84th Annual Meeting of the APS Southeastern Section
Milledgeville, Georgia
http://www.aps.org/meetings/meeting.cfm?name=SES17
Thursday, November 16, 2017 8:30AM - 10:00AM –
Session A1 Photonuclear Physics  MSU Building University Banquet Room A - Mohammad Ahmed, North Carolina Central University and TUNL

8:30AM A1.00001 A Study of the Nucleon Electromagnetic Response: the Compton@HIGS Program, MARK SIKORA, George Washington University — The electromagnetic properties of the nucleon arise from its composite nature. External electric and magnetic fields induce dipole moments described by the scalar polarizabilities (α_S and δ_S), while the response of the nucleon spin is described by four spin polarizabilities. Consequently, studying these observables provides a window into the interaction among the constituent charges and currents in the nucleon, described theoretically by QCD. High precision measurements of the scalar and spin polarizabilities provide critical benchmarks for studying the low-energy, non-perturbative regime of QCD and emerging calculations from lattice QCD and Chiral Effective Field Theories. To this end, a program of Compton scattering experiments on light nuclei is underway at the High Intensity Gamma Source (HIγS) at Duke University, with the aim of providing the world’s most precise measurements of the polarizabilities. We report preliminary measurements of the Compton scattering differential cross section for 4He, 2H, and 1H and discuss the sensitivity of these data to the polarizabilities.

9:00AM A1.00002 Photofission measurements using the HIγS facility at TUNL1, KRISHICHAYAN, Duke University/TUNL — In an effort to understand and compare the effect of the incoming probe on the fission product yield distribution (neutron vs. photon), a program has been initiated to measure fission product yields in photoinduced fission. Photofission measurements were performed at the High Intensity γ-ray Source (HIγS) at Triangle Universities Nuclear Laboratory on 235U, 238U, and 239Pu at Eγ = 13 MeV. Results on the first ever photofission product yield measurements obtained with monoenergetic photon beams will be discussed during the meeting.

9:30AM A2.00001 A Study of the Nucleon Electromagnetic Response: the Compton@HIGS Program, MARK SIKORA, George Washington University — The electromagnetic properties of the nucleon arise from its composite nature. External electric and magnetic fields induce dipole moments described by the scalar polarizabilities (α_S and δ_S), while the response of the nucleon spin is described by four spin polarizabilities. Consequently, studying these observables provides a window into the interaction among the constituent charges and currents in the nucleon, described theoretically by QCD. High precision measurements of the scalar and spin polarizabilities provide critical benchmarks for studying the low-energy, non-perturbative regime of QCD and emerging calculations from lattice QCD and Chiral Effective Field Theories. To this end, a program of Compton scattering experiments on light nuclei is underway at the High Intensity Gamma Source (HIγS) at Duke University, with the aim of providing the world’s most precise measurements of the polarizabilities. We report preliminary measurements of the Compton scattering differential cross section for 4He, 2H, and 1H and discuss the sensitivity of these data to the polarizabilities.

9:30AM A2.00003 CALIOPE: A Test of CPT-invariance in o-Ps Decay, CHELSEA BARTRAM, University of North Carolina at Chapel Hill — We propose a test of CPT-invariance in ortho-positronium (o-Ps) decays with CALIOPE, or CP(T) Aberrant Leptons in o-Ps Experiment. CPT-violation could manifest itself in angular correlations between the directions of the three gamma rays emitted in the decay of o-Ps. We use an array that provides 75% of 4π angular acceptance, increasing our statistics over previous such experiments. The array is composed of 24 NaI(Tl) bars arranged cylindrically. A cylinder of aerogel adjacent to a tagged source supplies positronium at the center of the array. We will present a systemsatics study and the first detection of o-Ps. A search for CP-violation is also possible with the addition of an electromagnet.

