for the full range of amplitude values, i.e., \( 0 < A < \infty \).


9:42AM GC.00007 On a Connection Between the Eigenvalues of the One-dimensional Finite Square Well and Number Theory, WALTER JARONSKI, Radford University — The problem of the one-dimensional finite square well is a standard exercise in the introductory quantum mechanics course. As is well known, the energy eigenvalues cannot be determined in closed form. However, for a given range of the well parameter, the energies can be represented as an infinite series in this parameter. Although this series cannot be summed to give a common function, the coefficients in the series can be determined from a simple formula. In particular, for small values of the well parameter, the coefficients can be expressed in terms of generalized Euler numbers. This technique will be compared with standard numerical procedures for determining the energies, with regard to both computational ease and pedagogical benefits. The opportunity to introduce students to new mathematics will be emphasized.

9:54AM GC.00008 Teaching Introductory Physics with Turning Point Software, R. SETH SMITH, Francis Marion University — Physics professors attempt to engage students in the learning of physics by teaching this subject in a manner that students will perceive as relevant, interesting, fun, intriguing, and clear. Perhaps, the most valuable contribution that a professor can make to a student’s education is to stimulate an interest in a particular discipline. To accomplish this, a professor has to be a performer. One doesn’t necessarily have to entertain, but one must bring a certain level of enthusiasm and energy to a classroom in order to engage the students. If they are not engaged in the classroom, students will not learn effectively. Towards this end, Turning Point software was used to create new classroom presentations for FMU’s introductory physics class in the Fall of 2008. Turning Point is essentially Power Point, but it provides one with the ability to embed interactive questions within a presentation. Students in the class respond to these questions by using radio frequency devices known as “clickers.” An analysis of the effectiveness of this approach, as well as a comparison to traditional chalk and blackboard methods, will be presented.

10:06AM GC.00009 Investigation of 60Hz electromagnetic environmental noise, JOHN HOWELL, JOHN GAFFNEY, SANICHIRO YOSHIDA, Southeastern Louisiana University — In addition to many other sources, alternating current causes electromagnetic noise. This noise is generated at close to 60Hz in the United States. Many different factors can influence the specifications of the noise, including mechanical load on the power company’s generator. By using a simple antenna consisting of a capacitor and iron-core inductor along with gathering and processing programs (Labview and Matlab), we have characterized this 60Hz noise. Peak shifts as well as broadening and narrowing phenomena were common in measurements. By constructing a program script to step through the measured data in a set increment, we were able to determine the frequency and amplitude fluctuations of particular samples. Different times of day show different fluctuations as conditions such as seismic disturbance change and possibly electric load varies.
HA.00001 Correlations between nuclear and fluorescent Imaging of mammary tumors in mice\(^1\)
ROBIN CARROLL, JOHN STONE, Randolph Macon, ERIC BLUE, Biology, William and Mary, ERIC BRADLEY, JIANGUO QIAN, Applied Science, William and Mary, MARGARET SAHA, Biology, William and Mary, ROBERT WELSH, Physics, William and Mary — Progress with new imaging technologies permits the study of biological processes both in vivo and noninvasively. Two systems, a position-sensitive gamma camera and a cooled-CCD camera have been applied in this work. A C3H strain of mouse carrying the Mouse Mammary Tumor Virus (MMTV) was imaged using 880 nm Q-tracker fluorescent dots conjugated to a peptide targeting integrin \(\alpha_v \beta_3\) a mammary marker for angiogenesis. We subsequently imaged with the gamma camera to detect low levels of \(^{125}\text{I}\) distribution, and hence, the activity of a trans-membrane protein called the sodium iodide symporter (NIS) responsible for iodine transport. Preliminary results indicate that the biodistribution of the tagged Q-tracker dots and \(^{125}\text{I}\) co-localize very early in seemingly normal mammary glands of infected MMTV mice, while in larger palpable tumors the Q-dot signals are less apparent in comparison with the \(^{125}\text{I}\) signal.

\(^1\) Supp: NIH R15 EB000458-2, DOD W81XWH-05-1-0480, NSF-REU

HA.00002 Testing local DNA stiffness by nanoconfinement
ALENA KARPUSENKA, ROBERT RIEHN, North Carolina State University — The primary intent of this work is the study of DNA movement inside curved nanochannels. In particular, we considered channels with a cross-section smaller then the DNA persistence length, and channel length far beyond the contour length of the molecule. This allows us approximation of the polymer with the model of an elastic rod (Odijk model). We are testing the local DNA stiffness by bending the molecule in curved channels, and a bending energy landscape is constructed by comparing forces due to bending stiffness to known electrophoretic forces. To estimate the limiting radius of nanochannel curvature permeable for DNA molecules at a given driving force, two sets of nanochips were fabricated. The first set of nanochannels is formed by the sequence of semi-circumferances with descending radius (20 \(\mu\text{m}\) to 50 \(\mu\text{m}\)) and tests moderate bending of a set of length scales. A second set of nanochannels is shaped as a zigzag of constant steps, and tests local bending stiffness.

HA.00003 Multi-Color Single Molecule Fluorescence Resonance Energy Transfer (smFRET),
TREVOR ANDERSON, KEITH WENINGER — The assembly of multi-protein complexes is a vital part of intracellular biology. High resolution methods for characterizing such multi-protein complexes are required to understand functions of these complexes at the mechanistic level. Single molecule Fluorescence Resonance Energy Transfer is a promising method for both characterizing protein conformations and co-localizing different members of such multi-protein complexes. We present our progress towards developing an instrument for three and four color FRET studies at the single molecule level. This method will be useful for characterizing multi-protein complexes.

HA.00004 Conformational fluctuation of Synaptotagmin-1 observed with single molecule fluorescence resonance energy transfer (smFRET),
UCHEOR CHOI, KEITH WENINGER, North Carolina State University — Calcium dependent neurotransmitter release at the synapses involves a synaptic vesicle protein synaptotagmin-1, a calcium sensor, to regulate exocytosis. It has been known that Synaptotagmin-1 interacts with assembled SNARE complexes, but it is unclear how their molecular mechanisms are coupled. X-ray studies in the absence of calcium revealed a closed conformation of synaptotagmin-1 and with calcium bound to the C2 domains of synaptotagmin-3 found extensive interactions holding the domains open. Suggesting the two conformations can be the key to the two functions of synaptotagmin in regulating neurotransmission. Here we use single molecule fluorescence resonance energy transfer (smFRET) to study synaptotagmin interactions with SNARE complexes and the spontaneous conformational changes of synaptotagmin-1 when calcium is induced.

HA.00005 Time-resolved spectroscopy of self-assembly of CCMV protein capsids,\(^1\)
JELYN MOORE, Hampton University, DINA ARONZON, Harvard University, V.N. MANOHARAN, Harvard University — In order to gain a deeper understanding of the process a virus undergoes to assemble; the purpose of this study to time resolve the self-assembly of a virus. Cowpea Chlorotic Mottle virus (CCMV), an icosahedral type virus, can assemble without its genetic code (RNA) depending on its chemical and physical surroundings. The surface plasmon resonance (SPR) of colloidal gold particles is known to display a shift when the gold interacts with the proteins of a virus. Surface plasmon resonance is the free electron oscillation occurring at the surface of the gold particle resulting in a characteristic peak location at maximal absorbance and peak width. The shift results from the change in the refractive index of the particles as induced by the presence of the proteins. We hope to detect this shift through total internal reflection microscopy (TIRM). The accomplishments of this research are the completion of the TIR setup and the purification of the virus and its proteins.

\(^1\) This research at Harvard University was supported by the National Science Foundation (ECCS-0709323).

HA.00006 Effects of AC/DC magnetic fields, frequency, and nanoparticle aspect ratio on cellular transfection of gene vectors,
KRIS FORD, LAMAR MAIR, MIKE FISHER, MD, ROWSHON ALAM, RUDOLPH JULIANO, RICHARD SUPERFINE, University of North Carolina at Chapel Hill, NSRG/PHARMACOLOGY COLLABORATION — In order to make non-viral gene delivery a useful tool in the study and treatment of genetic disorders, it is imperative that these methodologies be further refined to yield optimal results. Transfection of magnetic nanoparticles and nanorods are used as non-viral gene vectors to transfect HeLa EGF-P-654 cells that stably express a mutated enhanced green fluorescent protein (EGFP) gene. We deliver antisense oligonucleotides to these cells designed to correct the aberrant splicing caused by the mutation in the EGFP gene. We also transfet human bronchial endothelial cells and immortalized WI-38 lung cells with pEGFP-N1 vectors. To achieve this we bind the genes to magnetic nanoparticles and nanorods and introduce magnetic fields to effect transfection. We wish to examine the effects of magnetic fields on the transfection of these particles and the benefits of using alternating (AC) magnetic fields in improving transfection rates over direct (DC) magnetic fields. We specifically look at the frequency dependence of the AC field and particle aspect ratio as it pertains to influencing transfection rate. We posit that the increase in angular momentum brought about by the AC field and the high aspect ratio of the nanorod particles, is vital to generating the force needed to move the particle through the cell membrane.
HA.00007 Single Molecule Fluorescence Resonance Energy Transfer (smFRET) in Live Cells
JOHN SAKON, KEITH WENINGER, NCSU Physics — This research reports progress towards single molecule fluorescence resonance energy transfer (smFRET) in the cytoplasmic environment of live cells. Recombiantly expressed, externally dye-labeled SNARE proteins were microinjected into cultured cells, tracked and imaged to observe real-time conformational dynamics. We discuss the many obstacles lowering signal/noise in vivo (cellular and coverslip autofluorescence, dye photobleaching) and our methods for overcoming these obstacles. Initial findings and the implications for this technique will also be discussed.

HA.00008 Resonant Soft X-ray Reflectivity (RSoXR) for organic thin films characterzation
CHENG WANG, BENJAMIN WATTS, TOHRU ARAKI, HARALD ADE, ALEXANDER HEXEMER, ANDRES GARCIA, THUC-QUYEN NGUYEN, GUILLERMO BAZAN, KAREN SOHN, EDWARD KRAMER, NCSU COLLABORATION, LBNL COLLABORATION, UCSD COLLABORATION — The performance of organic multilayer PLED devices is strongly affected by the structure, e.g. chemical diffusion or physical roughness, of the interfaces between layers. Resonant soft x-ray reflectivity (RSoXR), a recently developed tool to characterize polymer thin films, is able to achieve greatly enhanced contrast between polymer components by tuning the photon energy to carbon 1s photon absorption resonances near 285eV. The measurement of interfacial width becomes possible without deuteration and the use of neutron reflectivity. The interfacial widths w of model bilayers of poly[9,9-bis(6'-N,N,N-trimethylammoniumhexyl)fluorene-co-alt-1,4 phenylene bromide] (PFNBr)/poly[2-methoxy-5(2'-ethylhexyloxy)-p-phenylene vinylene] (MEH-PPV) on SiO2 substrates manipulated by various sample preparation process were measured by RSoXR, allowing w to be correlated to device performance. In addition, for a real PLED device with a more complicated multilayer structure, but missing the top Al electrode, it was demonstrated that the top four interfaces can be fully characterized using RSoXR by adjusting the material contrast to selectively observe different layers at different photon energies.

HA.00009 Fusion between a content labelled liposome and an enveloped virus particle
LAURA WESSELS, KEITH WENINGER, NCSU — Membrane fusion is critical during enveloped virus entry into cells for release of the viral genome to the cell. We have developed a fluorescence assay to observe individual virus particles fusing with immobilized liposomes. Dye encapsulated inside a liposome will be released into the virus particle’s interior through a fusion pore that is created between the liposome’s bilayer and the viral envelope. We used Total Internal Reflection Microscopy (TIRFM) to observe fusion between a liposome with a calcium in the intravesicular buffer and an influenza particle. A sudden buffer exchange to acidic pH is used to trigger the fusion event. TIRFM allows a time resolution of ~100ms. We plan to use confocal microscopy to improve the time resolution of our measurements of the opening of the fusion pore.

HA.00010 DNA fluctuations under nanoconfinement
JUNHAN PAN, ROBERT RIEHN, North Carolina State University — DNA stretching in quasi one-dimensional nanochannels is an emerging technique for the analysis of genomic-sized DNA molecules. For formulating an optimal measurement strategy, the thermal fluctuations of confined molecules are of crucial importance. While previous measurements have concentrated only on the end-to-end length, we present here an experimental study of density fluctuations within the molecule, and find a good agreement with a model similar to a oscillator chain.

HA.00011 Nanoscale Effects on the Optical Performance of Nanofiber-Quantum Dot Nanocomposites
TERI WALKER, LYNN DAVIS, HOWARD WALLS, LI HAN, JENIA TUFTS, DAVID ENSOR, Research Triangle Institute — Photoluminescent nanofibers (PLNs) can be created by combining nanofibers and quantum dots using the process of electrospinning. The physical properties of PLNs are dependent upon many different parameters associated with both the nanofiber and the quantum dot and their interactions. By understanding and manipulating these properties, the performance of the resulting optical structure can be tailored for desired end-use applications. For example, the transmittance and reflectance of nanofiber substrates is controlled by factors such as refractive index, thickness, fiber diameter and density, and surface morphology. Likewise, the quantum efficiency of the quantum dots in PLNs depends upon multiple parameters including quantum dot chemistry, method of forming the PLN nanocomposite, and prevention of quantum dot agglomeration. Methods to optimize the performance of PLNs are discussed along with guidelines for tailoring the performance of nanofibers and quantum dots for application specific requirements.

HA.00012 Detection of residual traces of explosives by Surface Enhanced Raman Scattering using gold coated substrates produced by nanospheres imprint technique
FERNANDO CALZZANI, REDAHEGNI SILESHI, ASCHALEW KASSU, JEAN MICHIEL TAGUENANG, ABDUL CHOWDHURY, ANUP SHARMA, PAUL RUFFIN, C. BRANTLEY, E. EDWARDS — Explosives detection for national and aviation security has been an area of concern for many years. In order to improve the security in risk areas, much effort has been focused on direct detection of explosive materials in vapor and bulk form. New techniques and highly sensitive detectors have been extensively investigated and developed to detect and identify residual traces that may indicate an individual’s recent contact with explosive materials. This paper reports on the use and results of Surface Enhanced Raman Scattering (SERS) technique, to analyze residual traces of explosives in highly diluted solutions by using low-resolution Raman spectroscopy (LRRS). Detection sensitivity of this technique has been measured by using samples of explosives such as TNT, RDX and HMX evaluated at different concentrations. Additionally, results from homemade SERS substrates have been compared to a commercial gold-coated substrate of nanocavities. Sample concentration, starting from 1000ppm was gradually diluted to the smallest detectable amount. Raman spectrum was obtained using a portable spectrometer operating at a wavelength of 780nm.

HA.00013 Nanosphere Templating Through Controlled Evaporation: A High Throughput Method For Building SERS Substrates
KRISTEN ALEXANDER, RENE LOPEZ, Department of Physics and Astronomy, University of North Carolina at Chapel Hill, MEREDITH HAMPTON, JOSEPH DESIMONE, Department of Chemistry, University of North Carolina at Chapel Hill — When a pair of noble metal nanoparticles are brought close together, the plasmonic properties of the pair (known as a “dimer”) give rise to intense electric field enhancements in the interstitial gap. These fields present a simple yet extremely sensitive system for performing single molecule surface-enhanced Raman spectroscopy (SM-SERS). Problems associated with current fabrication methods of SERS-active substrates include reproducibility issues, high cost of production and low throughput. In this study, we present a novel method for the high throughput fabrication of high quality SERS substrates. Using a polymer templating technique followed by the placement of thiolated nanoparticles through meniscus force deposition, we are able to fabricate large arrays of identical, uniformly spaced dimers in a quick, reproducible manner. Subsequent theoretical and experimental studies have confirmed the strong dependence of the SERS enhancement on both substrate geometry (e.g. dimer size, shape and gap size) and the polarization of the excitation source.
HA.00014 Length scale effects on percolation of geometrically complex nanocomposites, T.J. HOFFMAN, D.R. STEVENS, Department of Physics, N.C. State University, W.A. ROBERTS, Department of Physics, N.C. State University, R.E. GORGA, Department of Textile Engineering, N.C. State University, L.I. CLARKE, Department of Physics, N.C. State University — With growing interest in materials that include nanostructures the focus on nanocomposites (a polymer-based matrix that is enhanced by a nanometer sized particle) has grown. Electros spun nanocomposites contain a complex geometry including fiber sizes of ≈ 200 nm arranged in a random mat with a porosity of ≥ 70%. Composites utilize connected paths of particles throughout the sample to enhance the mechanical and electrical properties of the matrix. Previous literature has shown, in the case of continuous films, that this percolation phenomenon is affected by the sample size. This work aims to investigate these length scale effects within a complex morphology, such as a nanofiber mat. For a clear understanding of the change in percolation vs. length scale we fabricated interdigitated electrodes (IDEs) with a finger spacing of 10 to 100 µm, electros spun mats onto the IDEs, and performed electrical conductance measurements. In addition, computation simulations of the experimental systems were undertaken. I will discuss our results and the role sample size/shape plays on 1) the percolation threshold and 2) the conductivity vs. doping fraction curve.

HA.00015 Ultrahigh Vacuum Growth and PEEM Characterization of Patterned Graphene Nanostructures on Si-Polar 6H-SiC Surfaces, ZHENGANG WANG, ANDREAS SANDIN, JOSEPH TEDESCO, XIANHUA KONG, J.E. (JACK) ROWE, NC State University — We report the growth and Photoelectron Emission Microscopy (PEEM) characterization of graphene films on Si-polar surfaces of 6H-SiC by thermal decomposition in an ultrahigh vacuum (UHV) chamber. Following growth, focused ion beam lithography has been used to successfully etch the graphene films and control the lateral dimensions of a number of nanostructures on these graphene layers with etch rates of ~18 nm/s and lateral dimensions of ~250 to 1500 nm. Epitaxial graphene films (1-4 layers thick) have been grown on the Si face. Theoretical reports have recently addressed the bandgap engineering of graphene nanoribbons by altering the physical dimensions, edge structure, and edge atoms of the nanoribbons. However, experimental control of the growth and quality graphene nanostructures is still a challenge. Our PEEM results show that the electronic properties of the graphene are very different near step edges which indicates that some confinement effects expected for graphene nanoribbons may be achieved by selected stepped surfaces. The patterned surfaces show additional sites that are chemically different and may be useful for certain sensor applications. Possible interpretations of the PEEM contrast mechanisms will be discussed.