Thursday, November 16, 2017 8:30AM - 10:30AM –
Session A2 High Intensity Frontier  MSU Building University Banquet Room B - Dr. Romulus Godag, University of South Alabama

8:30AM A2.00001 Probing the Frontiers of Physics Using Muons, EDMOND DUKES, University of Virginia — The absence of any signature for new physics beyond the standard model at the Large Hadron Collider has left the field of elementary particle physics in a quandary. We know there is new physics out there: where best to look for it? Searches for certain rare processes provide ultra-sensitive probes for new physics and can probe mass scales unobtainable by any conceivable accelerator, present or imagined. We show how such searches can probe mass scales unobtainable by direct searches at any conceivable particle accelerator and describe an experiment, Mu2e, that intends to use a novel technique to search for new physics through lepton flavor violation in muon decays with sensitivities a factor of 10,000 over existing limits.

9:00AM A2.00002 B Physics from Belle and Prospects at Belle II1, MILIND PUROHIT, Univ of South Carolina — We present some interesting recent results from the Belle experiment and some forthcoming physics topics of interest for the Belle II experiment which will begin data taking very soon. The highlights cover B and D decays, although some related and some other results and projections will also be presented.

9:30AM A2.00003 The muon g-2 experiment: overview and prospects1, DINKO POCANIC, University of Virginia — The muon gyromagnetic factor gμ has long occupied a prominent place among the observables used in precision tests of the Standard Model (SM). The current discrepancy between the SM prediction and the value measured by the Brookhaven E821 Experiment stands at about 3.5 standard deviations, with comparable experimental and theoretical uncertainties. Two new experiments, one at Fermilab and the other at J-PARC, aim to improve the experimental uncertainty by a factor of 4. Meanwhile, the SM prediction is also expected to undergo a significant increase in precision. We review the status of the Fermilab experiment E989, currently operational and undergoing commissioning. E989 will analyze 21 times more muon decays than BNL E821, and is also poised to reduce the systematic uncertainty by a factor of 3. The overall goal of E989 is to achieve the precision of 0.14 ppm for aμ = (gμ − 2)/2.

1Supported by a grant from the U.S. DOE

10:00AM A2.00004 Reactor Neutrino Experiments, JONATHAN LINK, Virginia Tech — Neutrinos from nuclear reactors have had an impressive record of discovery in particle physics, from the first observation of neutrinos by Reines and Cowan in 1956, through the resolution of solar neutrino oscillations, to the measurement of the last neutrino mixing angle, θ13. Today, there remain many questions that can best be addressed with reactor neutrinos, including a precision determination of the solar mixing angle and a resolution of the light sterile neutrino question. This talk will focus on selected recent success and future measurements, with special attention paid to new technologies that are enabling these measurements.

1Work supported by grants from the US NSF and DOE
8:30 AM A3.00001 Recent Results from EXO-200. TIMOTHY DANIELS, University of North Carolina at Wilmington. EXO-200 COLLABORATION — EXO-200 is a low-background time-projection chamber employing about 150kg of enriched liquid $^{136}$Xe and located underground at the WIPP site outside Carlsbad NM. In its first phase of data-taking between 2011 and 2014, the experiment made the first observation of two-neutrino double-beta decay of $^{136}$Xe, provided the most precise measurement of any two-neutrino half-life to date, and provided one of the most sensitive searches for neutrinoless double-beta decay. While the first phase ended with the 2014 fire and radiation events at WIPP, a second phase of data collection with upgrades including improved energy resolution began in 2016. Results including the first year of data with the upgraded detector will be shown.

8:42 AM A3.00002 The measurement of neutron beta decay observables with the Nab spectrometer. STEFAN BAESSLER, University of Virginia and Oak Ridge National Lab, NAB COLLABORATION — Nab, an experiment that allows studying unpolarized neutron beta decay at the Spallation Neutron Source at Oak Ridge National Lab, aims to determine $a$, the neutrino-electron correlation coefficient, and $b$, the Fierz interference term, with high precision. Such measurements provide opportunities to search for evidence of extensions to the Standard Model. Nab is presently being constructed, with beam readiness planned for mid 2018. I will discuss the experiments motivation and design, the planned modes of operation, and the performance of its components.

8:54 AM A3.00003 The Electric Field in the Neutron Decay Region of the Nab. HUANGXING LI, University of Virginia, NAB COLLABORATION — The Nab collaboration will determine two parameters in free neutron beta decay: (a) the electron-antineutrino correlation coefficient $a$ to $|\delta a/a| \leq 10^{-3}$ and (b) the Fierz interference term $b$ to $|\delta b| \leq 3 \times 10^{-3}$. Part (a) will be done with a measurement of the two-dimensional electron energy and proton time-of-flight spectrum in the neutron beta decay. We will discuss the requirements for the electric field in the neutron decay region to achieve the desired experimental uncertainty. We will present our solution: an electrode system made from materials with low work function variations, and its characterization with a Kelvin probe.

9:06 AM A3.00004 Fitting Methods in the Nab Experiment. WENJIANG FAN, Univ of Virginia, NAB COLLABORATION — The Nab collaboration aims to measure the electron-antineutrino correlation parameter $a$ with a relative uncertainty of about $10^{-3}$, and the Fierz interference term $b$ with absolute uncertainty of $3 \times 10^{-3}$ at the Spallation Neutron Source (SNS). In Nab, $a$ is determined by combined precise determinations of the electron energy and the proton time-of-flight. In this talk, we will present a fitting method to analyze $a$ and its uncertainties, as well as specific techniques developed to increase the fitting performance based on experimental scenario.

9:18 AM A3.00005 Approximate approaches for nuclear weak interaction rates for astrophysics. B.M. ANDERSON, G.W. HITT, Department of Physics & Engineering Science, Coastal Carolina University, P.O. Box 261954 Conway, SC 29528, USA, S.S. GUPTA, Indian Institute of Technology Ropar, Nangal Road, Rupnagar (Ropar), Punjab 140 001, India — Nuclear weak interactions, like beta decay and electron capture, are important inputs for modeling explosive astrophysical events. In the allowed approximation, nuclear weak interactions proceed as either Fermi or Gamow Teller (GT) processes where the spins of the electron and neutrino are either anti-parallel or parallel, respectively. In the GT case, transition probability is spread over many final states in the daughter nucleus, so each probability determination requires numerical integration of the available phase space. Developing a fast and accurate method for calculating each contribution to the total decay rate would provide reliable weak rate libraries for astrophysical modelers. The integrand for the phase space includes the classical statistical factor, a coulomb correction, and the Fermi Dirac distribution of continuum electrons in the stellar material. In this talk, we will discuss the discrepancies between measurements of the proton charge radius using muonic and electronic probes, has led to theoretical and experimental investigations. The Muon Scattering Experiment (MUSE) at the Paul Scherrer Institute (PSI) will address the puzzle by determining the proton charge radius with electron- and muon-scattering measurements off the proton with high precision. The MUSE scattered-particle scintillators, built at University of South Carolina, are part of the readout trigger and serve as time-of-flight detectors for particle identification. The system is comprised of 18 120-cm long detectors in a front wall and 28 220-cm long detectors in a rear wall. In this talk I will discuss a testing procedure for the TOF system using cosmic rays and six detector elements to determine their time resolutions. With this procedure, an average time resolution of better than 60 ps over the full length of a long detector bar ($6 \times 6 \times 220$ cm) and better than 50 ps for a short bar ($6 \times 3 \times 120$ cm) was demonstrated. The time resolutions are well within the requirements of the experiment.

Supported in parts by the U.S. National Science Foundation: NSF PHY-1614773
9:42AM A3.00007 The MUSE Experiment and Proton Radius Puzzle: Design and Status of LH$_2$ Cryotarget. PRIYASHREE ROY, NOAH STEINBERG, LUC LEPOTIER, RICHARD RAYMOND, WOLFGANG LORENZON, University of Michigan, MUSE COLLABORATION — A fundamental challenge faced by the scientific community is to resolve the proton radius puzzle: the $\sigma$ discrepancy observed between muon spectroscopy and atomic measurements of the proton radius. The discrepancy, if real, could point to interesting new physics. The MUon Scattering Experiment (MUSE), which will take place at the Paul Scherrer Institute in Switzerland, will play an instrumental role towards resolving this puzzle since it will be the first muon elastic scattering experiment at low $Q^2$ of about 0.0016 – 0.08 GeV$^2$ and the first to perform simultaneous elastic scattering measurements using both muons and electrons. This will allow a direct comparison of the proton radius from the two leptonic probes to a sub-percent level. An essential and arguably the most complex part of MUSE is the liquid hydrogen (LH$_2$) cryotarget system. Dictated by physics needs, the cryotarget system needs to satisfy many requirements, including a vertically movable target ladder consisting of three more targets in addition to the LH$_2$ target housed inside a vacuum chamber and large vacuum windows on both sides of the beamline. Here we report on the design and status of the MUSE cryotarget system, and our technique to fabricate the LH$_2$ target cell.