HA.00016 Ultra low temperature high magnetic field materials' characterization tool, Dmitri PONARIN, Alex SMIRNOV, William HOLTON, NC State University — Development of a Cross-disciplinary Quantum Engineering Laboratory at NCSU for characterization of a wide range of materials for next generation of information devices operating on spin principles is being reported. The tool provides electrical and magnetic resonance measurements for samples subjected to mK temperatures and high magnetic fields to achieve the highest polarization of electronic or nuclear spins. This first-of-its-kind instrument operates in cryogen-free mode and comprises of a high homogeneity (10 ppm over 1 cm³) 9 T superconducting magnet with a wide (89 mm) room-temperature bore to accommodate an independent dilution refrigerator (DR). The tested DR base temperature is below 20 mK and the cooling power exceeds 350 µW/100 mK. The magnet and the DR are cooled from room temperature by independent pulse-tube cryocoolers in less than 48 hours. The magnet is equipped with an uncoupled ±/−600 G sweep coil and a persistent switch. Magnetic field drift of <1ppm/hr is acceptable for high resolution ESR experiments. Flexible design and the short turnaround time makes the tool convenient for conducting a wide range of experiments.

HA.00017 Analysis of gel heterogeneities on a local level, Philip BOYNE, Frederic LECHENAULT, Karen DANIELS, Dept. of Physics, NC State Univ. — We study the heterogeneity of gels near the sol-gel transition through measurements of the spatial variations in positional order and motion of fluorescent polystyrene microspheres suspended in gels is measured via two-point microheliogy. Analysis of this correlated motion provides a local measure of gel heterogeneity. Additionally, we divide the images into micro-scale squares and determine how rheological properties spatially vary as a function of gel concentration. Our results imply that weaker gels exhibit more heterogeneity than stronger gels.

HA.00018 Shear segregation of granular materials as a function of particle size and confining pressure, Laura GOLICK, Karen DANIELS, North Carolina State University — We experimentally investigate the dependence of granular shear segregation rates on particle size ratio and confining pressure. Within a cylindrical annulus, we shear two monodisperse layers of spherical glass beads, with an equal volume of small beads initially placed in a layer above the large. From changes in the height of the sample, we compute the mixing and segregation rates of six different particle size ratios. We observe that contrasting as well as similar particle size ratios segregate and mix more slowly than intermediate particle sizes, in disagreement with kinetic sieving theory. Additional pressure reduces the segregation and mixing rates.

HA.00019 Spreading of a Fluorescent Surfactant on a Glycerine Layer, David FALLEST, North Carolina State University, Christopher FOX, Harvey Mudd College, Karen DANIELS, North Carolina State University — We study the spreading of a fluorescent surfactant on a thin layer of glycerine. Measurements of the height profile of the capillary ridge are conducted as the surfactant travels outward from the point of deposition. We examine the dynamics of the ridge as a function of the surfactant released, and find that for the largest volumes the shape and speed of the spreading ridge are influenced by the outer edge of the underlying glycerine layer. The intensity of the fluorescence is also used to visualize the position of surfactant as it spreads. The location of the surfactant is compared to the location of the capillary ridge.

HA.00020 Magnetic Properties of Dihydrate and Monohydrate Forms of Nickel Dibromide, G.C. DEPOTIS, C.L. DESANTO, C.M. DAVIS, J.M. POTTHEN, A.S. HAMPTON, College of William and Mary — As with transition metal bromides generally, especially hydrates, the title materials are either little studied previously or not at all (monohydrate). Curie-Weiss analysis of paramagnetic region susceptibilities yields Weiss theta values of 8.0 and 2.73 K for dihydrate and monohydrate respectively, indicating predominant ferromagnetic interactions but less so in the dihydrate. Peculiar behavior appears in the susceptibility of the monohydrate in the 40-100 K range. A large zero field splitting of the triplet ground state emerges from fits to dihydrate data especially. Susceptibility maxima occur just below and, unexpectedly, just above 6.0 K for dihydrate and monohydrate respectively. Fits to the data suggest more lower dimensional magnetic character in the monohydrate. While magnetization isotherms in the two systems are without hysteresis, a remarkable contrast in their temperature evolution distinguishes the two materials.

1 Acknowledgment is made to the Donors of the American Chemical Society Petroleum Research Fund for support of this research.

HA.00021 Jamming in Microfluidic Devices, Carlos ORTIZ, Karen DANIELS, Robert RIEHN, North Carolina State University — Systems of grains, colloids, and foams cease to flow or jam, under poorly understood conditions. The phase transition common to these jamming phenomena depends on imposed load, temperature, and packing fraction. We study microfluidic jamming by flowing aqueous suspensions of sub-micron fluorescent polystyrene spheres through a microfluidic device. The device consists of a single wide channel followed by parallel rows of varying-size posts. These posts focus the bead flow into micron-sized channels, allowing us to control the particle volume fraction. Varying the particle size and the flow rate of the suspension allows us to indirectly control the importance of thermal effects and the applied load on the particles. Preliminary results show that bidisperse suspensions jam more readily at a lower flow rate, whereas monodisperse suspensions require ten times higher flow rates to jam. These results suggest that jamming transitions depend strongly on polydispersity.
HA.00022 Magnetic Behavior in Dihydrate and Monohydrate Forms of Manganese Dibromide¹

G.C. DEFOTIS, A.S. HAMPTON, J.M. POTHEN, College of William and Mary — Transition metal bromides, especially hydrates, are much less examined than chlorides, and the title materials are believed to be previously unstudied. Curie-Weiss analysis of paramagnetic region susceptibilities yields Weiss theta values of -13.1 and -3.9 K for dihydrate and monohydrate respectively. A susceptibility maximum appears at 6.34 and 3.20 K in the same order, with the maximum broader in the monohydrate. Ordering temperatures are suggested by susceptibility anomalies at 5.91 and 2.63 K in the same order. The ratio (T(ordering))/T(maximum) is 0.93 and 0.82 for dihydrate and monohydrate respectively. These results are consistent in suggesting three-dimensional magnetic character in the dihydrate but lower dimensional in the monohydrate. A similar relation was found previously for corresponding chloride systems, with which further comparison can be made. The results can also be considered in the broader context of other metal dihalide dihydrate and monohydrate pairs of materials.

¹Acknowledgment is made to the Donors of the American Chemical Society Petroleum Research Fund for support of this research.

HA.00023 Energetics, coherent transport and work fluctuations of a Brownian particle driven by time dependent temperature . RONALD BENJAMIN, University Of Alabama at Birmingham — We study the efficiency and transport coherence of a Brownian particle in an asymmetric potential and driven by time dependent temperature, also known as a diffusion ratchet. Effect of coupling between many different Brownian particles is also discussed. Work fluctuations of the Brownian particle in a bistable potential and subject to time dependent temperature is studied and the Jarzynski equality is confirmed from numerical solution of the Langevin equation. Analytical results obtained for a harmonic potential are also presented.

HA.00024 Atomic Force Microscopy and Low Energy Electron Diffraction of Epitaxial Zinc Oxide Films . MARK LEARNER¹, Y. ZHANG, ANDREAS SANDIN, DONG WU, J.E. (JACK) ROWE, NC State University — The purpose of the current thin-film Zinc Oxide (ZnO) research is to characterize OMCVD-grown heteroepitaxial thin films of ZnO, which are thought to be single crystal. These ZnO films have many interesting technological applications, including LCD screens and solar cells. We use We also use Atomic Force Microscopy (AFM) and Low Energy Electron Diffraction (LEED) to measure the topography and investigate the periodicity of the ZnO samples produced. The topography data shows nanoscale domains that appear to range in length from 300-700nm, width from 180-270nm, and height from 20-50 nm depending on growth conditions. Optical microscopy has been used to gain an additional quantitative understanding of surface topography features on different areas of the samples. We observe single crystal patterns with LEED and thus confirm the expected epitaxial nature of the growth process. Analysis of the energy dependent LEED data has shown that the diffraction patterns are always single crystal orientation in good registry with the substrate orientation. However, we have also found that there are sample charging effects (which shift the apparent energy by 26 to 43 eV) occur during LEED measurements due to the high resistance of the samples on insulating substrates and Al₂O₃.

¹REU student, summer 2008

HA.00025 Optical Properties and Aging of Gasochromic WO₃ . RUDRESH GHOSH, MATTHEW B. BAKER, RENE LOPEZ, University of North Carolina at Chapel Hill — WO₃ as a possible optical gas sensor has gained increasing importance with H₂ becoming a major fuel of the future. This has led to efforts to understand the theoretical and practical aspects of the gasochromic behavior of WO₃. WO₃ films were fabricated using pulsed laser deposition (PLD). Morphological and stoichiometric ratios of films obtained were observed as functions of deposition parameters. We present the optical constants induced by 2% H₂:Ar in WO₃ films. This allows us to obtain the limits of the gasochromic change in comparison to ion injection. It was found using Langmuir’s adsorption equation that at low H₂ concentrations a high sensitivity is predicted but the coloration could saturate at 57.9 % of the material’s maximum ion adsorption. Poisoning of the films was also addressed by coating with a permeable polydimethylsiloxane layer. It is shown that gasochromic degradation is prevented thus eliminating common atmospheric gases as possible contaminants. Our studies suggest WO₃ thin films as highly sensitive and stable optical hydrogen sensors.

HA.00026 A novel nanoglue and whole wafer self-alignment based upon self-assembled monolayers . AKO EMANUEL, ERNEST WALKER, HANS HALLEN¹, North Carolina State University — New methodologies for fabrication of multilevel packaging, particularly for RF signal analysis, are investigated. A new method for “gluing” silicon wafers together with a Self Assembled Monolayers (SAMs) based nanoglue are discussed, as are methods to enable its use with nonconforming wafers. Results of bond strength measurements as a function of temperature and process will be presented. Surface area bonded is characterized by infrared (IR) imaging. We will also present a method of inducing self-alignment between whole silicon wafers with micrometer precision. This represents a qualitative departure from alignment of millimeter-sized object as has been previously demonstrated. Self-alignment is induced by creating hydrophilic and hydrophobic regions on the wafers and using capillary forces of water in these regions to force the wafers to align with little to no outside influence. Results are characterized by IR imaging. Physical ideas that enable the whole-wafer alignment such as flow channels, elimination of secondary minima, large central capture areas and small edge features are discussed. The possibility of aligning with the nanoglue materials as the alignment drivers is discussed.

¹Directing Professor

HA.00027 Infrared Laser-Induced Breakdown Spectroscopy of Alkali Metal Halides . EI BROWN, UWE HOMMERICH, Hampton University, CLAYTON YANG, Battelle Eastern Science and Technology Center, SUDHIR TRIVEDI, Bramrose Corporation of America, ALAN SAMUELS, PETER SNYDER, Edgewood Chemical Biological Center — 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. LIBS is a relatively simple technique and has been successfully employed in applications such as environmental monitoring, materials analysis, medical diagnostics, industrial process control, and homeland security. Most LIBS applications are limited to emission features in the ultraviolet-visible-near infrared (UV-VIS-NIR) region arising from atoms and simple molecular fragments. In the present work, we report on the observation of mid- infrared emission lines from alkali metal halides due to laser-induced breakdown processes. The studied alkali metal halides included LiCl, NaCl, NaBr, KCl, KBr, RFCl, and RbBr. The laser-induced plasma was produced by focusing a 16 mJ pulsed Nd:YAG laser (1064 nm) on the target. The LIBS infrared emission from alkali halides showed intense and narrow bands located in the region from 2-8 μm. The observed emission features were assigned to atomic transitions between higher-lying Rydberg states of neutral alkali atoms. More detailed results of the performed IR LIBS studies on alkali metal halides will be discussed at the conference.
HA.00028 Ion Molecule Collisions at Low Energies. Dwayne Joseph, Department of Physics, Florida A&M University, Robert Buenker, Fachbereich C-Mathematik und Naturwissen-Schaften, Bergische Universitat Wuppertal, D-42097, Wuppertal, Germany. BIDHAN SAHA, Department of Physics, Florida A&M University, Florida-32307. — Charge transfer is a fundamental phenomenon in nature, playing a crucial role in many chemical and biological processes. The capture of electron (also known as charge transfer or charge exchange) is well known to be an important collision process in nearly all types of plasma environments from terrestrial laboratories [1] to solar system atmospheres [2] to astrophysical sources. Ion-molecule collisions have received less attention both theoretically and experimentally than its atomic counterpart due to extra degree of freedom. Using ab initio calculations we report the potential surfaces and coupling matrix elements. Our results will be compared with both theoretical and experimental results, if available. [1] R. K. Janev, in “Atomic and Molecular Processes in Fusion Edge Plasmas” (Plenum Press, NY, 1995), p. [2] T. E. Cravens, Science 296, 1042 (2002).

1Supported by NSF-CREST.

HA.00029 Near-field photoemission microscopy. A. Fisher, St. Lawrence University, C.T. Chadwick, H.D. Hallem, North Carolina State University — Near-field scanning optical microscopy (NSOM) with UV illumination can be used to provide high resolution images of photoelectron production as well as optical and electrical data. A tunable ultraviolet laser can be used to create photoelectrons, which can be collected with the metal coating on the NSOM tapered optical fiber tip. The collection geometry does not permit energy analysis so the source energy must be varied for spectroscopy, but the close proximity of the tip to the sample allows the creation of an extremely high electric field with only a modest (few volt) bias between the tip and sample. These high fields can change the local work function of the material and thus aid the removal of the electrons. This NSOM configuration permits variations of laser wavelength, tip-sample distance, collection voltage, and lateral position on a sample, enabling robust model testing of voltage-assisted photoemission.

HA.00030 ABSTRACT WITHDRAWN

HA.00031 Rate Coefficients for H$_3^+$ Production Measured in an RF Ion Trap. Sam Ronald, Emily Mount, Nick Pope, Adrian Daw, Anthony Calamai, Appalachian State University — The reaction H$_2^+$ + H$_2$ → H$_3^+$ + H is studied using a quadrupole radio frequency ion trap coupled with a time of flight mass spectrometer. protonated molecular hydrogen is one of the most abundant ions in the universe, and is believed to be responsible for the formation of many molecular ions in, for example, the interstellar medium and the aurorae of Jupiter. Also, since this ion is the simplest polyatomic molecule, it can be used as a basis for comparison with other polyatomic molecules. H$_3^+$ is created in a RF ion trap by electron bombardment of H$_2$, and then allowed to react with H$_2$ for varying time intervals before the H$_3^+$ and H$_2^+$ populations are ejected from the trap and detected with an active film electron multiplier. A number of different experimental parameters (H$_2$ pressure, trapping parameters and electron bombardment conditions) are explored and preliminary rate coefficients for the H$_3^+$ + H$_2$ → H$_3^+$ + H reaction are presented.

This work is supported in part by North Carolina Space Grant and by NSF grant AST-04-06706 to ASU.

HA.00032 Optical Filtering with Phase Singularities. William Ames, Irina Novikova, College of William and Mary — It is a common situation in nonlinear optics for strong and weak light fields to propagate nearly collinearly inside an interaction region, but for detection the strong field must be completely removed without attenuating the weak field. To solve this problem we have adopted the idea of the optical vortex coronagraph [G. Foo et al., Opt. Lett. 30, 3308 (2005)]. This optical filtering device converts the strong field into a “doughnut” intensity profile by introducing an optical vortex using a step phase mask, and then filters it out by blocking everything but the dark central part. The weak field, on the other hand, propagating at small angle, is not affected by the mask and can be detected. We demonstrate the effectiveness of the technique, discuss its limitations, and propose improvements to the design.

HA.00033 Dye Assisted-Optical Lithography of Polymers from Liquid-Phase. Redahegn Silshi, Jean-Mishel Taguenang, Fernando Calzanni, Aschalew Kassu, Anup Sharma, Alabama A&M University — There has been much recent interest in polymeric materials for holographic gratings in the field of information storage, wave guide coupling, and nonlinear optoelectronics. Polybutadiene which is synthetic rubber is biologically benign and used in making it attractive as a platform for biomolecular applications. NBD dye assisted optical Lithography of polybutadiene polymers from liquid phase is our main interest here. aqueous solution of NBD (NBD dissolved in distilled water having various concentration) is used as a mask for polymerization of polybutadiene. The basis for this is the synthesis of protonated molecular hydrogen in a RF ion trap by electron bombardment of H$_2$, and then allowed to react with H$_2$ for varying time intervals before the H$_3^+$ and H$_2^+$ populations are ejected from the trap and detected with an active-film electron multiplier. A number of different experimental parameters (H$_2$ pressure, trapping parameters and electron bombardment conditions) are explored and preliminary rate coefficients for the H$_3^+$ + H$_2$ → H$_3^+$ + H reaction are presented.

This work is supported in part by NSF-CREST.


1BCS would like to thank NSF-CREST for Support.
HA.00035 Optical Fluorescence of Long Lived States in NO$^{+1}$, EMILY MOUNT, SAM RONALD, NICK POPE, ADRIAN DAW, ANTHONY CALAMAI, Appalachian State University — By examining the UV and VUV photons emitted from a population of NO$^{+}$ ions stored in a radio-frequency ion trap, we have observed the optical fluorescence of at least two long-lived excited states of NO$^{+}$. These states lie above the NO$^+$ $a^3\Sigma^+$ metastable state and have significantly shorter apparent lifetimes, Calamai and Yoshino J. Chem. Phys. 101 (1994) 9480, than the $a^3\Sigma^+$ state. The measurements we present in this work were obtained as part of a systematic plan to study reaction rate coefficients, decay rates, and cross sections for metastable states of molecules containing nitrogen and/or oxygen. Small atomic and molecular ions, such as O$^+$, O$_2^+$, O$_3^+$, O$_2^{2-}$, N$^+$, N$_2^+$, N$_3^+$, and NO$^+$, are particularly relevant to the Earth’s ionosphere. By improving our knowledge of radiative and collisional parameters associated with metastable states of these ions, significant uncertainties in current ionospheric models will be minimized, and our understanding of the ionosphere will be improved. Data and tentative assignments of the radiative decay signals are presented and discussed.

3This work is supported in part by North Carolina Space Grant and Research Corporation grant CC6409 to ASU.

HA.00036 Mid-infrared Emission and Energy Transfer Properties of Sensitized Nd$^{3+}$ Ions in Low Phonon-Energy Hosts, ALTHEA BLUETT, NATASHA JACOBITZ, NATASHA STOKES, Elizabeth City State University, EIEL BROWN, UWU HOMMERICH, Hampton University, SUDHIR TRIVEDI, Brimrose Corporation of America, JOHN ZAVADA, North Carolina State University — Mid-infrared emission (4-6 µm) stemming from the first excited state of Nd$^{3+}$ can be generated in KPb$_2$Cl$_5$ by pumping its $^{1}F_5/2$ absorption band at ∼800 nm. It has been proposed that 4-6 µm emission of Nd$^{3+}$ could be enhanced by directly pumping the $^1I_{15/2}$ absorption band centered at ∼1650 nm. This pumping scheme could initiate a 3-for-1 cross relaxation, which ultimately increases the population in the first excited state of Nd$^{3+}$. Unfortunately, the $^1I_{15/2}$ absorption band of Nd$^{3+}$ is weak and diode laser pumping of this level is not practical. To more efficiently populate the $^1I_{15/2}$ level in Nd: KPb$_2$Cl$_5$, Tm sensitization of Nd$^{3+}$ via ∼1700 nm excitation is under exploration. Experimental results show that the Tm:Nd energy transfer was successful with energy transfer efficiencies ranging from 46% - 98%. The energy transfer was followed by strong 4-6 µm emission from co-doped Tm, Nd: KPb$_2$Cl$_5$ samples. Preliminary results on Tm, Nd: KPb$_2$Br$_5$ will also be discussed.

HA.00037 Pulsed Proton Beam from an ECR Ion Source, MATTHEW Q. BUCKNER, UNC-Chapel Hill and TUNL, BRET P. CARLIN, Duke University and TUNL, JOHN M. CESARATTO, THOMAS B. CLEGG, UNC-Chapel Hill and TUNL — A remote, LabView-controlled circuit producing variable beam pulse widths and periods has been implemented for an electron-cyclotron-resonance (ECR) ion source at TUNL’s Laboratory for Experimental Nuclear Astrophysics. The pulsed signal programs high voltage power supplies of the ECR source’s beam extraction system. Because the Coulomb barrier lowers the rate for very-low-energy nuclear reactions of astrophysical significance, and environmental and cosmic-ray backgrounds often dominate the signal, pulsed beam can reduce these backgrounds. Increasing the beam intensity by a factor of 10 and pulsing the beam with a 10% duty factor (i.e. 100 ms on and 900 ms off), leaves the average target current unchanged. By gating detector electronics on only during the pulse, 90% of environmental and cosmic-ray backgrounds are suppressed. The pulsing circuit utilizes a 555 timer to produce a pulse, and digital potentiometers to adjust the pulse width and period remotely. Relays allow the ECR source operator to switch between a constant DC beam and a pulsed beam.

3Work supported in part by the US DOE Office of Nuclear Physics.

HA.00038 Search for fractionally-charged particles in Super-Kamiokande, ALEXANDER TUNA, Duke University, SUPER-KAMIOKANDE COLLABORATION — In this study, the search for a fractionally-charged particle (FCP) is extended to the Super-Kamiokande water-Cherenkov particle detector. Monte Carlo techniques are used to simulate FCPs in Super-K and establish cuts to differentiate FCPs from their normally-charged counterparts. The size of this data set will make this study the most sensitive search for FCPs in the cosmic rays to date.

HA.00039 Study of Dark Noise in Super-K Outer Detector, ASHLEY JONES, Duke University, SUPER-KAMIOKANDE COLLABORATION — Super-Kamiokande is a large water Cherenkov neutrino detector in Japan. New algorithms were written to determine the dark noise rates in the photomultiplier tubes of Super-K’s outer detector. They were determined over a period of several years in order to track variations. The sensitivity of neutrino selection routines to the dark noise rates was monitored to improve simulations for the detector.

HA.00040 Method to Investigate the Charging Characteristics of Lunar Dust Particles, STACY IRWIN, SAMUEL DURRANCE, Florida Institute of Technology, CHARLES BUHLER, ASRC Aerospace, CARLOS CALLE, Electrostatics and Surface Physics Laboratory, NASA Kennedy Space Center — We have designed an experiment to investigate the induction charging and charge decay characteristics of lunar dust particles. The induction and charge decay characteristics of granular materials depend on their surface resistivity. Since the surface resistivity properties of hydrophilic materials can be easily controlled with humidity, we have conducted initial experiments with borosilicate glass beads in a 10-20 kV constant electric field at various humidities in a controlled environmental chamber. We report on the results of these initial experiments.

HA.00041 Effects of fluid instabilities in three-dimensional SNR structure, DION WARREN, JOHN BLONDIN, North Carolina State University — The Chandra X-Ray Observatory has provided spectacular high-resolution views of the shocked ejecta in young supernova remnants like Tycho. We use large-scale three-dimensional simulations to investigate the hypothesis that the spatial structure seen in these images is attributable to the fluid instabilities at the interface between shocked ejecta and shocked circumstellar gas. Simulations were run on the University of Texas’ Ranger supercomputing cluster, over many expansion times, on grids of ~500-1000 zones on a side.

HA.00042 GRB 080319b: Modeling the Naked Eye Burst, MARK SCHUBEL, UNC Chapel Hill, UNC GRB TEAM — Modeling Gamma-Ray Bursts (GRBs) requires both rapid response and attention to detail. GRBs often only last several seconds, and in that time, one needs to be able to image the field, and then begin to quickly reduce and analyze the data to determine if the burst can be found, and then to begin to determine its brightness. This is especially true when a truly unique burst occurs, such as GRB 080319b. This burst, often referred to as the “Naked-Eye” burst since it was so bright (~5 magnitude in R at peak) it could have been seen by the naked eye. We will discuss the process of getting this burst ready for modeling, including the prompt-response by the PROMPT telescopes (which responded 32 seconds after the burst and had detections in UVRI), reduction in IRAF, field-calibration and finally modeling the burst using Galapagos, a genetic-algorithm powered modeling suite that can efficiently maneuver the multi-dimensional parameter space to determine some of the environmental conditions of the burst, and shed some light on conditions of the early universe.
HA.00043 The GRB Afterglow Modeling Project: Extinction of Extragalactic Point Sources 1.

ADAM TROTTER, DANIEL REICHART, University of North Carolina, Chapel Hill — The Afterglow Modeling Project (AMP) will determine, in a statistically self-consistent way, parameters that describe the time- and frequency-dependent emission and absorption of every gamma-ray burst (GRB) afterglow observed since the first detection in 1997. The result will be an ever-growing catalog of GRB afterglow models that can itself be analyzed to better describe the range of and relationships among the physical properties of GRBs and their environments. We present the model for GRB afterglow extinction. Approximately 40 parameters describe line-of-sight extinction due to: dust, neutral Hydrogen and molecular Hydrogen in the GRB host galaxy; neutral Hydrogen in the intergalactic medium (the Lyman-alpha forest); and dust in our own Galaxy. This very large parameter space is significantly reduced by priors, which we determined by analyzing previously published extinction measurements of stars in our Galaxy, and flux deficits due to Lyman-alpha absorption in the spectra of quasars at redshifts in the range 1<z<5 (which includes the Gunn-Peterson trough). The AMP project aside, these parameters and priors can be used to model extinction towards any extragalactic point source, including supernovae.

1 AT Acknowledges support of the N.C. Space Grant.

HA.00044 Origin of the Ring Fingers in Supernova 1987A.

JOHN BLONDIN, CLINT GIBSON, North Carolina State University — We demonstrate that the fingers of dense gas protruding inwards from the equatorial ring of SN 1987A is a natural consequence of the interacting winds model invoked to explain the circumstellar rings. At early times in the formation of the circumstellar shell, the wind shocks must have been strongly radiative, leading to a thin, dense, shock-bounded shell. Such a shell is subject to the non-linear thin shell instability, albeit in a more complex geometry than the early planar studies of the NTSI. Using three-dimensional hydrodynamic simulations, we show that the observed characteristics of the “string of pearls” around SN 1987A are consistent with the canonical interacting winds model subject to the NTSI.

HA.00045 Mechanics in Early Solar System Formation.

JUNICHIRO FUKAI, Auburn University — The generally accepted model for the early stage of the evolution of the solar system is the solar nebula, where a protostar, in this case our sun, at the origin is surrounded by a rotating material disk. The material in the disk collides, coalesces, and gradually forms aggregated objects. This coalescence of objects increases the total angular momentum of the resulting aggregate and the aggregating objects consequently experience an effective force of the form A/r^2 (where A is a constant) in the radial direction (Bacon 1959). Taking into account the gravitational force exerted by the sun, the force acting on such an aggregating object is A/r^2 - B/r^2, leading to logarithmic spiral orbits with a periodic feature of 2π in the azimuthal angle. This paper treats the interactions of these small spiraling objects with larger protoplanets as perturbations to the Kepler problem of the planets (Gryzinski 1980). When stability conditions are imposed, the periodicity of the planetary orbits are found to be discrete; T_n = (2nπ)/(B^2 - A^2), where n = 0, 1, 2, 3, . . . measured in days, which is in good agreement with observations (Graner and Dubrulle 1994).

Reference:

HA.00046 Acoustic Wave Dynamics in the Post-Bounce Phase of Core Collapse Supernovae.

KEITH HEYWARD, North Carolina State University — How a core collapse supernova successfully “explodes” is only partially understood. Computer models indicate that the accretion shock wave stalls about 200 km from the newly formed proto-neutron star. Despite the abundance of energy from the gravitational collapse and theories predicting how this energy might reenergize the accretion shock, simulations still fail to produce a robust explosion. Hydrodynamic models play an important role in this analysis. Using hydrodynamic modeling, I will describe the nature of acoustic waves driven by the proto-neutron star and the dissipation of thermal energy by these waves into the critical “Gain Region.” Using the criteria for a successful explosion laid out by Janka in 2001, I will then describe the impact that this energy has on a successful restart of the stalled accretion shock.

HA.00047 Supernova neutrino sensitivity of a water Cherenkov detector.

MARK STEADMAN, Duke University — One of the most interesting recent discoveries is that of neutrino oscillations. Even with recent progress some of the parameters of the mixing matrix, such as θ13, are not well-known. A galactic supernova provides the possibility to measure these parameters, as well as to determine the nature of the mass hierarchy. I will present a poster on the potential to measure these parameters using current water Cherenkov detectors such as the Super-Kamiokande detector.

HA.00048 The Earthly Origin of the Penzias-Wilson Microwave Background According to General Relativity.

DIMITRI RABOUNSKI, LARISSA BORISSOVA — According to General Relativity, an observer on board of a satellite fixed to the Earth should register a Doppler-like anisotropy in the field of photons, emitted on the Earth, due to the rotation of the Earth’s space and its motion relative to the resting stars (Rabounski, Borissova: Fall 2008 Meeting of the New England Sect. of APS). Thus the Doppler anisotropy of temperature in the Penzias-Wilson microwave background, obtained from photons by the COBE satellite (Rabounski: Fall 2008 Meeting of the Ohio Sect. of APS; Prog. Phys., 2007, v.1, 24), indicates the earthly origin of the background. This is the complete theoretical proof to the experimental analysis by Robitaille (Prog. Phys., 2007, v.1, 3, 19), according to which the Penzias-Wilson microwave background is of the Earth, and is generated by the oceans. The monopole component of the Earth’s microwave background decreases with altitude, while its dipole anisotropy remains the same (Rabounski, Borissova: 2008 APS March Meeting; Prog. Phys., 2008, v.2, 3). Thus the PLANCK satellite targeting the monopole at the L2 point (1.5 mln km from the Earth), will give the final answer to the problem.


ARIA A. MINOT — Several leading astrophysical models associate a diffuse flux of high-energy neutrinos from active galactic nuclei and other extra-galactic sources. It is expected that, for muon energies about 1 TeV, the upward-going muon flux induced by neutrinos from astrophysical sources should exceed the flux of muons induced by atmospheric neutrinos. A search for high energy neutrinos of the ≳ 1 TeV range in Super-Kamiokande II’s data was performed by looking in the data for ultra-high energy upward-going muons induced by the high energy neutrinos interacting in the rock beneath the detector. One UHÉ-upmu candidate was found in the 860.37 days of live-time. The method used to fit the track of the muons’ path in the detector has been improved, so the search is now less dependent on human classification and more automated than the previous search. This search will be used to place a 90% classical confidence level limit on the diffuse flux of upward-going muons due to neutrinos from astrophysical sources in the muon energy range 3.16-100 TeV.


ARIA A. MINOT, Duke University — Evidence of gravitational waves associated with gamma ray bursts (GRBs), in addition to perhaps revealing new physics, may explain the cause of these highly energetic events. In order to detect the presence of gravitational waves in association with GRB events, it is necessary to separate signal and background effectively. Different multivariate analysis algorithms using Boosted Decision Trees (BDTs) and Artificial Neural Networks (ANNs) were implemented to achieve better separation during this project. Using simulated events of gravitational wave signal and real LIGO data not associated with GRBs, trees and networks were trained and tested under many different configurations. Currently, the best classifier is a BDT that achieves a signal efficiency of 89.5 ± 0.2% at 1% background contamination.
HA.00051 Comparison of Water Vapor Measurements from GPS Atmospheric Remote Sensing Techniques, IAN C. COLON-PAGAN, University Center for Atmospheric Research (UCAR)/Significant Opportunities in Atmospheric Research and Science (SOARS) Program, BILL KUO. National Center for Atmospheric Research (NCAR)/Constellation Observing System for Meteorology, Ionsphere, and Climate (COSMIC) Center, COSMIC TEAM — In this study, we compare precipitable water vapor (PWV) values from two different observing techniques over the Caribbean Sea, Gulf of Mexico, and U.S. regions, including ground-based GPS water vapor sensing and COSMIC radio occultation (RO) measurements, as well as global analyses from NCEP and ECMWF models. The PWV values estimated by ground-based GPS receivers tend to have a slight dry bias for low PWV values and a slight wet bias for higher PWV values, when compared with space-based techniques. This may be a consequence of missing low altitude data from RO in areas where the water vapor is concentrated, locations of the RO soundings with respect to ground-based stations, or simply the difference of these two measurement techniques. A student T-test application gives a retrieved t-value of 2.35, which is larger than the sample's critical value, 1.96. This means there is a significant difference between both GPS techniques datasets with a 0.01% chance of observing a difference as large as it was observed in other random samples.

HA.00052 The Topology of Chaotic Transport and Escape, JAIWON NOVICK, College of William and Mary, KEVIN MITCHELL, University of California Merced, JOHN DELOS, College of William and Mary — Chaotic transport and escape appears in many different systems such as the escape of an asteroid from a planet's gravitational field to the escape of ionizing electrons from hydrogen in parallel electric and magnetic fields. Numerical simulations have shown that the times to escape some region without return possess a complicated fractal structure. These fractals result from the intersection of a line of initial conditions and a homoclinic tangle, which is formed from the intersections of infinitely long stable and unstable manifolds emanating from an unstable fixed point. Our group has developed Homotopic Lobe Dynamics, a topological theory that allows one to predict subsets of the fractals seen in numerical simulations. We first show how to apply homotopy to a homoclinic tangle to obtain a set of symbols and a dynamical mapping on the symbols. A symbol and its mappings encode the evolution of an entire family of trajectories. Given a symbol and its mappings, we show how to construct a theoretical fractal. Finally, we compare a predicted fractal to one obtained from a numerical simulation of trajectories propagating in an open chaotic vase-shaped billiard.

3Supported by NSF

HA.00053 Chaotic Escape of Particles from a Vase-shaped Cavity: Theory and Experiment, JAIWON NOVICK, College of William and Mary, LEN KEELER, University of Minnesota Morris, JOHN DELOS, College of William and Mary — We study the escape of particles from a two dimensional, specularly-reflecting open vase-shaped cavity. The narrowest point of the vase's neck defines a dividing surface between particles that escape without return and those turned back into the vase. We find trajectories whose path displays a sensitive dependence on launch angle. For our analysis, we consider a point burst of particles emitted in all directions and record the time to reach the vase's neck. We find that this escape time versus the launch angle displays a complex fractal structure. First, we outline a topological theory that predicts a subset of the fractals seen in numerical simulations. We perform a simulation of classical trajectories and compare the simulated fractal to the theoretical prediction. Through a collaborative effort we have experimentally verified the early fractal structure in the escape time using ultrasound. A microphone was placed along the vase's neck to record escaping pulses. We find that classical trajectories arriving at the microphone positions arrive very near the times at which the experimental signal is strongest.

1Supported by NSF

HA.00054 Why So Many Calories?, H.L. NEAL, Physics Dept., Clark Atlanta University, Atlanta GA 30314 — It is observed that there are at least four definitions of the calorie, including the one used in nutrition. In this note a detailed review of each of these definitions is presented. This is followed by a discussion of why and how multiple definitions were developed.

HA.00055 QMC Goes BOINC: Using Public Resource Computing to Perform Quantum Monte Carlo Calculations, CAMERON RAINNEY, LARRY ENGELHARDT, Francis Marion University, Florence, SC, CHRISTIAN SCHRODER, THOMAS HILBIG, University of Applied Sciences Bielefeld, Bielefeld, Germany — Theoretical modeling of magnetic molecules traditionally involves the diagonalization of quantum Hamiltonian matrices. However, as the complexity of these molecules increases, the matrices become so large that this process becomes unusable. An additional challenge to this modeling is that many repetitive calculations must be performed, further increasing the need for computing power. Both of these obstacles can be overcome by using a quantum Monte Carlo (QMC) method and a distributed computing project. We have recently implemented a QMC method within the SpinSinh@Home project, which is a Public Resource Computing (PRC) project where private citizens allow part-time usage of their PCs for scientific computing. The use of PRC for scientific computing will be described in detail, as well as how you can contribute to the project.

1Funding was provided by the FMU quality enhancement plan.
4Project URL: http://spin.fh-bielefeld.de

HA.00056 What is Fine-structure Constant?, SHANTILAL GORADIA, Gravity Research Institute, Inc. — Equation in [1]

\[ \alpha \geq \frac{1}{\ln \sqrt[4]{\lambda}}, \]

\[ \text{linking fine-structure constant and cosmological constant derived by using } S = k \ln W, \text{ the total number of microstates used (W) is } 10^{60}, \]

\[ \text{justified based on a unique age tagged to each Planck time. The OPEN and CLOSED states of the particle's mouth illustrated in [1] could be two different types of entropic repositioning pulses, say attractive and repulsive. The characteristics of a microstate need not change the number of microstates. Mathematically then, } W = N! / n!(N-n)!, \text{ where } N = 10^{60} \text{ and } n = 1; \text{ giving } W = 10^{60}, \text{ used in [1].} \]

[1] There are reasons to consider each Planck time as unique microstate based on its unique age. While investigating the proposal in terms of other theories, one has to be in mind that the knowledge that created one problem cannot solve another. Refer to [1] Goradia, Shantilal, "What is Fine-structure Constant?" http://arXiv.org/pdf/physics/0210060v3

HA.00057 The Hyperbolic Law in the Periodic Table, ALBERT KHAZAN — My recent presentations at the APS Meetings gave a theory which gave the heaviest (last) element of the Periodic Table of Elements. The basis of the theory is the equilateral hyperbola Y=K/X. These arcs taken in the logarithm coordinates (Ln Xo, Ln Yo) draw straight lines in the 4th quadrant right of Hydrogen, and parallel to it. The real axis (Ln Yo=Ln Xo-6,0202) transects them at the points which present the tops of the elements of the Periodic Table. The number of the heaviest (last) element was calculated: the element content Y per gram-atom in any chemical composition of the molecular mass X can be given by the equations of the positive branches of the equilateral hyperbola Y=K/X (Y \leq 1, K < X), which are located according to the increase of the nuclear charge, and are a real axis common with their tops: with distance from the origin of the coordinates they approach to the positions Y=1 or K=X where the atomic mass is ultimate high - the last element of the Table (Progr. Phys., 1/2007, 38; 2/2007, 83, 104; 3/2008, 56).
HA.00058 Photoactivity of Chemically Deposited Rutile Thin Films on Si(111) , JOHN F. ANDERSON, University of Louisiana at Monroe, ERIE MORALES, Tulane University. KENNETH HARRIS, University of Louisiana at Monroe, ULRIKE DIEBOLD, Tulane University, ULM PHYSICS COLLABORATION, TULANE SURFACE SCIENCE COLLABORATION — Chemical Bath Deposition from acidic (pH < 2) solutions at low temperature (35°C – 55°C) produced thin titanium dioxide films with rutile crystalline structure on clean Si(111) wafers. The films were characterized by X-ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscopy (SEM), and X-ray Diffraction (XRD). Their thicknesses varied from 300 nm up to ~1 µm, and annealing was required to ensure adherence to the Si(111) substrate. SEM images show a rough TiO₂ surface, and XRD indicates the rutile structure of TiO₂. The rutile films exhibit photoactivity as evidenced by a physical decomposition of methyl orange when exposed to a 254 nm (4.88 eV) lamp.