1This work is supported by NSF grant 1505458

9:54AM A3.00008 Studies of new GaInP based Geiger-mode APD arrays. GRACE CUMMINGS, ROBERT HIROSKY, U. Virginia — Devices composed of wide band gap semiconductors such as GaInP have the theoretical potential to withstand many orders of magnitude larger radiation exposures compared to silicon. The demonstration of functional devices with new semiconductor materials and epitaxies is a prerequisite to evaluating this potential. We will discuss results from measurements of performance and radiation damage studies of two recent generations of prototype devices and discuss plans for future work.

Thursday, November 16, 2017 11:00AM - 12:36PM – Session B1 Applied Physics  MSU Building University Banquet Room A - David Lawrence, Jefferson Lab

11:00AM B1.00001 Composite reinforced metallic cylinder for high speed rotation , DR. SAHADEV PRADHAN, Chemical Technology Division, Bhabha Atomic Research Centre, Mumbai- 400085 — The objective of the present study is to design and development of the composite reinforced thin metallic cylinder to increase the peripheral speed significantly and thereby improve the separation performance in a centrifugal gas separation processes through proper optimization of the internal parameters. According to Dirac equation (Cohen (1951)), the maximum separative work for a centrifugal gas separation process increase with 4th power of the peripheral speed. Therefore, it has been intended to reinforce the metallic cylinder with composites (carbon fibers: T-700 and T- 1000 grade with suitable epoxy resin) to increase the stiffness and hoop stress so that the peripheral speed can be increased significantly, and thereby enhance the separative output. Here, we have developed the mathematical model to investigate the elastic stresses of a laminated cylinder subjected to mechanical, thermal and thermo-mechanical loading. A detailed analysis is carried out to underline the basic hypothesis of each formulation. Further, we evaluate the steady state creep response of the rotating cylinder and analyze the stresses and strain rates in the cylinder.

11:12AM B1.00002 Residual stress analysis based on an optical interferometric method , SAGNHUN OH, JUN SHITAKA, SANICHIRO YOSHIDA, Southeastern Louisiana Univ — This paper discusses a method of residual stress analysis based on an optical interferometric method known as Electronic Speckle-Pattern Interferometry (ESPI). We apply a small tensile load to the specimen and measure the resultant displacement with ESPI. Our hypothesis is that compressive/tensile residual stress causes acceleration in the same/opposite direction to the displacement due to the tensile load as the material returns/deviates from the equilibrium. Here we evaluate the acceleration by numerically differentiate displacement data taken successive time steps. Our preliminary study supports this hypothesis. The challenge is that the high frequency speckle noise superposed on the ESPI fringe patterns used for the displacement measurement compromises the evaluation of displacement and acceleration. We apply low-pass filtering techniques to remove the noise. Estimated residual stress data is being compared with results from X-ray diffractometry. Recent progress on the low-pass filtering and X-ray diffraction measurement will be reported.

11:24AM B1.00003 Quantum Efficiency Determination using Photothermal Deflection Spectroscopy, BRANDON COUCH, STEPHEN JOHNSON, Transylvania Univ — In this study, we present a new method to measure the fluorescence quantum efficiency (QE) of organic dyes using photothermal deflection spectroscopy (PDS). While PDS has been used in the past to measure QE, the data presented in this study were taken without the use of reference standards. Dyes used in the study had QE ranging from 0-1 and data agree well with reported literature values. This new method obviates the need for integrating sphere setups and multiple calibration measurements, thereby streamlining the entire measurement process.