HA.00059 In vitro Electroperoration on a microchip with heart valve cells , HONGBAE KIM, Solco Biomedical Institute, Solco Biomedical Company, JUNGHAN YI, HUNGSIK KIM, College of Biomedical & Life Science, Konkuk University, Chungju-si, 380-701, YOUN-SUK CHOI, Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology, SAEYOUNG AHN, Solco Biomedical Institute, Solco Biomedical Company — Electroperoration in biological cells involves rapid structural rearrangement and formation of pores in the lipid bilayer, in response to an externally applied electric field. To investigate electroperoration, we fabricated a chip with two electrodes that is 1mm in distance between them, having six electroporation sites of the same geometry that mounted on a Pyrex glass substrate. The electroporation was performed using a sequence of nine dc pulses of having a pulse width 100 µs each varying the applied amplitudes (375, 750, 1k, 1.3kV/cm), at a frequency of two and five pulses per second so that we may investigate how the applied voltages and pulse number may exert on efficacy of the chip. We used PI and Calcein-AM to measure the efficacy of the electroporation. Cell viability was also measured after electroporation. The analysis have showed that the sample applied 1kV/cm gated at a rate 15.9% and 88.9% than the control along with pulse number 2 and 5 respectively, revealing the increasing exponentially. The cell viability was over 91% as all the applied electrical conditions.

HA.00060 Controlled Deposition of SWNTs for Fabrication of Flexible Structural Health Monitoring Strain Sensors , PHILLIP WILLIAMS, BUZZ WINCHESKI, NASA Langley Research Center, DAVID BROWNE, Lehigh University — Single-wall carbon nanotubes (SWNTs) are currently investigated for a host of aerospace applications due to their remarkable strength-to-weight ratio and electromagnetic properties. Based on the predicted strength-to-weight advantages and inherent multifunctionality, single-wall carbon nanotube (SWNT)-based materials represent an ideal candidate for the construction of sensors capable of measuring several parameters related to an aerospace vehicle’s structural health (e.g., strain, temperature, etc.), i.e. structural health monitors (SHMs). Specifically, individual SWNTs can exhibit electrical conductivity changes due to strain. Here we report on progress in utilizing this phenomenon to produce SWNT strain-sensing SHMs. Prototype device geometries are fabricated via lithographic techniques to pattern contact electrodes on substrates and controlled depositions of SWNTs between the electrodes using electric fields via dielectrophoresis. After deposition, conductivity measurements and scanning electron and probe microscopy characterize the degree of SWNT alignment and the physical and electromagnetic properties of the devices. Optimization of the carbon nanotube deposition parameters and transfer of the patterned SWNT devices to flexible, polymer-based substrates are discussed as a basis for flexible, SHM strain sensors.

HA.00061 Single Molecule Measurements of Protelomerase TelK-DNA Complexes , MARKITA LANDRY, Graduate Student, RUSTEM KHAFIZOV, Co-author, WAI MUN HUANG, Collaborator, YANN CHEMLA, Primary Investigator, PROTEIN SAMPLES COLLABORATION — Protein-DNA interactions lie at the heart of many essential cellular processes such as replication, recombination, and repair. Recent advances in optical “tweezers” have made it possible to resolve motions on the scale of a single base pair of DNA, 3.4 Å. High-resolution optical traps have the potential to reveal these interactions at their fundamental length scales and should reveal how certain proteins bind to DNA or recognize target sequences. Telomerases are enzymes that have been actively studied in various organisms because of their fundamental involvement with both cancer and aging. Telomerase TelK is an enzyme responsible for forming closed DNA hairpin ends in linear DNA. TelK is not an ATP dependant enzyme, which is surprising given the degree of DNA distortion accomplished by the enzyme, and the large energy barrier intrinsic in DNA hairpin formation. Therefore, our focus is on TelK mutants lacking their c-terminal domain, and TelK YF mutants lacking their tyrosine active site amino acid. Preliminary data have shown remarkable differences in protein binding and unbinding forces caused by the removal of a single oxygen atom from a 73 kDa protein. Further measurements using high-resolution optical tweezer should provide fundamental insights into the nature and importance of the electrostatic interactions between TelK and its DNA substrate. 1. Shay, J. et al. Rad. Res. 155, 188 (2001) [1] Huang, W. et al. Mol. Cell. 27, 901 (2007).

HA.00062 Is there Significant Evidence for a Sterile Neutrino? , AARON ALLEN, Clemson University, NATHANIEL MOORE, University of Missouri–Columbia, DAVID ERNST, Vanderbilt University — Throughout the history of neutrino physics and neutrino experiments, there have been significant hints in the data that seemingly give rise to new implications for neutrino physics. Neutrino oscillations are the only experimentally verified particle phenomenon not accounted for in the Standard Model of particle physics. Evidence for a new type of neutrino has been proposed. In this project, we seek to re-analyze and reproduce key results from LSND and MiniBoone. Combining with existing analysis programs, we look to achieve a consistent data approach fitting into a 3+1 (sterile) neutrino scheme. Finding a neutrino such as this would have major effect on existing cosmological models as a new candidate for dark matter and the early development of the universe.

HA.00063 Quasiguided optical modes in nanophotonic organic solar cells , JOHN TUMBLESTON, DOO-HYUN KO, EDWARD SAMULSKI, RENE LÓPEZ, University of North Carolina - Chapel Hill — Organic photovoltaics with highly ordered, nanopatterned photofactive layers offer an alternative to conventional planar devices that suffer from a competition between absorption and free carrier transport. Our recent studies have shown that nanopatterned devices exhibit enhanced absorption and excitation collection profiles as compared to planar cells. Improved absorption results in part from the excitation of quasiguided optical modes where certain photon energies near the semiconducting band edge are enhanced 20-fold. Prerequisites for their excitation include an index of refraction contrast of 0.3 for the two nanopatterned materials and a periodicity comparable to the band edge wavelength. Quasiguided mode dispersion determined via photonic band calculations and variable angle absorption measurements indicate that both fast and slow modes exist in nanopatterned devices. Quantum efficiency measurements also confirm that quasiguided mode excitation occurs in the photovoltaic material leading to improved electrical performance.

HA.00064 Visible Far-Field Superlens for Two-Dimensional Imaging Below the Diffraction Limit , EMILY RAY, RENE LÓPEZ, University of North Carolina at Chapel Hill — Retaining the information carried by evanescent waves scattered from an object could allow for imaging features below the diffraction limit without time consuming scanning procedures. We show experimental results of sub-diffraction-limit imaging using multilayer stacks. The multilayer stack has an effective negative index of refraction that enhances evanescent waves. Interaction with the diffraction grating converts waves from evanescent into propagating, enabling collection with conventional optics. We are able to tune this far-field superlens (FSL) to our choice of operating wavelengths by modulating the thickness of the metal and dielectric layers. For a wavelength of 532 nm, we used thicknesses of 20 and 100 nm for the Ag and Al₂O₃ layers, respectively, and simulated the evanescent waves by launching beyond the critical angle of a 1.5 refractive index material. This data supports that a FSL of this type can be used in the visible to amplify evanescent waves in spite of the metal absorption.

1 NSF Center for the Living Cell. Graduate College Fellowship. Burroughs Wellcome Fund

1 Special thanks to Vanderbilt University REU coordinators for support and the National Science Foundation for funding.
Friday, October 31, 2008 1:30PM - 3:30PM –
Session JA Nuclear Exotic Beams Holiday Inn Brownstone Washington

1:30PM JA.00001 Spectroscopy of light exotic nuclei in resonance reactions1. Grigory Rogachev, Florida State University — Light exotic nuclei is an important arena where predictions of modern ab initio theories can be tested. Unfortunately, experimental information on the structure of many light exotic isotopes is very incomplete due to experimental difficulties. With Radioactive Nuclear Beams, however, one can use simple resonance reactions to probe the structure of exotic nuclei. The advantage of this approach is mainly related to the fact that resonance reactions have high cross section and provide direct way to extract spectroscopic information. Recent experimental advances in the spectroscopy of light exotic nuclei using resonance reactions will be discussed. More specifically the following nuclei will be considered: \(^{18}\)B was studied in an elastic and inelastic scattering of protons on \(^{7}\)Be, \(T=3/2\) isobaric chain of \(A=9\) nuclei was studied using the \(^{1}\)H(\(^{8}\)B,p) and \(^{1}\)H(\(^{7}\)Li,p) reactions, populating resonances in \(^{18}\)O and \(T=3/2\) states in \(^{18}\)Be respectively. Similar studies were performed for \(T=3/2, A=13\) isobaric chain, where states in \(^{18}\)O and \(T=3/2\) resonances in \(^{18}\)C were populated using \(^{1}\)H(\(^{12}\)N,p) and \(^{1}\)H(\(^{13}\)B,p) reactions. Level structure of these exotic nuclear systems will be discussed and compared to theoretical predictions. Experimental difficulties and possible ways to resolve them will be considered.

This work is supported by NSF under grants PHY04-57120, PHY04-56463, PHY06-52991.

2:00PM JA.00002 \(^{78}\)Ni, Nuclear Structure and LeRIBSS: New results from the HRIBF, Jeff Winger, Mississippi State University — The nucleus \(^{78}\)Ni is the most neutron-rich doubly magic nucleus (\(N/Z=1.79\)) which can be reached using the available experimental techniques for the foreseeable future. Or at least we have long considered this nucleus to be doubly magic. Recent theoretical studies have shown the importance of the tensor component of the neutron-proton interaction [1] and coupling to continuum states [3] in causing a shift in the single particle energies for this neutron-rich region. The net effect is that we may no longer live in a happy little world of robust shell closures at \(Z=28\) and \(N=50\) as we move away from stability. Hence, we have a region of great interest for experimental studies. At the Holifield Radioactive Ion Beam Facility (HRIBF) of ORNL, the UNIRIB Consortium has begun a systematic study of nuclei in the \(^{78}\)Ni region. This began two years ago with a successful campaign using re-accelerated radioactive beams of \(^{76}-^{79}\)Cu and \(^{83}-^{86}\)Ga. This year, we made our first measurements using the low-energy Radioactive Ion Beam Spectroscopy Station (LeRIBSS). I will give an overview of the results of the earlier experiment, present some preliminary results from the LeRIBSS runs, and discuss our future plans. Funded by DOE grant DE-FG02-96ER41006.


2:30PM JA.00003 Direct measurements with low-energy, rare isotope beams for nuclear astrophysics1, Jeff Blackmon, Louisiana State University — Measurements with beams of rare isotopes are now providing data that is helping to improve our understanding of stellar explosions. Beams of exotic proton-rich nuclei at low energies (\(E_{\text{cm}} < 2\) MeV/u) are of special interest since they allow cross sections for reactions that are important in novae and X-ray bursts to be directly measured over the energy range relevant in the stellar environment. These are challenging measurements due to small cross sections, but sensitive new techniques are allowing measurements even with weak radioactive ion beams. Measurements with \(^{17}\)F and \(^{18}\)F beams at the Holifield Radioactive Ion Beam Facility will be reviewed, focusing on a recent measurement of the \(^{17}\)F(p,\(n\))\(^{18}\)Ne cross section using the Daresbury Recoil Separator. The exciting future prospects for measurements will also be discussed, including a program with reaccelerated fragmentation beams at the National Superconducting Cyclotron Laboratory and the possibilities with a next-generation Facility for Rare Isotopes Beams now under development by the U.S. Department of Energy.

This work supported by the U.S. Dept. of Energy.

3:00PM JA.00004 Alpha decay studies near \(^{100}\)Sn, Sean Liddick, University of Tennessee — Nuclei around the exotic doubly-magic \(^{100}\)Sn can provide key information to, and serve as rigorous tests of, the nuclear shell model. In particular, the energy splitting between neutron single-particle orbits in this region, the \(\nu d_{5/2} - \nu g_{7/2}\), can be extracted from the low-energy excited states in the odd-N Sn isotopes, ideally from \(^{101}\)Sn. Identification and examination of these nuclei is aided by the presence of an island of alpha and proton radioactivity for nuclei with \(Z > 50\) near \(^{100}\)Sn. The isotopes \(^{109}\)Xe and \(^{105}\)Te were identified at the Holifield Radioactive Ion Beam Facility using the Recoil Mass Spectrometer through the observation of the characteristic alpha decay chain \(^{105}\)Xe \(\rightarrow ^{101}\)Te \(\rightarrow ^{101}\)Sn. The efficient identification of the fast \(^{105}\)Te alpha decay was enabled through the use of digital signal processing using advanced pulse shape analysis algorithms. The unique double alpha decay pulse provided an ideal tag to observe gamma-ray emission from the excited states of both \(^{105}\)Te and \(^{101}\)Sn at approximately 150 and 172 keV, respectively. Both excited states in \(^{105}\)Te and \(^{101}\)Sn were populated through alpha decay. The observation of the first excited state in \(^{101}\)Sn provides the \(\nu d_{5/2} - \nu g_{7/2}\) energy splitting. Using the experimental value in shell model calculations suggests an ordering of single particle states in \(^{101}\)Sn that contradicts previous expectations. The possibility of reaching the \(^{108}\)Xe \(\rightarrow ^{104}\)Te \(\rightarrow ^{100}\)Sn alpha decay chain will also be discussed.

Friday, October 31, 2008 1:30PM - 3:30PM –
Session JB History and Philosophy of Physics Holiday Inn Brownstone Roosevelt

1:30PM JB.00001 P.A.M. Dirac’s Impact on Physics, Eugen Merzbacher, University of North Carolina at Chapel Hill — Paul Dirac (1902-1984) was not as well known as the other founding fathers of quantum mechanics in the 1920’s, but his contributions were equally important, and he won the Nobel Prize in 1933, at the same time as Heisenberg and Schrödinger. He spent the last fifteen years of his life in the SESAPS region, in Tallahassee, Florida. I will describe his life and his work, comment on his style, and recount how he arrived at the relativistic wave equation. I will describe one of my personal encounters with Dirac and, if I can manage not to bungle it, show a physics demonstration that is relevant to the application of group theory to quantum mechanics, a subject that Dirac and other detractors scathingly referred to as ‘Gruppenpest’.

2:00PM JB.00002 Entanglement, Complementarity, and Decoherence: Bohr on the Classical and the Macroscopic, Don Howard, University of Notre Dame — Does decoherence validate or invalidate Bohr’s complementarity interpretation of quantum mechanics? Both positions have been asserted in recent literature. This paper argues that Bohr’s understanding of the relationship between quantum and classical descriptions is strongly reinforced by decoherence, but only if complementarity is rightly understood as (a) not asserting wave-packet collapse, (b) not requiring a classical description of the measurement apparatus in its entirety, and (c) taking entanglement as the essence of a quantum-mechanical description.
Finally, the transition characteristics is observed by the resistance with the increase of temperature by Van Der Pauw method from 25 to 100°C. The structure changes from monoclinic phase (semiconductor) into tetragonal phase (metal phase). We have grown high-quality epitaxial vanadium oxide (VO2) semiconductor to metal transition material (SMT) which has a very sharp transition temperature close to 340 K as the crystal structure of VO2. Using pulsed ENDOR and C pulsed ENDOR measurements at 240 GHz on the N14 in VO2 at 100 kHz, we have measured the ENDOR signals of different nuclei. Here we present the results of these experiments and discuss the implications for the future study of vanadium oxide.

This research was sponsored by the National Science Foundation.
Initio Quantum Calculations on RPE-MOCVD Deposited Titanium Silicate Alloys, NICHOLAS STOUTE, GERALD LUCOVSKY, DAVID ASPNES, North Carolina State University — We report thin film titanium silicate alloys, with a range of compositions between 0 and 100% TiO2, deposited on Si(100) substrates through Remote Plasma Enhanced Metal Organic Chemical Vapor Deposition (RPE-MOCVD). Samples were measured in both their as-deposited condition and after a range of annealing temperatures. The conduction-band electronic structure of these alloys were analyzed though O K \text{1s} and Ti L2,3 X-Ray Absorption Spectroscopy (XAS) measurements as well as Spectroscopic Ellipsometry measurements preformed in the 1.5 to 6 and 4.5 to 8.5 eV energy ranges. Results were correlated with previous theoretical and experimental studies as well as new Ab-Initio quantum calculations. Emphasis is placed on correlating spectroscopic data with calculations on 4-fold coordinated tetrahedral as well as 6-fold coordinated rutile and anatase structures to obtain spectroscopic signatures of phase changes and crystallization. Investigations into the effect of bond distortions on the electronic structure will also be presented.

2:30PM JC.00006 Tunable THz plasmon resonances in a InGaAs/InP heterostructure, HIMANSHU SAXENA, ROBERT PEALE, University of Central Florida Orlando 32816, WALTER BUCHWALD, AFRL/RYHC Hanscom AFB MA 01731 — Gate-bias tuned plasmon resonances excited by THz radiation in a two dimensional electron gas are reported. A commercial InGaAs/InP HEMT wafer is patterned with source, drain, and 500 nm period grating gate contacts. The grating couples THz radiation to the plasmons, defines their wavevector, and tunes the sheet charge density with applied bias. Fourier spectroscopy over the range 10 – 200 cm\(^{-1}\) at 4 K reveals absorption at the fundamental plasmon frequency along with several higher harmonics. These resonances shift to lower frequency with sheet-charge depletion as expected from theory and the device electrical properties. The device has potential as a tunable narrow-band detector for spectrometer on a chip and space situational awareness applications.

2:42PM JC.00007 Epitaxial growth of zinc oxide thin films on silicon (100) substrates with zirconia buffer layer, RAVI AGGARWAL, Department of Materials Science and Engineering, North Carolina State University, CHUNMING JIN, Joint Department of Biomedical Engineering, University of North Carolina, WEI WEI, JAGDISH NARAYAN, Department of Materials Science and Engineering, North Carolina State University, ROGER J. NARAYAN, Joint Department of Biomedical Engineering, University of North Carolina — As an II-VI semiconductor, with wide bandgap and high exciton binding energy, zinc oxide has been favored for the new opto-electronic devices. One of the key issues for such applications is the integration of the zinc oxide onto silicon substrates. In this paper, we report a new integration methodology for depositing high quality zinc oxide thin films on silicon substrates. We have developed a novel epitaxial system for this purpose. An yttria stabilized zirconia (YSZ) buffer layer was used for depositing high quality, single crystalline zinc oxide films on Si (100) substrates. The heterostructure was developed with a pulsed laser deposition system. The results show that ZnO films grow epitaxially on YSZ buffered Si (100) substrates, with c-axis perpendicular to the substrate surface. High resolution image demonstrated that the interface between YSZ and ZnO is atomically smooth without any evidence of reaction. These zinc oxide films on Si (100), with YSZ buffer, showed excellent photoluminescence, evidenced with an extremely high exciton emission centered at 377 nm, at room temperature.

2:54PM JC.00008 Cavity Ring Down Spectroscopy for Atmospheric Research, ISRAEL BEGASHAW, SOLOMON BILLIGN, ANTHONY COCHRAN, CHRISTOPHER JESSAMY, North Carolina A&T State University — The study of the atmosphere requires full appreciation for several important chemical processes that occur at very small scales. Cavity ring down spectroscopy is one of the most sensitive absorption techniques available. The technique involves measuring the rate of absorption of light by a sample placed in a high-finesse optical cavity. Our lab uses an Nd-Yag pumped dye laser. The laser light is passed through an isolator and telescope set up and is coupled into an optical cavity containing highly reflective mirrors. As the light reflects back and forth between the two mirrors, a small amount leaks out of the cavity the decay time of the leaked light is measured. This decay time constant is dependent on the cavity design and sample placed in the cavity. We are using this sensitive technique to study the spectra of water vapor around 715-740nm. Work is also underway to study NO3 + Isoprene with the same technique. Preliminary results will be reported.

3:06PM JC.00009 Wavelet-based adaptive mesh refinement algorithm for atmospheric chemical transport modeling, YEVENII RASTIGEJEV, North Carolina A&T State University — Numerical modeling of chemical transport in the Earth atmosphere is essential for addressing problems and issues related to atmospheric air quality, greenhouse gases budget and climate forcing. Chemical transport models (CTM) combine chemical reactions with advection by a meteorologically predicted flow velocity. The resulting system of equations is extremely stiff, nonlinear and involves a large number of chemically interacting species. The difficulty of solving these equations imposes severe limitations on the spatial resolution of the CTMs. Wavelet-based Adaptive Mesh Refinement (WAMR) algorithm has been developed to address these difficulties. WAMR allows a fine grid in the regions where sharp transitions and cruder grid in the regions of smooth solution behavior. Thus WAMR results in much more accurate solutions than conventional finite difference methods implemented on a uniform grids. Numerical experiments showed the algorithm ability to achieve much higher accuracy than traditional numerical methods with the same number of grid points.

Friday, October 31, 2008 3:45PM - 5:45PM –
Session KA Successful Programs in Physics Education Holiday Inn Brownstone Sessions

3:45PM KA.00001 The Evolution of and Evolution in the Next Generation Florida Science Education Standards, GERRY MEISELS, University of South Florida — Florida was one of the first states to establish education standards, including Science, in 1996. Recent evaluations of state standards, especially one released by the Fordham Institute, identified shortcomings and condemned avoidance of the word Evolution. In 2007, the legislature funded development of what it hoped would become a world class set of Science Education standards. A group of science teachers and postsecondary faculty chosen by the Florida Department of Education framed an overview based on an extensive review of standards in other states and countries. A second slightly overlapping group then wrote the new standards, which were submitted to the State Board of Education. The SBOE held a series of public hearings that dealt almost exclusively with evolution, which the new “next generation” standards identify as a “big idea” and major organizing principle of modern biology. The SBOE added “scientific” to all theories in all areas, and the standards passed with that revision by a vote of 4:3. The legislature subsequently debated but did not enact an “academic freedom” bill that would have allowed teaching creationism/intelligent design.
4:15PM KA.00002 Translating brilliance: Facilitating communication and growth among university and K-12 STEM faculty
1. SHARON SCHULIZE, The Science House, NC State University — The STEM world is broad, diverse, and receiving lots of press as a single entity even though STEM practitioners are diverse as any group can be. As barriers to interdisciplinary research blur or fall completely, the importance and connectedness of STEM preparation and communication among young children, middle and high school students, teachers of those students, undergraduates, grad students, post-docs, faculty, corporate researchers, legislators, and the public at large has become more important than ever. The Science House at NC State University has spent 17 years finding creative ways to implement ageless truths and cutting-edge research to foster collaboration among people with common goals and interests but remarkably different cultures and means of communication. In this session we will discuss key lessons from those 17 years of work and find ways to continue to grow communication and collaboration in the pursuit of excellence.

1Work funded by NSF, HHMI, Burroughs Wellcome fund and others.

4:45PM KA.00003 UFTeach: A Partnership for Training Math and Science Teachers at the University of Florida
1. ALAN DORSEY, University of Florida — The UTeach program at the University of Texas at Austin is justifiably acclaimed for its success in inspiring and training future middle and high school math and science teachers. The program operates on a simple premise: success in teaching a subject requires a mastery of its content with guided experience in classroom teaching. In 2007 the National Math and Science Initiative (NMSI), a non-profit dedicated to expanding proven math and science education programs, announced funding of 13 sites to replicate the UTeach program, including UTeach at the University of Florida. In this talk I will give an overview of the UTeach program, and share my experiences in partnering with the UF College of Education to establish a new math and science teacher education program.

1Supported by the National Math and Science Initiative.

5:15PM KA.00004 SKyTeach: Addressing the need for Science and Math Teachers in Kentucky
1. SCOTT BONHAM, Western Kentucky University — The shortage of good science and math teachers is a chronic problem that threatens to undermine the future of our profession and economy. While our world is becoming increasingly dependent on technology, many high schools do not even offer physics, in part due to of the unavailability of a qualified teacher. The entire state of Kentucky typically produces 0-2 new physics teachers per year, compared to 200+ elementary teachers per year from WKU alone. The picture is not much better in math and other sciences. SKyTeach is a new program at WKU to address this great need and is part of a national effort to replicate the successful UTeach program. The University of Texas UTeach program graduates 70-90 new math and science teachers a year, in the process providing them with a strong preparation based on current research on how people learn science and math, experience teaching in real classrooms from the start, and strong mentoring and support. UTeach graduates stay in the classroom at rates above the national average, and some fairly quickly move into leadership positions within their schools. A key element is good collaboration between the college of science, that of education, local P-12 schools, and others. Last year thirteen universities across the nation were selected as part of an effort to replicate the UTeach program nationwide. This effort is supported by the National Science and Math Initiative in a partnership with the UTeach Institute. Our first cohort of students has started this fall, and we have had many successes and challenges as we move forward.

1Supported by the National Math and Science Initiative.

Friday, October 31, 2008 3:45PM - 5:45PM —
Session KB Forefront Materials Physics III Holiday Inn Brownstone Washington

3:45PM KB.00001 Magnetocapacitance and the physics of solid state interfaces
1. ARTHUR HEBARD, University of Florida — When Herbert Kroemer stated in his Nobel address [1] that “the interface is the device,” he was implicitly acknowledging the importance of understanding the physics of interfaces. If interfaces are to have character traits, then “impedance” (or complex capacitance) would be a commonly used descriptor. In this talk I will discuss the use of magnetic fields to probe the “character” of a variety of interfaces including planar capacitor structures with magnetic electrodes, simple metal/semiconductor contacts (Schottky barriers) and the interface-dominated competition on microscopic length scales between ferromagnetic metallic and charge-ordered insulating phases in complex oxides. I will show that seeking experimental answers to surprisingly simple questions often leads to striking results that seriously challenge theoretical understanding. Perhaps Herbert Kroemer should have said, “the interface is the device with a magnetic personality that continually surprises.”


1Supported by the NSF under Grant No. 0704240.

4:15PM KB.00002 Microstructure and Transport properties of epitaxial VO₂ thin films on TiO₂ substrates
1. JIWEI LU, University of Virginia — Vanadium oxides are paradigms of strongly correlated oxides and have attracted attention because of the metal insulator transitions (MIT) that several of the oxides and sub-oxides exhibit. In particular, VO₂ has a metal–semiconductor transition at 340 K. This transition in VO₂ combines the properties of a pure Mott Hubbard electronic transition with those of a Peierls structural transition. The Mott transition is responsible for the extreme speed of the optical switching that has been observed (faster than 100 fs). Understanding this transition and how to control it remains a challenge for both theory and experimental physics. We used a novel deposition technique, Reactive Bias Target Ion Beam Deposition, to grow 40 nm epitaxial VO₂ thin films on rutile TiO₂ substrates with various crystal orientations. X-ray diffraction (XRD) was used to explore the epitaxy of VO₂ and we found that all VO₂ thin films on TiO₂ substrates showed tetragonal symmetry at room temperature due to the constrain from rutile substrates. We also characterized the metal-insulator transition of VO₂ films as the function of the crystal orientation of rutile TiO₂. We also characterized the anisotropy of VO₂ thin films. In collaboration with Kevin West and Stuart Wolf, University of Virginia.

1This project is funded by DARPA through ARO.
4:45PM KB.00003 A surface-driven approach to the synthesis of basic building blocks for the design of complex Si-Ge-Mn nanostructures, PETRA REINKE, University of Virginia — The combination of Silicon and Germanium with Manganese is highly desirable for the development of novel spintronics devices. We will describe a surface-driven approach to the tailored synthesis of basic building blocks for the design of complex Si-Ge-Mn nanostructures. The goals are to incorporate Mn as delta-doped layers in a Si matrix, and to magnetically dope Ge-quantum dots. These processes are studied with STM and photoelectron spectroscopy. The Si(100) 2x1 surface functions as a template and Mn-nanowires are formed which run perpendicular to the Si-dimer rows. The bonding sites of the Mn-adatoms, the wire length and spatial distribution are interpreted within the framework of recent theoretical predictions. The bonding of Mn-adatoms changes with temperature: at 500 K the adatoms move into sub-surface sites, higher temperatures initiate Silicide formation, which is controlled by the Si surface atom mobility. In a next step we deposited a Ge-overlayer on the Mn-wires, and used voltage dependent STM analysis to separate the Ge and Mn contributions. In the low-adatom-mobility regime the Mn-wires are preserved. The low temperature growth therefore offers a pathway to create buried nanostructures in controlled manner. The formation of Mn-doped Ge-quantum dots is approached by the deposition of Mn on the Ge-QDs at 273 K. On both surfaces, the Ge(100) wetting layer and the Ge (105) facet of the QDs, the Mn adatoms form nanoclusters. On the Ge(105) facet the flat clusters are aligned with respect to the reconstruction, and the wetting layer surface is considerably roughened. Annelling of the surface structures to initiate a diffusion of Mn into the Ge-QD bulk is investigated as a means to achieve local doping. However, the annealing process leads to a highly complex response which is extremely sensitive to temperature. While these processes are by no means currently understood, we will offer a first qualitative interpretation of the observed reactions.

5:15PM KB.00004 Metal Clusters as Superatoms and Nanostructures, VITALY KRESIN, University of Southern California — Atomic nanoclusters are agglomerates of a discrete number of atoms, from a few to thousands, forming a bridge between small molecules and crystalline materials. By studying the properties of size-resolved clusters, the evolution of finite systems can be traced as a function of the precisely known number of atoms. In addition, nanoclusters can serve as model sensors and as potential building blocks for novel materials. In many metallic clusters, size-quantized electronic levels give rise to a striking shell structure pattern, akin to that of atoms and nuclei, which controls particle stabilities, shapes, and other physical and chemical properties. The talk will touch upon shell effects, collective excitations (plasmons), fast electron-hole recombination (escaping the phonon bottleneck), the determination of work functions, and the possibility of strengthened pairing.

Friday, October 31, 2008 3:45PM - 5:33PM Session KC Nuclear Physics II Holiday Inn Brownstone Jefferson

3:45PM KC.00001 A MultiStrip Detector for the JLab Hall C Compton Polarimeter, AMRENDRA NARAYAN, Mississippi State University, THE QWEAK COLLABORATION — Precision polarimetry is essential for any precision asymmetry measurement. The QWeak experiment at Jlab will use purity violating electron scattering from the proton to perform a precision measurement of the weak charge of the proton (QWeak). This experiment requires the knowledge of the electron beam polarization at a level of ~1%. To achieve this, a Compton Polarimeter is under construction in JLab Hall C. The Polarimeter includes a recoil electron detector. The QWeak experiment plans to use a 180 µA polarized electron beam, in order to get the highest luminosity possible at JLab. At these luminosities, the typically used silicon detectors are rendered unsuitable due to rapid radiation damage. Thus, Chemical Vapor Deposited (CVD) diamond was chosen for the recoil electron detector. CVD Diamond detectors are well known for their radiation hardness. A prototype diamond multi-strip detector was characterized at Mississippi State University. We will present preliminary spectra obtained from this detector. The status of the full-size detector currently under construction will also be presented.

3:57PM KC.00002 Novel Likelihood PID Method for Hypernuclear Spectroscopy, PAULO BATURIN, JOERG REINHOLD, Florida International University, JEFFERSON LAB E01-011 (HKS) COLLABORATION — Jefferson Lab experiment E01-011 (HKS), undertaken in Fall 2005, measured the electroproduction of Λ-hypernuclei in the (e,e'K+) reaction with a resolution of 400 keV (FWHM), a record for reaction spectroscopy. The experiment employed time-of-flight and several layers of aerogel and water Čerenkov detectors for particle identification (PID). At the current moment, the entire analysis has been done by applying hard cuts to the corresponding distributions. Here we present an alternative PID approach that employs a likelihood method. Probability density functions were obtained for each detector distribution, which then were combined to likelihood values for each possible particle. This improves the efficiency for kaon identification and should also reduce background due to misidentification of protons and pions. The expected increase in signal to background ratio will improve the statistical significance of the observed excitation spectra, especially for the core exited states with poor statistics. It might also improve the energy resolution. The presentation will explain the new likelihood PID approach, compare it to the standard one, and give a brief outline of the method’s benefits.

4:09PM KC.00003 Electroproduction of Hyperons at Low Momentum Transfer, ARMANDO ACAH, PETE MARKOWITZ, Florida International University, HALL A COLLABORATION, JLAB COLLABORATION — A H(e,e'K) measurement was performed at Hall A, TJNAF. E94-107 hypernuclear spectroscopy measurements on 9Be, 12C and 16O targets allow the study of the Λ-N interaction. Moreover, one important ingredient to the hypernuclear cross section calculation is the elementary cross section for production of hyperons, Λ and Σ. This was measured using a hydrogen (i.e. a proton) target. In addition, there is not much data available for electroproduction of hyperons at low Q² and ΣCM. Also the available theoretical models differ a lot in this kinematical region of W. The measurement of the elementary cross section will help not only in the hypernuclear spectroscopy studies but also in constraining existing theoretical models for the elementary reaction. Measurements of the differential cross sections will be reported as well as their results binned in Q², W and ΣCM to understand the dependence on these variables. To extract the cross sections a Hall A Monte Carlo simulation (MCEEP) was used in comparison, assuming a smooth dependence of these variables. Details of the calculations and results will be shown.

4:21PM KC.00004 The Padua Algorithm for the Computation of Deuteron wave functions, BINDING ENERGY and Other Properties, MESSUGN SEBHATU, Wionthrop University — The deuteron is a bound state of a neutron and proton in 3S1- and 3D1- states. The wavefunctions that represent the 3S1(u) and 3D1(w) are obtained by solving a Rarita-Schwinger (RS) equation. In this presentation, an algorithm pioneered by a Padua group [1] for solving the RS equation is described. The Padua algorithm yields accurate results with fewer mesh points (N=300 or more) compared to standard methods [2]. The algorithm relies on the transformation y = tan⁻¹r. This truncates the infinite integration domain 0<r<∞ to 0<x<π/2. This enables a grid that is uniform in x to explore the inner most region of r with a finer mesh than the asymptotic region. After second-order central difference approximations are used to replace the derivatives in the modified RS equation, it reduces to a standard eigenvalue problem of the form AY = EY, where A is a 2N x 2N matrix, N the maximum number of steps, E the binding energy and Y is u(n) (1<n<N) and w(n) (N+1<n<2N). n is an index for individual steps. A FORTRAN program with a subroutine from IMSL is used to solve the RS equation for the Reid Soft Core Potential to illustrate the algorithm. [1] T.A. Minnelli, A.Pacolini, and C. Villi, Nuovo Cimento, 101, (1991) p.1626 [2] W.H.Press et al. Numerical Recipes, 1986, Ch. 16.
4:33PM KC.00005 The $^3$He injection test for the search of neutron electric dipole moment (nEDM) . XIAOFENG ZHU, Duke University, NEDM COLLABORATION — The proposed nEDM experiment at the Spallation Neutron Source (ORNL) aims at a sensitivity of $10^{-28}$ e·cm. The experimental strategy is to form a three-component fluid of ultracold neutrons and $^3$He atoms in a bath of superfluid $^4$He. Polarized $^3$He serves as a co-magnetometer and an ultracold neutron spin precession frequency analyzer, using the spin-dependent nuclear reaction: $\overrightarrow{n} + ^3$He $\rightarrow p + t + 764$ keV. The injection test described in this talk is to study methods of injecting polarized $^3$He from an Atomic Beam Source (ABS) into the superfluid $^4$He and demonstrate that the polarization loss is acceptable for the nEDM experiment. In this presentation, I describe the design of the magnet system, a pulsed NMi system for polarization measurement, and cryogenic issues associated with the injection test apparatus.

4:45PM KC.00006 $^3$He Relaxation Time Measurements at $\sim$400mK for the neutron electric dipole moment (nEDM) experiment$^1$. QIANG YE, HAIYAN GAO, Duke University, ROBERT GOLUB, NC State University, DI-PANKAR DUTTA, Mississippi State University, PAUL HUFFMAN, FRANKLIN DUBOSE, NC State University, NEDM COLLABORATION — In the new nEDM experiment planned to be carried out at the SNS, the measurement cell will be made of dTPB-dPS (wavelength shifting material) coated acrylic and filled with superfluid $^4$He. NMR technique will be used to measure the neutron precession frequency by comparing with that of the polarized $^3$He using the spin-dependent nuclear reaction: $\overrightarrow{n} + ^3$He $\rightarrow p + t + 764$ keV. The polarized $^3$He will be used as a comagnetometer to monitor the B field in situ during the experiment. Understanding the relaxation mechanism of polarized $^3$He under the experimental conditions and maintaining $^3$He polarization is crucial. Following our earlier study of the $^3$He relaxation time in a dTPB-dPS coated cylindrical acrylic cell at a temperature of 1.9K in the presence of superfluid $^4$He with a magnetic holding field of 21 G, similar measurements at $\sim$400 mK (the proposed nEDM experimental temperature) have been carried out using a dilution refrigerator in TUNL at $\sim$7 G. Preliminary results will be presented.

This work is supported in part by the U.S. Department of Energy under contract number DE-FG02-03ER41231.