11:36AM B1.00004 Noninvasive method of detecting blistering in thin-film specimens, DAVID DIDIE, JONGSUNG KIM, SANICHIRO YOSHIDA, Southeastern Louisiana University — With our newly created noninvasive technique of detecting blistering in thin-film systems, we analyzed platinum-silicon specimens. These thin-film specimens were configured as an end-mirror of the Michelson interferometer with the film surface facing the beam splitter and oscillated with an acoustic transducer from the rear in driving frequency of 3 kHz- 10 kHz. The reference arm was slightly tilted horizontally so that the interference image had carrier fringes. The fringe pattern was monitored with a digital camera. Since the digital cameras frame rate was significantly lower than the acoustic frequency, the fringe contrast reduced as the oscillation amplitude increased. The film-surface oscillation amplitude was evaluated from the reduction in the fringe contrast. We hypothesized that blistered area had weaker adhesion, hence resonance frequency of oscillation is lower than well-adhered region. Our experimental results indicate that at some driving frequencies, the fringe contrast of certain regions is clearly lower. These results support our hypothesis.
Scalable patterning using laser-induced shock waves. SAID JAFARZODA ILHOM, KHOMEIDKHOZH KHALIKOV, Western Kentucky University, PEIZHEN LI, University of Kentucky, CLAIRE OTTMAN, DYLAN SANFORD, ZACHARY THOMAS, Western Kentucky University, OMER SAN, Oklahoma State University, HALUK E. KARACA, University of Kentucky, ALI OGUZ ER, Western Kentucky University, PEIZHEN LI, HALUK E. KARACA. COLLABORATION, OMER SAN COLLABORATION — An advanced direct imprinting method with low cost, quick, and minimal environmental impact to create thermally controllable surface patterns using the laser pulses is reported. Patterned micro indentations were generated on Ni$_3$Al Ti$_{50}$ shape memory alloys (SMA) and aluminum using an Nd:YAG laser operating at 1064 nm combined with suitable transparent overlay, a sacrificial layer of graphite, and copper grid. Laser pulses at different energy densities generate plasma which forms a cushion of gas that transfers the grid pattern onto the surface. Scanning electron microscope (SEM) and optical microscopy images show that various patterns were obtained on the surface with high fidelity. Optical profile analysis indicates that the depth of the patterned sample initially increases with the laser energy and later levels off. Simulations of laser irradiation process also confirm that high temperature and high pressure could be generated when laser energy of 2 J/cm$^2$ is used.

Evaluation of residual stress by measuring resonant frequency with Optical Method. SHUHEI MIYAZAKI, SANICHIRO YOSHIDA, Southeastern Louisiana Univ, TOMOHIRO SASAKI, Niigata Univ — Residual stress in dissimilar welding is important for quality management. A number of techniques are available for residual stress analysis such as X-ray diffraction and hole-drilling methods. However, these methods are time-consuming. We propose to assess residual stress of dissimilar lap-welded plates from analysis of harmonic response of the specimen. We hypothesize that residual stresses alter the elastic modulus and hence shifts the resonant frequency. In this study, as the first step for the above approach, we used annealed and quenched cantilever specimens of the same material for a proof of the principle. We oscillated the cantilever by applying sinusoidal force at the free end. By sweeping the driving frequency around theoretical resonant frequency, we observed resonant behaviors of the oscillation. We used optical interferometry to visualize the out-of-plane oscillation of the specimen. We develop a technique to use a digital camera whose frame rate is significantly lower than the driving frequency. As expected, the amplitude of specimen changed remarkably around the resonant frequency, and digital camera was able to detect this as fringe images. We were able to identify the resonant frequency.