4:57PM KC.00007 Cryogenic Engineering for the Neutron Electric Dipole Measurement at the Spallation Neutron Source$^1$. D.G. HAASE, P.R. HUFFMAN, NC State University, J. BOISSEVAIN, Caltech, E.I. IHLOFF, C. VIDAL, MIT — A planned experiment at the SNS at ORNL will increase the precision of present limits on the electric dipole moment of the neutron by almost two orders of magnitude. Neutrons from the Fundamental Neutron Physics Beamline will enter a container of liquid helium at 0.45 K and become trapped by losing their kinetic energy in collisions with phonons in the superfluid helium. The experiment requires a large insulated cryovessel, several containers of liquid helium including a 1000 l chamber, a high cooling power dilution refrigerator and a dedicated helium liquefier/refrigerator. The final design must include limited use of magnetic, conducting and neutron activated materials. The time for cooling and warming the cryovessel must be minimized to facilitate the testing process. We will describe the design of this system, and an analysis of the heat flows and experimental constraints of this large cryogenic experiment.

1Work supported by the U.S. DOE and LANL.

5:09PM KC.00008 Purification of $^4$He through Differential Evaporation$^1$. F. DUBOSE, D.G. HAASE, P.R. HUFFMAN, NC State University — The neutron electric dipole moment (nEDM) experiment, to be housed at the Spallation Neutron Source at Oak Ridge National Laboratories, will probe for a dipole moment at the level of $10^{-28}$ e·cm. As part of the measurement process, neutrons precess in an environment of isotopically pure helium, doped with polarized $^3$He. After this $^3$He depolarizes it must be removed. We are developing an evaporative purification technique for this removal, lowering the concentration of $^3$He in $^4$He from $10^{-4}$ to $10^{-10}$, at an operating temperature of 300 – 350 mK. Because the vapor pressure of $^3$He is enhanced at temperatures below 500mK, $^3$He atoms can be preferentially removed from the solution. The purifier requires a large liquid surface area, while minimizing superfluid film flow. The evaporated atoms are adsorbed on activated charcoal. We have built a device to measure $^4$He/$^3$He ratios using a leak detector mass spectrometer and a residual gas analyzer.

1Work supported by US Department of Energy contract DE-FG02-97ER414042.

5:21PM KC.00009 A thermal model for cooling the nEDM $^3$He services$^1$. D.P. KENDELLEN, D.G. HAASE, P.R. HUFFMAN, NC State University — The neutron electric dipole moment (nEDM) experiment proposed for the Spallation Neutron Source is a precision test of time reversal symmetry, probing the same physics believed to be responsible for the matter-antimatter imbalance in the universe. In the experiment, polarized neutrons and polarized $^3$He atoms suspended in a bath of superfluid $^4$He at 0.35 K precess in a weak magnetic field. When a strong electric field is applied parallel or antiparallel to the B-field, a change in the neutron precession rate signifies a nonzero nEDM. The polarized $^3$He, which acts as a co-magnetometer, must be replenished every 1000–2000 seconds. Electrical heaters produce heat flows to sweep $^3$He in and out of the measurement cells. The heat is transferred to a dilution refrigerator through plastic or sintered metal heat exchangers. We have modeled the heat flows needed for $^3$He transport, to determine the heat load to the refrigerator and to guide the design and placement of the heat exchangers.

1Work supported by US Department of Energy contract DE-FG02-97ER414042.

Saturday, November 1, 2008 8:15AM - 10:15AM –
Session NA Physics Education (Joint with NCS-AAPT)
Holiday Inn Brownstone Roosevelt

8:15AM NA.00001 Innovations in Physics Education at NC State . ROBERT BEICHNER, North Carolina State University — NC State has a long history of creating and evaluating instructional innovations in the physics courses it offers. During this talk I will highlight a few of these, describing some of the history of their development as well as the innovations themselves. Several of these began as physics education research efforts and now have successful commercial products associated with them.
8:35AM NA.00002 Contemporary Introductory Physics: Matter & Interactions¹, RUTH CHABAY, NC State University — The goal of the contemporary physics enterprise is to explain a broad range of phenomena by using only a very small number of powerful fundamental principles. Matter & Interactions is a modern, calculus-based introductory physics curriculum for engineering and science students, which places a strong emphasis on making and using physical models, and on starting from fundamentals in analyzing physical systems. Computational modeling is an integral part of the course. An emphasis on microscopic models and on the atomic nature of matter makes possible the unification of topics that are traditionally taught as disconnected, and allows deeper exploration of the predictive power of fundamental principles. A collaborative project involving Purdue, Georgia Tech, and NC State is focused on institutionalizing this reform curriculum in large universities.

¹Supported in part by NSF grants DUE-0320608, DUE-0237132, and DUE-0618504

8:55AM NA.00003 Interactive Computer-based Models and the Internet¹, WOLFGANG CHRISTIAN, Davidson College — Over the past dozen years Davidson College physics faculty have produced some of the most widely used and most widely distributed interactive computer-based curricular materials for the teaching of introductory and advanced physics. These materials are based on Java applets called Phsylets and new Open Source Physics (OSP) programs. This talk outlines the pedagogical and technical features of Physlet- and OSP-based materials that have lead to their success and briefly describes current efforts to create and distribute material using the ComPADRE national digital library. The Open Source Physics collection of source code, programs and curricular materials is freely available at: <http://www.compadre.org/osp/>.

¹Partial funding for this work was obtained through NSF grant DUE-0442581.

9:15AM NA.00004 Panel Discussion — A panel discussion on physics education with the speakers and led by John Risley, North Carolina State University.

9:45AM NA.00005 Posters —

Saturday, November 1, 2008 8:15AM - 10:15AM — Session NB Astrophysics, Nuclear Astrophysics, and Some Particle Physics

8:15AM NB.00001 The DEAP/CLEAN dark matter search, MICHAEL AKASHI-RONQUEST, University of North Carolina, DEAP/CLEAN COLLABORATION — The DEAP/CLEAN collaboration is constructing the latest generation of a series of single-phase Noble-liquid dark matter experiments. The Mini-CLEAN-360 detector will be the next of these experiments to be brought on-line in 2009, and is expected to obtain a sensitivity to the spin-independent WIMP-nucleon cross-section in the neighborhood of $10^{-46} 	ext{cm}^2$ for $M_{\text{WIMP}} \approx 100 \text{GeV}$. The DEAP/CLEAN detectors observe only the scintillation light from the liquid target, removing the need for TPCs which can lower the light yield and make larger scale experiments a challenge. The ratio of the amount of prompt to total scintillation light provides an excellent statistic with which to discriminate background electron from signal nuclei recoils. The Mini-CLEAN-360 experiment will have the ability to utilize LAr or LNe as a target, which in the event of a positive signal will allow the expected $A^2$ dependence in cross section to be probed, as well as produce very different intrinsic background characteristics. In addition to the status of the Mini-CLEAN-360 detector, data from the smaller R&D detectors MicroCLEAN and DEAP-1 will be presented, including their demonstrated background rejection power. Finally, the schedule and design for a ton-scale detector, DEAP/CLEAN-3600, will be reviewed.

8:27AM NB.00002 Search for Friendly Mini Black Holes in the Laboratory¹, ROMULUS GODANG, C.M. JENKINS, University of South Alabama, MARCO CAVAGLIA, LUCIEN CREMALDI, ROY ARUNAVA, DON SUMMERS, University of Mississippi — Black holes are among the most intriguing objects in the universe. Massive astronomical black holes are now believed to exist with masses as large as a billion times the mass of the Sun. In this paper we discuss the possibility of finding observational evidence for friendly mini-black holes in the laboratory if they exist in nature. We study the mini-black holes using our Monte Carlo generator called “CATFISH” (Collider graVitiTational Field Simulator for black Holes). We are investigating the signatures of mini black hole production in the proton-proton collisions at the CMS experiment (Compact Muon Solenoid) at CERN (European Organization for Nuclear Research) near Geneva, Switzerland.

¹This work was supported by University of South Alabama and the U.S. Department of Energy, DE-FG02-91ER40622.

8:39AM NB.00003 Enhanced LIGO Update, KATHERINE DOOLEY, University of Florida, LIGO COLLABORATION — A series of upgrades on the Initial LIGO (Laser Interferometer Gravitational-Wave Observatory) detectors is almost complete and will result in an improved configuration called Enhanced LIGO with a two to three time increase in sensitivity above 100Hz. Changes include increased laser power, new Input Optics (Faraday isolator and Electro-optic modulators), DC readout, an Output Mode Cleaner, in-vacuum readout hardware, a new Thermal Compensation System, and an advanced seismic isolation table. It is expected that Enhanced LIGO will be operational by spring 2009, marking the commencement of a sixth science run which will last until the interferometers are decommissioned for building the Advanced LIGO system. I will briefly describe the improvements and present the status of the upgrade.

8:51AM NB.00004 Magnetic Field Amplification in Nonlinear Diffusive Shock Acceleration - a Monte Carlo Model¹, ANDREY E. VLADIMIROV, DONALD C. ELLISON, North Carolina State University, ANDREI M. BYKOV, Ioffe Physical-Technical Institute, St. Petersburg, Russia — Recent observations indicating very high values of magnetic fields in collisionless shocks of supernova remnants have triggered extensive research in magnetic field amplification (MFA) by diffusive shock acceleration (DSA). The problem is essentially nonlinear — that is, magnetic turbulence and accelerated particles produced in the process of DSA carry enough energy to feed back on the structure of the collisionless shock that determines the regime of DSA. Although many aspects of MFA and of dynamics of charged particles in the amplified fields are unknown, the structure of shocks can be studied from the standpoint of fundamental conservation laws. We present the outline and some results of a Monte Carlo model of nonlinearly modified shocks with efficient acceleration of particles and generation of strong stochastic magnetic fields. The model provides insight on the complex connections between components of strong collisionless shocks and makes predictions applicable in various astrophysical problems ranging from structure formation in the Universe to supernova remnant evolution and the origin of cosmic rays.

¹Supported by NASA grants NNH04Zss001N-LTSA and 06-ATP06-21.
9:03AM NB.00005 Measurement of the Total Cross-Section for the $^9\text{Be}(\gamma,n\alpha)\alpha$ reaction$^1$. C.W. ARNOLD, T.B. CLEGG, H.J. KAROWSKI, UNC-Chapel Hill, TUNL, C.R. HOWELL, A.P. TONCHEV, G. RUSEV, Duke University, TUNL — The $^9\text{Be}(\gamma,n\alpha)\alpha$ cross section is key to understanding isotopic abundances of nuclei produced during the r-process. The inverse reaction bridges the unstable mass gaps at $A=5$ and $8$ leading to $\alpha(\gamma,n)^9\text{Be}(\alpha,n)^{12}\text{C}$ and so on, producing seed nuclei for the r-process and setting the neutron-to-seed nucleus ratio that drives universal isotopic abundance predictions [Ref 1,2]. In order to make high precision measurements ($\pm 5\%$) of the $^9\text{Be}(\gamma,n\alpha)\alpha$ cross-section which includes narrow resonances, tunable gamma ray beam with small $\Delta E/E$ is required along with gamma and neutron detectors whose efficiencies are well known. We used TUNL's high intensity gamma ray source (HrS) to measure the cross sections for $^9\text{Be}(\gamma,n)$ in the energy range of 1.55 to 5.0 MeV with beam energy resolutions between 14 and 150 keV as determined by large Ge detector. The neutrons were detected using $^3\text{He}$ proportional counter. Experimental details will be discussed and the results as well as their astrophysical consequences will be presented. [Ref 1] B. Meyer et al., Astro J., 399 656-664 (1992). [Ref 2] T. Kajino et al., Nucl. Phys. A, 704, 165C-178C (2002)

9:15AM NB.00006 Study of Stellar Helium Burning with O-TPC at TUNL/Hi$\gamma$S. P.-N. SEO, UConn/TUNL, A.H. YOUNG, W.R. ZIMMERMAN, M. GAI, UConn, M.W. AHMED, E.R. CLINTON, S.S. HENSHAW, C.R. HOWELL, B.A. PERDUE, S.C. STAVE, C. SUN, H.R. WELLER, Y. WU, TUNL/Duke, P.P. MARTEL, UMass, B. BROMBERGER, V. DANGENDROF, K. TITTERMEIER, PTB, Braunschweig, A. BRESKIN, Weizmann — The Optical-readout Timing Projection Chamber (O-TPC), operating with a CO$_2$(80%)+N$_2$(20%) gas mixture at 150 Torr, has been successfully commissioned at TUNL/Hi$\gamma$S with alpha-particles from a $^{144}\text{Nd}$ standard source. The O-TPC will be used to study the $^{16}\text{O}(\gamma,\alpha)^{12}\text{C}$ reaction, the time-reversed reaction of the oxygen formation in stellar helium burning. This reaction is considered to be of major importance since it determines the C/O ratio that in turn determines the final state of a supernova (black hole or neutron star). While we studied this reaction at 9.55 MeV, on the $1^-$ resonance of $^{16}\text{O}$, we also took an advantage of the powerful detection system to investigate the $^{16}\text{O}(\gamma,3\alpha)$ reaction at 10.53, 10.84, and 11.16 MeV gamma energy from Hi$\gamma$S, spanning the $1^-$ resonance of $^{12}\text{C}$ located at 10.84 MeV which may or may not contribute to carbon formation during stellar helium burning. We will describe these two recent experiment and preliminary results from our data analysis that is in progress both at Yale and TUNL/Duke University.

9:27AM NB.00007 The Influence of Neutron Capture Rates in the Rare Earth Region on the r-Process. MATTHEW MUMPOWER, GAIL MCLAUGHLIN, North Carolina State University, REBECCA SURMAN, Union College — The r-process has long been known to be an integral component of heavy element nucleosynthesis. We study the sensitivity of the r-process to neutron capture rates along the rare earth peak. We identify important neutron capture rates in this region and show how these rates influence specific sectors of the abundance pattern.

9:39AM NB.00008 Simplicial Matter for Simplicial Spacetimes. JONATHAN MCDONALD, WARNER MILLER, Florida Atlantic University — If spacetime is indeed discrete at a fundamental level, then it is imperative that we develop a description of matter consistent with discrete spacetimes. Here we develop a method of coupling of non-gravitational sources to lattice spacetimes by utilizing the inherent properties of the simplicial structure. The contracted Bianchi identities are used as a guide to identifying how one incorporates matter fields into the lattice. We then use this guiding principle to define the fields using the inherent structure of the lattice. We also discuss the subtle properties of the lattice that become important when simplicial spacetimes are extended beyond the vacuum theory. This understanding of the coupling between lattice geometry and matter fields becomes useful with discrete spacetimes. Here we develop a method of coupling of non-gravitational sources to lattice spacetimes by utilizing the inherent properties of the simplicial structure. The contracted Bianchi identities are used as a guide to identifying how one incorporates matter fields into the lattice. We then use this guiding principle to define the fields using the inherent structure of the lattice. We also discuss the subtle properties of the lattice that become important when simplicial spacetimes are extended beyond the vacuum theory. This understanding of the coupling between lattice geometry and matter fields becomes useful with discrete spacetimes.

9:51AM NB.00009 On a Latent Structure of Lepton Universality. RASULKHOKZA SHARAFIDDINOV, Institute of Nuclear Physics, Uzbekistan Academy of Sciences, Tashkent, 702132 Ulugbek, Uzbekistan — The mass of an electroweakly charged lepton consists of the $\Delta E/E$ is required along with gamma and neutron detectors whose efficiencies are well known. We used TUNL's high intensity gamma ray source (HrS) to measure the cross sections for $^9\text{Be}(\gamma,n)$ in the energy range of 1.55 to 5.0 MeV with beam energy resolutions between 14 and 150 keV as determined by large Ge detector. The neutrons were detected using $^3\text{He}$ proportional counter. Experimental details will be discussed and the results as well as their astrophysical consequences will be presented. [Ref 1] B. Meyer et al., Astro J., 399 656-664 (1992). [Ref 2] T. Kajino et al., Nucl. Phys. A, 704, 165C-178C (2002)

10:03AM NB.00010 New Covariant Constraints for New Forces of Nature. JEFFREY TITHOF, YURI KAMYSHKOV, University of Tennessee, MIKHAIL VYSOTSKY, ITEP — Four fundamental interactions exist (strong, weak, electromagnetic, and gravity) which are well modeled by modern physics, but can additional interactions exist in nature? I will present results from our work in reanalyzing data from the previously published neutron-proton scattering experiment “Measurement of np Elastic Scattering at High Energies and Very Small Momentum Transfers” (Nuclear Physics, B232 (1984) 365-397). The 4-momentum transfer distribution for scattered neutrons is fit by taking into account a strong interaction Regge-like term, a Schwinger scattering term (which is the scattering of the magnetic moment of the neutron on the proton and electron electric charges), and a term describing the new force in a covariant form. Constraints on the new force were obtained from a statistical chi-square analysis of the theoretical fit to the experimental data. New constraints were analyzed for the new forces described by covariant amplitudes, corresponding to scalar, pseudoscalar, vector, or axial vector exchange particles. Findings are that new vector and axial vector light particle exchanges are strongly bounded by high energy data and the analogous bound for a scalar particle is weaker. For a pseudoscalar exchange, bounds cannot be set from present data. Our limits are compared with similar searches in several other experiments.

Saturday, November 1, 2008 8:15AM - 10:03AM — Session NC Particle Physics  Holiday Inn Brownstone Lincoln

8:15AM NC.00001 Two Dimensional Large Nc QCD at Finite Density. RICHARD GALVEZ, Department of Physics, Florida International University, Miami, FL, 33199 U.S.A., BARÁK BRINGOLTZ, Department of Physics, University of Washington, Seattle, WA 98195 U.S.A., RAJAMANI NARAYANAN, Department of Physics, Florida International University, Miami, FL, 33199 U.S.A. — The study of Quark Gluon Plasma (QGP) is within experimental reach at BNL and CERN. Lattice Field Theory is a non-perturbative method to study QCD at finite density thus providing a theoretical framework to analyze QGP. Progress towards an understanding of two dimensional QCD in the limit of large number of colors (Large Nc Limit) at finite density will be reported. The chiral condensate and the phase of the fermion determinant will play a central role in the analysis.
8:27AM NC.00002 Search for New Physics with Bs Mesons at CMS/LHC, GIORDANO CERIZZA, University of Tennessee, CMS COLLABORATION — The large cross section for the production of b-quarks in LHC’s proton-proton collisions allows precision measurements of CP violation in the Bs meson system. The CMS experiment is well suited to search for new generations of quarks and forces between them (New Physics) complementary to the B-Factories in decay channels such as Bs → J/Ψ φ. New Physics could significantly alter CP observables with respect to their predicted values in the Standard Model. We report on simulation studies of the channel Bs → J/Ψ φ. The extraction of CP parameters from the proper lifetime distribution relies strongly on the CMS pixel detector. It is mounted closely to the interaction point and has an unprecedented about 60 Million readout channels. At present this detector is commissioned in the CMS detector and will be exposed to first proton-proton collisions in fall of this year. We present the detector and first operational experiences.