Laser-induced hydrogen generation from graphite and coal. KHOMEIDKHOZH KHALIKOV, DOVLETGELDI SEYITLIYEV, BYRON GRANT, Western Kentucky Univ, OMER SAN, Oklahoma State University, ALI ER, Western Kentucky Univ — We present a simple way of obtaining hydrogen gas from various ranks of coal, coke, and graphite using nanosecond laser pulses under different conditions such as water, air and argon atmosphere. Coal samples were initially characterized by scanning electron microscope (SEM), Fourier transform infrared (FTIR) spectroscopy, and calorimeter. It was observed that 532 nm laser pulses were more effective than 1064 nm pulses in gas generation and both were nonlinearly correlated with respect to the laser energy density. Gas chromatography measurements indicate that mainly hydrogen and carbon monoxide were generated. The hydrogen to carbon monoxide ratio shows that the highest efficiency rank was anthracite coal, with an average ratio of 1:4 due to its high fixed-carbon content and relatively high hydrocarbon amount. Graphite was used as a pure carbon source to study the possible reactions of gas yielded during the irradiation process. In addition, theoretical simulations using a standard finite difference method supported experimental observations. The possible mechanisms of gas generation were explained with chemical reactions.

Residual stress analysis with visualization thermal deformation using Electronic Speckle Pattern Interferometry. JUN SHITAKA, SANICHIRO YOSHIDA, Southeastern Louisiana Univ, TOMOHIRO SASAKI, Niigata Univ — A nondestructive method to analyze brazing-induced residual stress is proposed. This method applies thermal loads to the specimen and visualizes the resultant deformation using optical interferometry known as Electronic Speckle-Pattern Interferometry (ESPI). Using the temperature dependence of the thermal expansion and elastic modulus known for the material, we estimate the residual stresses from the visualized deformation. As a temperature rise, the coefficient of thermal expansion increases and elastic modulus decreases. On the other hand, compressive/tensile residual stress increases/decreases elastic modulus as the inter-atomic distance decreases/increases. This is because the inter-atomic potential energy curve is steeper on the short interatomic distance side of the equilibrium. In this study, we used a dissimilar joint tool steel SKD11 and cemented carbide V30, as a sample specimen. We plan to compare the estimated residual stress with an analysis based on X-ray diffractometry. Our final goal is to develop a totally nondestructive method based on the thermal loading and ESPI deformation analysis. We will report our preliminary results of the research.

Session B2 Biophysics and Medical Physics

11:00AM B2.00001 Novel exchange-coupled core/shell nanoparticles for advanced magnetic hyperthermia. CAROLINE COLLINS, Bob Jones University, JOSHUA ROBLES-GARCIA, RAJA DAS, MANH H. PHAN, HARRY SRIKANTH, University of South Florida — Of any disease, probably the most well-known is cancer, and while there are treatments available, a new form of treatment is needed that is safer for the patient. Studies on magnetic nanoparticles (MNPs) have shown their promise in biomedical applications, such as magnetic hyperthermia, which employs MNPs for localized destructive heating of cancer cells. It has been found that as the size of the MNP decreases, the heating efficiency drastically decreases. Recently, however, a large improvement in heating efficiency has been reported in exchange-coupling of MNPs between a soft and a hard magnetic material. In this study, we optimized the heating efficiency of exchange-coupled MNPs composed of a soft magnetic core (Fe$_3$O$_4$) and a hard magnetic shell (CoFe$_2$O$_4$) by tuning both the shape of the nanoparticles and their concentration in solution. The MNPs show high magnetization (~ 80 emu/g) and superparamagnetic-like behavior at room temperature. We compare the specific absorption rate (SAR) for each set of MNPs and correlate the results to shape distribution and concentration in solution. This study shows that exchange-coupled MNPs for magnetic hyperthermia are promising as route for non-harmful cancer treatment. A new approach for controlling the inductive heat for cancer treatment using a mixture of spheres and cubes is proposed.