8:39AM NC.00003 Randoms Counter Analysis, WINSTON HENSLEY, KEVIN GIOVANETTI, James Madison University, MULAN COLLABORATION — A 1 ppm precision measurement of the muon lifetime is being conducted by the MULAN collaboration. The reason for this new measurement lies in recent advances in theory that have reduced the uncertainty in calculating the Fermi Coupling Constant from the measured lifetime to a few tenths ppm. The largest uncertainty is now experimental. To achieve a 1ppm level of precision it is necessary to control all sources of systematic error and to understand their influences on the lifetime measurement. James Madison University is contributing by examine the response of the timing system to uncorrelated events, randoms. A radioactive source was placed in front of paired detectors similar to those in the main experiment. These detectors were integrated in an identical fashion into the data acquisition and measurement system and data from these detectors was recorded during the entire experiment. The pair were placed in a shielded enclosure away from the main experiment to minimize interference. The data from these detectors should have a flat time spectrum as the decay of a radioactive source is a random event and has no time correlation. Thus the spectrum can be used as an important diagnostic in studying the method of determining event times and timing system performance.

8:51AM NC.00004 Adaptation of a Fortran-Based Monte-Carlo Microscopic Black Hole Simulation Program to C++ Based Root, C.M. JENKINS, R. GODANG, University of South Alabama, M. CAVAGLIA, L. CREMALDI, D. SUMMERS, University of Mississippi — The 14 TeV center of mass proton-proton collisions at the LHC opens the possibility for new Physics, including the possible formation of microscopic black holes. A Fortran-based Monte Carlo event generator program called CATFISH (Collider GRAVitational Field Simulator for black Holes) has been developed at the University of Mississippi to study signatures of microscopic black hole production (http://www.phy.olemiss.edu/GR/catfish). This black hole event generator includes many of the currently accepted theoretical results for microscopic black hole formation. High energy physics data analysis is shifting from Fortran to C++ as the CERN data analysis packages HBOOK and PAW are no longer supported. The C++ based root is replacing these packages. Work done at the University of South Alabama has resulted in a successful inclusion of CATFISH into root. The methods used to interface the Fortran-based CATFISH into the C++ based root will be presented. Benchmark histograms will be presented demonstrating the conversion. Preliminary results will be presented for selecting black hole candidate events in 14 TeV/ center of mass proton-proton collisions.

9:03AM NC.00005 The mass, energy, space and time system theory of universe -MEST, DAYONG CAO, Beijing Natural Providence Science & Technology Development Co., LTD — Things have their own system of mass, energy, space and time of themself. (The MEST for short thereafter). Mass is density, energy is force, time is frequency, space is amplitude square. In MEST of White hole, Mass-energy particle condense to center, Space-time wave radiate to Around. Solar system is a MEST of White hole. Sun is mainly mass-energy; light wave mainly is space-time. Light is Around Sun. In wave-particle duality, the wave mainly is quantum space-time; The particle is mainly quantum mass-energy. There are the transmutation between space-time and mass-energy. When they get a balance, they get the inertia and electron system in space. In MEST of Black hole, Space-time particle condense to center, Mass-energy wave radiate to Around. The Dark matter-energy is from the Black hole. It is the radiation mass-energy Wave around Black hole. The dark-matter-energy is from the Black hole like that the light wave is from star. Black hole have many dark planets who is made up of dark matter-energy like that Sun have many planets. There is a interaction between Back hole and White hole. In MEST of Back hole and White hole, There are the transmutation between space-time and mass-energy. There is a interaction between space-time and mass-energy. When they get a balance, they get a steady-going system like Homeostasis. There are the conservation of space-time and mass-energy.

9:15AM NC.00006 Derivation of the Fine Structure Constant, RAMIRO MONTALVO, SPAWAR Retired — A geometrically based calculation of the fine structure constant alpha is presented based on the known properties of the electromagnetic (EM) field and assumptions on the way the photon field may be quantized. Based on the fact that the photon field of a stationary charge has an energy density given by εE(r)=2/ε2 around the charge, a radial photon field of stationary states is assumed which then interacts with the photon field of other charges. From the geometry of the configuration the interacting states are those along the line joining the two charges. Using the uncertainty principle to determine the angular extent of the interacting photons the EM coupling constant α becomes the ratio of the interacting photons over all the photons around the sphere for one charge times the same ratio for the other charge. The answer reduces to α=[(14/75)6]1/2/1/32=.007067 which differs from the experimental value by 3.2%.

9:27AM NC.00007 Fiber Optics at the JLab CLAS12 Detector, JOHN KROON, KEVIN GIOVANETTI, James Madison University — The performance of wavelength shifting fibers, WLS, and method of coupling these fibers to extruded polystyrene scintillators are currently under study at James Madison University. These components are two of the main elements for the PCAL, preshower calorimeter, proposed as part of the 12 GeV upgrade for the CLAS detector at Jefferson Laboratory. The WLS fibers have been prepared, optically coupled to scintillator, and tested in order to determine their overall performance as a method of readout. Methods of coupling fiber to scintillator, a description of the test setup, test methods, PCAL readout performance, and fabrication recommendations will be presented.

9:39AM NC.00008 Searching for Isospin Violation at the Upsilon(4S) at BABAR, ROMULUS GODANG, University of South Alabama, LUCIEN CREMALDI, DON SUMMERS, University of Mississippi — Isospin violation at the Upsilon(4S) resonance is an important input for many B meson measurements at B factories. Isospin violation at Upsilon(4S) resonance may be at the level of a few percent mostly due to electromagnetic interactions and the mass difference of the up and the down quarks. In this paper, we reconstruct neutral B meson in the channel D*+. Lepton Neutrino using a partial reconstruction method. Based on a data sample of 514 million B pairs collected at the Upsilon(4S) resonance with the BABAR detector at the PEP-II asymmetric-energy B Factory at SLAC, we discuss a model independent measurement of the branching fraction of Upsilon(4S) decays to neutral B pairs.

1National Science Foundation Grant
2Advisor
3This work was supported by University of South Alabama and the U.S. Department of Energy, DE-FG02-91ER40022.
For the Rare Decay \( K_L \rightarrow \pi^0 \mu^+ \mu^- \), DAVID PHILLIPS, University of Virginia, KTEV COLLABORATION

— Using data collected by the KTeV Experiment at Fermi National Accelerator Laboratory in Batavia, Illinois, this study will be the first experimental analysis of \( K_L \rightarrow \pi^0 \mu^+ \mu^- \). Although this decay mode is possible within the Standard Model, it is limited to a very narrow band of phase space. The HyperCP Experiment has recently observed three \( \Sigma^+ \rightarrow p \mu^+ \mu^- \) events within a narrow dimuon mass range of 213.8 MeV/c\(^2\) to 214.8 MeV/c\(^2\). This suggests that the process occurs via a neutral intermediary particle, \( \Sigma^+ \rightarrow p \pi^0 \rightarrow p \mu^+ \mu^- \), with an \( \pi^0 \) mass of 214.3 MeV/c\(^2\). Since the \( \pi^0 \) has a light mass and a low interaction probability, then it is not feasible within the Standard Model. However, the \( \pi^0 \) could be explained by a theory known as the “Next-to-Minimal Supersymmetric Standard Model” (NMSSM). In NMSSM, there are seven Higgs bosons and theorists believe that the \( \pi^0 \) may be the lightest of this group. Recent theoretical predictions suggest that the decay mode \( K_L \rightarrow \pi^0 \mu^+ \mu^- \) can also occur via the aforementioned neutral intermediary particle: \( K_L \rightarrow \pi^0 \pi^0 \rightarrow \pi^0 \mu^+ \mu^- \). Therefore, in addition to a Standard Model measurement, the search for \( K_L \rightarrow \pi^0 \mu^+ \mu^- \) is also carried out in an effort to address the viability of \( \pi^0 \) in explaining the HyperCP phenomena.

\( ^{3}\) for the KTeV Collaboration

Saturday, November 1, 2008 10:30AM - 12:30PM –
Session PA Applied Physics II Holiday Inn Brownstone Roosevelt

10:30AM PA.00001 Bifurcations and Averaging in a Series Array of Tunnel Diodes, KEVIN J. BROWN, HUIDONG XU, STEPHEN W. TEITSWORTH, Duke University — We investigate nonlinear electrical conduction properties of a series array of tunnel diodes using both numerical simulation and experimental measurement. Tunnel diodes are negative differential resistance (NDR) circuit elements and, in a series configuration, provide a useful model system for nonlinear transport in more complex electronic structures such as semiconductor superlattices [1]. Measurements reveal high-frequency (of order 1 GHz), small-amplitude oscillations in the current when the diodes are voltage-biased in the NDR region. For a system of \( N \) diodes, these fast oscillations are associated with Hopf bifurcations in a \( 3N \)-dimensional nonlinear circuit model that includes intrinsic reactances for each diode. A nonlinear averaging method is applied to the full model, allowing the elimination of fast time scale behavior, and results in a reduced dynamical system of dimension \( N \). Simulations of the reduced model are found to accurately describe the experimental circuit behavior on time scales that are much larger than the oscillator time scale. [1] H. Xu and S. W. Teitsworth, Phys. Rev. B 76, 235302 (2007).

10:42AM PA.00002 Infrared absorption and emission studies of Er:YAG, Er:KPB\(_2\)Cl\(_5\), and Er:KPB\(_2\)Br\(_5\) for eye-safe laser applications, CRAIG HANLEY, EI BROWN, UWE HOMMERICH, Hampton University, SUDHIR TRIVEDI, Birmoore Corporation of America, JOHN ZAVADA, North Carolina State University — There exists a significant current interest in the development of a new generation of 1.5-1.6\( \mu \)m eye-safe solid-state lasers with resonant diode laser pumping. Applications of laser sources that operate in the eye-safe wavelength regime near 1.5-1.6\( \mu \)m include remote sensing, long distance telemetry, and optical communications. Eye-safe laser wavelengths can be achieved by using trivalent Er\(^{3+}\), which has an emission transition at \( \sim 1.5\mu m \). Prior to the development of resonantly pumped erbium lasers, two approaches were employed for eye-safe lasers, Nd-based lasers driving nonlinear optical parametric oscillators and erbium-doped glass lasers. System complexity and heat management limits the power scaling of these two approaches. The availability of new diode-pumped sources operating at \( \sim 1.45\mu m \) has made resonantly pumped Er\(^{3+}\) lasers a viable choice for high-power eye-safe lasers. Crystalline Er:YAG is currently the main gain medium under consideration for 1.5\( \mu \)m Er lasers. In this work we present spectroscopic results of ceramic Er:YAG, Er:KPB\(_2\)Cl\(_5\), and Er:KPB\(_2\)Br\(_5\). Infrared absorption and emission cross-sections were analyzed and evaluated for potential applications as 1.5\( \mu \)m gain media.

10:54AM PA.00003 Growth and spectroscopic characterization of Ho-doped KPB\(_2\)Cl\(_5\) crystal for mid-IR laser applications, OLUSOLA OYEBOLO, EI BROWN, UWE HOMMERICH, Hampton University, SUDHIR TRIVEDI, Birmoore Corporation of America, ALTHEA BLUETT, Elizabeth City State University, JOHN ZAVADA, North Carolina State University — Results of the crystal growth and infrared spectroscopy of Ho:KPB\(_2\)Cl\(_5\) (KPC) are presented for possible applications in mid-infrared solid-state lasers. KPC was synthesized from high purity PbCl\(_2\) and KCl materials and purified through horizontal zone-refinement. 1-3 wt% of HoCl\(_3\) was mixed to the purified KPC and molten under a chlorinating atmosphere. Ho: KPC crystals were then grown using a self-seeded horizontal Bridgman technique. Absorption and emission studies were carried out on the polished crystal. Following optical excitation at 750 nm and 885 nm, several emission bands were observed in the near- and mid-IR spectral region. Further spectroscopic studies were focused on the mid-IR emission at 3900 nm arising from the Ho\(^{3+}\) transition \( ^1I_5 \rightarrow ^1I_4 \). The room temperature emission lifetime of the \( ^1I_5 \) level was measured to be 4.9 ms, which is in good agreement with the radiative lifetime determined from a Judd-Ofelt analysis. This result indicates that multi-photon relaxation processes are not significant for the 3.9\( \mu \)m emission from Ho: KPC. Further results of the infrared absorption and emission properties of Ho: KPC will be presented at the conference.

11:06AM PA.00004 Theory of single nuclear spin detection in magnetic resonance force microscopy, SRINIVASA CHEMUDUPATI, VLADIMIR TSIFRINOVICH, Polytechnic Institute of NYU — We develop a theory for the measurement of a nuclear spin state in a paramagnetic atom with Oscillating Cantilever-Driven Adiabatic Reversals (OSCAR) in Magnetic Resonance Force Microscopy (MRFM). In this theory, we use a semi-classical approach where the electron-nuclear spin system, with hyperfine interaction, is treated quantum mechanically and the motion of the ferromagnetic particle on the cantilever tip is treated classically. Our computations support the idea of the measurement of a nuclear spin state in a paramagnetic atom with Oscillating Cantilever-Driven Adiabatic Reversals (OSCAR) in Magnetic Resonance Force Microscopy (MRFM).

11:18AM PA.00005 Optimizing extraction of information from resonance lines in Fourier-transform infrared spectroscopy, P. AGGARWAL, Duke, D.E. ASPNES, NCSU — The major analytic challenge in spectroscopy is to extract the maximum amount of information from an optical feature or features that are usually defined by a small number of data points. These in turn are often adversely influenced by both noise and the resolution function of the spectrometer. In dispersive-optical data the optimal approach for analyzing in a single nuclear spin state in a paramagnetic atom with Oscillating Cantilever-Driven Adiabatic Reversals (OSCAR) in Magnetic Resonance Force Microscopy (MRFM). In this theory, we use a semi-classical approach where the electron-nuclear spin system, with hyperfine interaction, is treated quantum mechanically and the motion of the ferromagnetic particle on the cantilever tip is treated classically. Our computations support the idea of the measurement of a nuclear spin state in a paramagnetic atom with Oscillating Cantilever-Driven Adiabatic Reversals (OSCAR) in Magnetic Resonance Force Microscopy (MRFM).

11:30AM PA.00006 Prolonging Electron Emission in Pyroelectric Crystal Accelerators, STEPHEN SFAFROTH, ANYA DERBAKOVA, VISHAL RAO, KUAI YU, University of North Carolina at Chapel Hill — Pyroelectric crystal accelerators have been used to accelerate electrons which produce X-rays on interacting with matter and are commercially available (Amptek). They have also been used to accelerate positive ions such as deuterons, which when colliding with deuterium targets produce nuclear fusion, giving rise to fast neutrons and protons. A problem with these crystal accelerators is that as the crystal temperature changes, particularly for fast temperature changes, the emission rate increases too much and a discharge before the surface charge can build up sufficiently to accelerate ions or electrons to the highest energies. To address this problem we have developed LabView v6 which allowS crystal heating rate and ambient pressure to be controlled. Electron emission has been recorded for about one hour without a discharge.
11:42AM PA.00007 Novel Pyroelectric Material Systems for Infrared Sensor Applications . PADMAJA GUGGILLA, ASHOK BATRA, MATTHEW EDWARDS, Alabama A&M University — Perovskite structured ceramics have been investigated due to their excellent dielectric, electro-optical, piezoelectric, and pyroelectric properties. Often dopants or additives are used in basic formulations of the materials to enhance or tune the material properties. Lead zirconate titanate (PZT), Cation(s) modified lead zirconate titanate such as lead lanthanum zirconate titanate (PLZT: lanthanum doped PZT), Mn doped lead lanthanum zirconate titanate (STPZT-2) and commercially available modified PZT (BM740) ceramics have been studied for their use in infrared detectors. Oxygen ions with 200 KeV energy and doses of 1.0 × 1016 ions/cm² are irradiated onto BM 740 and its response is studied in terms of dielectric and pyroelectric properties before and after irradiation. As the pyroelectric materials’ figure-of-merit depend upon the element size and the element thermal conductance, pyroelectric materials have also been examined in the form of thick film and thin film. Specified materials’ figures-of-merit for their use in infrared detector are calculated and results are compared with several existing candidate materials.

11:54AM PA.00008 Investigation of locally favored structures in Al-La-Ni metallic glasses using 27Al NMR Spectroscopy . MAGDALENA SANDOR, XUEKUI XI, YUE WU, Department of Physics and Astronomy, University of North Carolina — Al-TM-RE (TM= transition metal, RE = rare earth) bulk metallic glasses (BMGs) with high Al content have gained much research interest due to their high potential as structural and functional materials. The first recent fabrication of La₆₀₋ₓAlₓNi₁₅ (15 ≤ x ≤ 70) BMGs have inspired an NMR systematic study of their locally favored structures (LFSs). These BMGs are reported to show characteristics of high thermal stability, fragility, and considerable mechanical strength. 27Al NMR spectroscopy and neutronation experiments are performed to unveil the sensitive structural dependence on line width and quadrupolar frequency with Al composition. It is observed that maximum glass forming ability (GFA) for this system prefers a decrease of symmetry at Al sites. Minimal GFA corresponding to instances of high symmetry occur in Al-rich and Al-poor regimes. These results, in addition to previous work, suggest that Ni and La atoms have unique local chemical and topological environments at different Al compositions. The monotonic decrease of relatively small 27Al Knight shifts with increasing Al concentration demonstrates the evolution of local electronic structure at Al sites. This study is valuable in correlating the unique role that TM and RE elements play in local compositional and geometrical order of high glass-forming Al-based BMGs.

12:06PM PA.00009 Effect of Preloading Condition on Fringe Pattern in Electronic Speckle Pattern Interferometry . TOMOHIRO SASAKI, SANICHIRO YOSHIDA, JOHN GAFFNEY, Southeastern Louisiana University — Electronic speckle pattern interferometry (ESPI) has received considerable attention as a measurement method capable of whole-field, dynamic analysis. In this study, an attempt is made to diagnose the degree of deformation based on the fringe patterns formed with an in-plane ESPI setup. We focus on the change in fringe pattern that preloaded specimens show when they are reloaded after released from the initial tensile load. If the degree of deformation can be identified from a specific change in the fringe pattern, this technique can be potentially used to predict material’s remaining life. In this report, we discuss difference in the fringe pattern observed in Al-Mg alloy specimens preloaded to an under- and over-yield stress levels. In addition, difference in the fringe pattern based on the difference in Mg content is discussed.

12:18PM PA.00010 Can we know loading history of solid-state materials? . SANICHIRO YOSHIDA, JOHN GAFFNEY, TOMOHIRO SASAKI, CHRISTOPHER SCHNEIDER, Southeastern Louisiana University — Using an optical interferometric technique called electronic speckle-pattern interferometry (ESPI) and a deformation theory called physical mesomechanics (PMM), an attempt is made to identify the loading history of aluminum specimens. The ESPI is used to form interferometric fringes representing in-plane displacement under tensile loading. PMM is used to interpret the obtained fringe patterns. Specimens preloaded to different degrees, ranging from a moderate elastic stage to late plastic stage, are reloaded within the elastic limit for multiple times. Fringe patterns resulting from each reloading cycle are classified in terms of the basic patterns, each representing longitudinal deformation, shear deformation, rotation, and their combinations. Specimens under the same preload/reload condition show a common feature in the transition of the classified patterns, whereas specimens under different preload/reload conditions show different transitions. Generally speaking, fringe patterns tend to show more rotational nature as deformation develops even in the reloading within the elastic limit. This result is consistent with PMM, which characterizes plastic deformation as shear instability leading to rotation.