1 This project is supported by the NSF REU grant 1560090
11:12AM B2.00002 Simulating nanoscale particle suspensions using a coupled lattice-Boltzmann and Langevin-dynamics method: application to particle transport in cellular blood flow. ZIJIANG LIU, YUANZHENG ZHU, Georgia Institute of Technology, REKHA RAO, JONATHAN CLAUSEN, Sandia National Laboratories, CYRUS AIDUN, Georgia Institute of Technology — A novel computational approach coupling the lattice-Boltzmann (LB) method and a Langevin-dynamics (LD) approach has been developed to simulate nanoscale particle (NP) suspensions in the presence of both thermal fluctuation and many-body hydrodynamic interactions (HI). The Brownian motion of NPs is explicitly driven by the stochastic force term in the LD. The LB method is coupled with the LD in a two-way fashion through a discrete forcing source distribution term in the LB method. The validity and accuracy of this LB-LD approach is demonstrated through several verification problems, including velocity relaxation of an isolated particle, self-diffusion of a Brownian particle, and relaxation of a polymer chain. Good agreement between simulation and theory is observed. The verified algorithm is applied to study the migration of NPs in cellular blood flow within microvasculature. For NPs of diameter \(1-100\) nm, Brownian diffusion, compared to the red blood cell (RBC)-enhanced diffusion, is shown to be the predominant driver for the NP radial diffusion process. For larger NPs of diameter \(500\) nm, Brownian diffusion and RBC-enhanced diffusion are shown to be comparably significant.

11:24AM B2.00003 Nanofibrous gelatin structures: Effect of high-yield electrospinning on the fiber formation and stability. AMANDA KENNELL, ANNA KRAM, ANDREI STANISHEVSKY PHD, University of Alabama in Birmingham — Nanofibrous biopolymer materials represent an attractive platform for many biomedical applications. Such materials are frequently made by the electrospinning process, which is based on complex hydrodynamic phenomena leading to the formation of solid nanofibers from electrified polymer solutions. Textural properties and composition of nanofibers and fibrous assemblies play a big role in the physiological performance of electrospun biopolymer structures. In this study, gelatin nanofibers were produced at a rate of up to \(20\) g/h by using a recently developed high-yield free-surface electrospinning process. The dense nanofibrous flow in this process moves at \(0.2-7\) m/s speed due to the effect of ionic wind, which allowed easy assemblage of the resulting nanofibers. Depending on the type of gelatin and process parameters, the fiber diameter varied from \(100\) nm to \(2000\) nm. Nanofibrous gelatin mats with up to \(3\) mm thickness were physically and chemically crosslinked to increase the material stability in simulated body fluids (SBFs). The effect of process conditions on the changes in the fiber morphology and textural properties of as-prepared, crosslinked, and SBF-exposed nanofibrous mats was explored. Initial results on the tensile properties of gelatin nanofibers are discussed.

11:36AM B2.00004 Imaging and Treatment Isocenter Coincidence for a Linear Accelerator Using Oblique Projection Imaging. JAKE DOWNEY, University of Tennessee Chattanooga, MARIAN AXENTE, CHENGUANG LIU, Erlanger health systems, Department of Radiation Oncology, Chattanooga, Tennessee — Modern radiotherapy treatments involve advanced patient imaging systems to allow for more accurate and reproducible patient positioning. This is known as image guided radiotherapy (IGRT). To conduct IGRT, the user needs to validate that the coincidence of the imaging system and the treatment beam's center is within acceptable tolerances (<2mm). The equipment under investigation was a double oblique kV projection imaging system and a C-arm gantry mounted medical linear accelerator (linac). Using radiochromic film, the coincidence of the linac mechanical center, and radiation beam center was found to be 0.91mm. The imaging system center was calibrated to be <1mm from linac mechanical center. Using IGRT, a hidden spherical target phantom was aligned. Using radiochromic films were also inserted in the phantom to capture the target shadow made by the treatment beam. The test indicated an alignment error of 1.30±0.27mm between the imaging and treatment center, which was within stated tolerance. These experiments provide a conclusive and deconvoluted map of uncertainties using IGRT as well as understanding of quality assurance methods used by a medical physicist in a clinical setting.