Saturday, November 1, 2008 10:30AM - 12:30PM – Session PB Optical Physics Holiday Inn Brownstone Washington

10:30AM PB.00001 UV Induced Photopatterning of Poly-L-Lysine and Photodegradation of Poly(methylmetacrylate) . JEAN MICHEL TAGUENANG, ASCHALEW KASSU, REDAHEGN SILESHI, FERNANDO CALZZANI, ANUP SHARMA, Alabama A&M University — We present the effects of UV irradiation on two different organic polymers. In the first part, deep UV lithography on poly-L-lysine thin films is used to generate microarrays with enhanced hydrophilicity. This is manifested as adsorption of ambient humidity from air by areas exposed to UV fluence around 5 J/cm² and is made visible by phase-contrast microscopy. Kinetics of adsorption is investigated by a novel technique involving fabrication of submicrometer hydrophilicity grating by two-beam UV interferometry. In an aqueous colloidal medium, gold and polystyrene microspheres preferentially attach to areas that are relatively less hydrophilic, i.e., those areas not exposed to UV light. This provides a method for fabricating micro- and nanoporous arrays with controlled porosity. Laser-induced fluorescence, Raman and absorption spectroscopies are used to investigate reversible degradation of transmittance of the plastic fiber recovers to a significant fraction of its pre-exposure value. Nanoporous arrays with controlled porosity. Laser-induced fluorescence, Raman and absorption spectroscopies are used to investigate reversible degradation of polybutadiene polymer as a photopatterning substrate . ASCHALEW KASSU, JEAN MICHEL TAGUENANG, FERNANDO CALZZANI, REDAHEGN SILESHI, ANUP SHARMA, Alabama A&M University — Surface relief gratings produced on planar substrates have been widely investigated for their application as a holographic recording medium. In this work, surface relief holographic gratings are fabricated on polybutadiene-coated walls of a cell filled with an aqueous solution of azo-dye-labeled phospholipid as well as rhodamine 6G. This deposition as a grating pattern is photodegraded in a dye solution by holographic interference of low power 488 nm light from an argon-ion laser. Dynamics of this aqueous-phase grating deposition is investigated for various concentrations of the dye. A plausible mechanism of grating formation involves photochemical reaction of polybutadiene substrate with the laser-excited dye. Lithographic masks are used to show that photochemical pattern on the substrate is an exact replica of the light intensity distribution and so the technique can be used for holographic recording as well as for biomolecular applications. Surface relief structure of the grating is characterized with an atomic force microscope.
10:54AM PB.00003 Investigating Capacitance Behavior of Nanomaterials through Split-tip Scanning Capacitance Microscopy, BEVERLY CLARK III, HANS HALLEN, NCSU Near-field Optics Lab — A split-tip Near-field Scanning Optical Microscope (NSOM) probe is used to measure capacitance. We build a model for the instrument by solving Poisson’s equation for a simplified system using the finite element program Femlab. The governing equations and boundary conditions are paramount in obtaining a converging solution. Values obtained from a simple capacitor model are compared to calculated values found from the Scanning Capacitance setup. The split-tip capacitance values will be compared with measured values from the Scanning Conductivity Microscopy (SCM) experimental setup. This scanning probe microscope uses two electrically-isolated electrodes fabricated on one split-tip probe to investigate local electrical behavior of nanostructures. The split-tip probe, which we have recently developed, is optimized for light coupling into a particular region of a nanostructure while non-contact capacitance measurements are simultaneously made between the two electrodes. The capacitance is influenced by the presence of a conducting region on the surface beneath the electrodes. The capacitance coupled or scanning conductivity mode allows rapid characterization of large areas of the sample so that regions of interest can be identified for further study. The finite element model aids in the quantification and understanding of the data.

11:06AM PB.00004 Optimal control of light pulse storage and retrieval in atomic vapor, NATHANIEL PHILLIPS, IRINA NOVIKOVA, The College of William & Mary, ALEXEY GORSHKOV, Harvard University — Efficient and reliable quantum communication will require the coherent control of individual photons. As a step toward this objective, we have demonstrated promising techniques that involve using the dynamic form of electromagnetically induced transparency to optimally and reversibly map arbitrary classical pulse shapes of light onto an ensemble of hot Rubidium atoms. One technique employs time-reversal to determine, using an iterative procedure, the optimally-stored signal field for a given control field. Another method makes use of the one-to-one mapping between the decayless spin modes of the atoms and the signal field to calculate the optimal control field for a given signal field. We show that both techniques equivalently obtain optimal memory efficiency for a given optical depth. We observe good agreement with theoretical predictions for lower optical depth (< 15), but memory efficiency falls below predictions at higher optical depths (> 25). We analyze possible effects responsible for this reduced memory, such as resonant four-wave mixing, ac-Stark shifts, etc, and present the results of current investigations into the optical depth dependence of such phenomena.

11:18AM PB.00005 ABSTRACT HAS BEEN MOVED TO HA.00064 –

11:30AM PB.00006 ABSTRACT HAS BEEN MOVED TO HA.00063 –

11:42AM PB.00007 Silicides for infrared surface plasmon resonance biosensors, J.W. CLEARY, R.E. PEALE, University of Central Florida, Orlando FL, W. BUCHWALD, R. SOREF, AFRL/RYHC Hanscom AFB MA 01731 — Biomolecules on a conductor strongly affect its surface plasmon modes, providing for real-time sensing of biomolecules. We consider silicides for IR plasmonic biosensors. The lower plasma optical depth dependence of such phenomena.

11:54AM PB.00008 The Terahertz Spectrum of Nitric Acid, PAUL HELMINGER, University of South Alabama, DOUGLAS T. PETKIE, Wright State University, IVAN MEDVEDEV, FRANK C. DE LUCIA, The Ohio State University — A solid state tripler has been put into operation on the FASSST system at Ohio State University. This device converts the microwave input power from a swept OB-30 backward wave oscillator (240-375 GHz) to terahertz output power. We have used this device to record the rotational spectrum of nitric acid in the 875-1100 GHz range. Spectral assignments have now been made for the molecule in the ground, v9=1, and v8=1 states, and work is underway on the assignment of spectral lines in several other excited vibration states. Results will be reported.

1This work is supported by NASA.

12:06PM PB.00009 Application of the Anisotropic Bond Model to a Single Bond Attached to a Sphere, E.J. ADLES, D.E. ASPNES, North Carolina State University — The configuration consisting of a single adatom on a sphere of dimensions small compared to the relevant wavelength of light is of interest to both surface-enhanced Raman scattering (SERS) and second-harmonic generation (SHG). Here we apply our recently developed anisotropic bond model (ABM) of nonlinear optics (NLO) to investigate this configuration. The ABM provides a simple means for calculating NLO properties by factoring the problem into the fundamental 4-step process of optics: first, determine the local field at the bond charge site; second, solve the anharmonic force equation for the bond charge; third, calculate the radiation from the accelerated bond charge; fourth, superpose the radiation from all charges. This factorization is possible because typical NLO signals occur at different energies with intensities that are orders of magnitude smaller than the driving fields. Therefore, NLO problems are actually simpler than linear-optics problems where all four steps must be solved self-consistently. For SERS, the calculations show that the strength of the exciting field is enhanced via the “lightning-rod” effect, but no such enhancement occurs for the emerging radiation.

12:18PM PB.00010 Magnetic field structure in photodetachment from the lowest threshold of the O− ion, JOHN N. YUKICH, ANNE JOINER, ROBERT H. MOHR, Davidson College — Numerous experiments have examined photodetachment in a magnetic field at the 2P1/2 → 3P0 threshold of ions such as S− and O−. The threshold energy is known as the atom’s electron affinity. Many of these experiments have visually resolved cyclotron and Zeeman structure in the detachment cross section. We report on an experiment that for the first time has resolved magnetic field structure in detachment at the lowest-lying threshold for the O− ion, the 2P1/2 → 3P0 threshold. Our experimental apparatus includes a Penning ion trap in which the ions are created, trapped and stored, and a single-mode, amplified diode laser. Our observations also yield a quantitative measurement for the threshold energy.

1Support from the Petroleum Research Fund and Davidson College

Saturday, November 1, 2008 10:30AM - 12:30PM – Session PC Geophysics and Atmospheric Physics Holiday Inn Brownstone Lincoln
10:30 AM PC.00001 Using Seismic Refraction Method to Image the Subsurface Structure of the Eastern Bushveld Complex in South Africa1, ABBEAW BELAY, North Carolina A&T State University, ANDREW NYBLADE, AUBREYA ADAMS, Penn State University, MULUGETA DUGDA, North Carolina A&T State University — Few undergraduate students had the opportunity to go to the field and image the subsurface structure of the eastern Bushveld Complex in South Africa. We applied the seismic refraction method which is a method based on a seismic wave refracted by 90 degrees (critical angle) and will generate a head wave that will be picked up by geophones as detectors. Sledgehammer was used to generate seismic waves (artificial pulses). Software called SeisModule Controller was used to record and process the seismic data. The idea is to model the subsurface structure and the modeling gave us the depth and velocity of different layers. We also utilized aeromagnetic and borehole information to make comparison with the results obtained. Each student in the field had a chance to utilize four different geometrical methods (electrical resistivity, magnetic, gravity and seismic refraction) but focused more on one of those methods in this geologically remarkable place that is rich in minerals.

1 Authors acknowledge the support from the National Science Foundations office of International Science and Engineering.

10:42 AM PC.00002 New Crustal Thickness for Djibouti, Afar, Using Seismic Techniques MULUGETA DUGDA, SOLOMON BILLILIGN, North Carolina A&T State University — Crustal thickness and Poisson’s ratio for the seismic station ATD in Djibouti, Afar, has been investigated using two seismic techniques (H-κ stacking of receiver functions and a joint inversion of receiver functions and surface wave group velocities). Both techniques give consistent results of crustal thickness 23±1.5 km and Poisson’s ratio 0.31±0.02. We also determined a mean P-wave velocity (Vp) of ~6.2 km/s but ~6.9-7.0 km/s below a 2 - 5 km thick low velocity layer at the surface. Previous studies of crustal structure for Djibouti reported that the crust is 6 to 11 km thick while our study shows that the crust beneath Djibouti is between 20 and 25 km. This study argues that the crustal thickness values reported for Djibouti for the last 3 decades were not consistent with the reports for the other neighboring region in central and eastern Afar. Our results for ATD in Djibouti, however, are consistent with the reports of crustal thickness in many other parts of central and eastern Afar. We attribute this difference to how the Moho (the crust-mantle discontinuity) is defined (an increase of Vp to 7.4 km/s in this study vs. 6.9 km/s in previous studies).

10:54 AM PC.00003 Orographic Effects on the Evolution of AEW-MCSs Across Northern Africa. JAMES SPINKS, WILSON JONES, YUH-LANG LIN, GUOQING TANG, NC A&T State University — The pre-development period of Tropical Storm Debby (2006) initially formed over the Ethiopian Highlands (EH) region is studied in conjunction with the African easterly wave (AEW) disturbance and the embedded mesoscale convective systems (MCS). Based on infrared satellite imagery and numerically simulated results, several convective genesis and lysis periods are identified. When mountains in central and western North Africa replaced by flat terrains, we found that the embedded MCS is weakened and the convective cycles less apparent. Similar effects are found with the reduced moisture content. It is found that the PBL effects and moisture availability are important for maintaining AEW-MCS system as it travels to the west and supporting sufficient moisture by allowing for surface moisture fluxes to affect the systems and aid in convective development. The AEW is slightly modulated by orography downstream from the EH region. Both the EH region and the PBL effects are essential in the proper development and propagation of the AEW and its subsequent disturbances.

11:06 AM PC.00004 Formation of AEWs and MCSs over Eastern Africa and its Implication to Tropical Cyclogenesis over Eastern Atlantic Ocean. GUOQING TANG, YUH-LANG LIN, JAMES SPINKS, WILSON JONES, NC A&T State University — The formation of African easterly waves (AEWs) and mesoscale convective systems (MCSs) in eastern North Africa and its impacts on the tropical cyclogenesis over the eastern Atlantic Ocean is studied. Based on numerical simulations using WRF model, the AEWs during the hurricane season may be generated by the orography and shear zone established by the Somali jet and anticyclonic circulation associated with the Asian monsoon to the north of the Ethiopian Highlands (EH) and Red Sea. The WRF is employed to simulate the pre-hurricane AEW-MCS system of Tropical Storm Debby (2006) near the EH. Finer-resolution numerical simulations demonstrate that the vortex generated on the lee and MCS over the mountain eventually merge and become an AEW-MCS system serving as a precursor of tropical cyclone. The larger-scale environments conducive to the formation of the AEW-MCS system are also investigated.

11:18 AM PC.00005 Orographic Effects on the Evolution of African Easterly Wave-Mesoscale Convective Systems Across Africa. JAMES SPINKS, WILSON JONES, YUH-LANG LIN, North Carolina A&T State University, GUOQING TANG, North Carolina State University — Effects of northern African mountains on the evolution of the Pre-Tropical Storm Debby (2006) African easterly wave-mesoscale convective system (AEW-MCS) are studied using a mesoscale numerical model. Specifically, we test the hypothesis, as proposed by previous studies, that moisture and vertical velocity played a major role in the generation and maintenance of the MCS convective cycles. With the mountains in central and western North Africa removed or the moisture reduced, we found that the embedded MCS is weakened and the convective cycles less apparent. Effects of PBL are also found to play a major role in modulating the AEW-MCS system. Both orographic and PBL effects are essential in the proper development and propagation of the AEW and its subsequent disturbances. This work is mainly supported by UCAR SOARS Program and partially supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.

11:30 AM PC.00006 Formation of African Easterly Waves and Mesoscale Convective Systems over Eastern Africa. GUOQING TANG, YUH-LANG LIN, JAMES SPINKS, North Carolina A&T State University, WILSON JONES, North Carolina State University — Based on simulations of Tropical Storm Debby (2006) using the Weather Research and Forecast (WRF) model, the African Easterly Waves (AEWs) during the hurricane season may be generated by the orography and shear zone established by the Asian monsoon currents. The vortices often form on the lee of major mountain ranges. The MCSs are originated from the moist convection over the major mountain ranges as triggered by diurnal sensible heating. An MCS may merge with a vortex in the shear zone and form a coupled AEW-MCS system. The larger-scale environments conducive to the formation of the AEW-MCS system are also investigated, but using a much larger numerical model domain. This work is supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.

11:42 AM PC.00007 Effects of Southern Appalachian Mountains with the Passage of Hurricane Ivan (2004). ALAN COVELL, YUH-LANG LIN, N. C. A&T State University — Effects of Appalachian Mountains on Hurricane Ivan (2004) are investigated using the Weather Research and Forecast (WRF) model. A single domain with 12 km resolution is used to simulate the storm from 0000UTC 16 to 1200UTC 18 September with a time interval of 3 h. The Appalachian Mountains have a much more profound effect at 1000mb than at 300mb, as revealed in vorticity fields. The simulated fields compare well with satellite imagery, however, the simulated track is slightly west of the actual track. The simulated rainfall indicates that most of the precipitation appears to be focused over the Appalachian mountains and far western N. C., as shown in the observed data, which is also known as rain-shadow phenomenon. The storm weakens as it passes over and around the mountains. The Appalachian mountains appear to have a focusing effect on getting the precipitation concentrated around the mountains. The mountains also seem to influence the path of the storm, causing it to move farther westward as it heads north. This work is supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.
11:54AM PC.00008 Comparison of Water Vapor Measurements from Ground-based and Space-based GPS Atmospheric Remote Sensing Techniques, IAN COLON-PAGAN, N. C. A&T State University, YING-HWA KUO, National Center for Atmospheric Research — In this study, we compare precipitable water vapor (PWV) values from ground-based GPS water vapor sensing and COSMIC radio occultation (RO) measurements over the Caribbean Sea, Gulf of Mexico, and United States regions as well as global analyses from NCEP and ECMWF models. The results show good overall agreement; however, the PWV values estimated by ground-based GPS receivers tend to have a slight dry bias for low PWV values and a slight wet bias for higher PWV values, when compared with GPS RO measurements and global analyses. An application of a student T-test indicates that there is a significant difference between both ground- and space-based GPS measured datasets. The dry bias associated with space-based GPS is attributed to the missing low altitude data, where the concentration of water vapor is large. The close agreements between space-based and global analyses are due to the fact that these global analyses assimilate space-based GPS RO data from COSMIC, and the retrieval of water vapor profiles from space-based technique requires the use of global analyses as the first guess. This work is supported by UCAR SOARS and a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.

12:06PM PC.00009 A study of ocean spray lubrication effect on tropical cyclone intensity, YEVGENII RASTIGEJEV, YUH-LANG LIN, N. C. A&T State University — It has been shown recently (Barenblatt, et al., 2005) that the presence of water droplets in the vortex of tropical cyclone (TC) leads to a significant reduction in turbulent intensity and consequently to a sharp flow acceleration. The developed theory has been extended by considering different mechanisms of ocean spray production, positive feedback of wind acceleration, different turbulence closure models and some other contributing factors. The sensitivity of ocean spray lubrication effect to the theoretical model has been investigated. A series of numerical experiments with an ideal hurricane model have been performed. The simulations have been run with and without spray for different theoretical models. An effort to develop a proper spray parameterization based on the theoretical consideration and the results of numerical experiments is undertaken. Consequently we will incorporate the spray parameterization in the realistic Weather Research and Forecast (WRF) numerical model in order to improve the accuracy of TC intensity prediction. This work is supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.

12:18PM PC.00010 Effects of Orography on the Genesis of Hurricane Javier (2004) in the Eastern Pacific Ocean, VAN NGUYEN, YUH-LANG LIN, N.C. A&T State University — Observational evidence shows that the Eastern Pacific Ocean is the most active region of tropical cyclone genesis in the world. In this study, we will perform numerical experiments using the Weather Forecast and Research (WRF) model to investigate the orographic effects on the genesis of Hurricane Javier (2004). In particular, we test the hypothesis that the formation of Hurricane Javier is due to the merging of the orographically modified African easterly waves by Central American mountains, mesoscale convective systems (MCSs) embedded within the AEWs, and the MCSs induced by diurnal heating over the mountains. Effects of orography and moisture are studied by performing sensitivity experiments using WRF with the mountains removed and moisture reduced, respectively. Fundamental understanding of the tropical cyclogenesis over the eastern Pacific is obtained by comparing the results from the control experiment, sensitivity experiments, and available data. This work is supported by a grant from the National Oceanic and Atmospheric Administration, Educational Partnership Program under the cooperative agreement NA06OAR4810187.