11:48AM B2.00005 Photodeactivation of pathogenic bacteria using methylene blue and graphene quantum dot. ZACHARY THOMAS, KHOMIDKHOZHA KHOLIKOV, SAIDJAFARZODA ILHOM, SKYLER SMITH, WILLIAM CRADDOCK, ALI ER, Western Kentucky Univ — A biocompatible photodynamic therapy agent that generates a high amount of singlet oxygen with high water dispersibility and excellent photostability is desirable. In this work, a graphene-based biomaterial which is a promising alternative to a standard photosensitizers was produced and its efficiency compared to a standard photosensitizer, methylene blue. Graphene quantum dots (GQDs) were synthesized by irradiating benzene and nickel oxide mixture using nanosecond laser pulses. High-resolution transmission electron microscopy (HR-TEM) results show GQDs whose size less than 5 nm with very good water dispersibility were successfully obtained. UV-Vis spectra and photoluminescence spectra shows that GQDs have an absorption peak around 270 nm and maximum emission at 430 nm with the excitation wavelength of 310 nm. Deactivation of Escherichia coli is an example of GQDs with methylene blue and carbon nanoparticles was studied by irradiating with different wavelengths. The results show a significant decrease in the number of colony forming units of E. coli. Our results show that GQDs can potentially be used to develop therapies for the eradication of pathogens in open wounds, burns, or skin cancers.

12:00PM B2.00006 Sorption of Potential Toxicants by PDMS in Microfluidic Devices. ALEXANDER AUNER, KAZI TASNEEM, LISA MCCAWLEY, DMITRY MARKOV, SHANE HUTSON, Vanderbilt Univ, EPA VPROMPT TEAM — The need for deeper understanding of how organoids can interact in toxicant assessment applications has advanced the design of interconnected polydimethylsiloxane (PDMS) organ-on-chip devices. Microfluidic devices adsorb chemicals through exposed PDMS surfaces creating problematic changes in dose response curves and timing of delivery. Recent efforts have attempted to quantify what molecular agents and reverse rate constants. The relationship between adsorption and select molecular properties was investigated, and we have shown the experimental rate constants used to model adsorption due to continuous and bolus exposure of several toxicants in a device. From this analysis, we determined that timing is critical for delivery of chemicals that reversibly bind to PDMS in order for cells to not be over- or under-dosed by a few orders of magnitude.
11:00AM B3.00001 Probing Nuclear Interactions and the Quark Gluon Plasma with sPHENIX  
ANTHONY HODGES, Georgia State University, SPHENIX COLLABORATION — A hot, dense state of matter, known as the Quark Gluon Plasma, is believed to have existed at the infancy of the universe, and it is also created in heavy ion collisions at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory. To analyze the QGP, a new particle detector, sPHENIX, is currently planned to begin taking data in 2022. The nuclear physics group at Georgia State University is involved in the development and construction of the Hadronic Calorimeter, which measures the energy of hadronic matter produced in the collisions. The sPHENIX hadronic calorimeter itself is composed of individual scintillator tiles embedded with wavelength shifting fibers readout to silicon photomultipliers (SiPMs). Results from the 2016 prototype test beam of the hadronic calorimeter subsystem demonstrate the hadron energy resolution satisfies the performance requirement for sPHENIX. Additionally, we are working to characterize the performance of the hadronic calorimeter tiles by exposing them to cosmic rays under different conditions. These cosmic ray tests include trigger configuration studies and discriminator threshold characterization using a CAEN DT7702 FEB. Results from these tests will allow us to establish a baseline calibration procedure for data taking with sPHENIX.

11:12AM B3.00002 Study of $bb$ production in $p + p$ collisions at $\sqrt{s} = 510$ GeV in the PHENIX experiment at RHIC  
TRISTAN HASELER, Georgia State Univ, PHENIX COLLABORATION — Heavy flavor quarks are an important probe of the initial state of the Quark Gluon Plasma formed in heavy-ion collisions. Bottom and charm quarks are produced early in the collision, primarily through hard interactions, and experience the full time evolution of the medium. Understanding bottom quark production in $p + p$ collisions gives a baseline reference for studying larger collision systems. The measurement of the $bb$ cross section gives insight into $b$ quark production mechanisms which can directly test pQCD predictions. The $bb$ signal can be isolated by taking advantages of $B^{0}$ oscillations in like-sign muon pairs with invariant mass of 5-10 GeV. Measuring like-sign dimuons within this mass range provides an enriched bottom signal with a semi-leptonic decay like-sign dimuon signal, in the rapidity range $1.2 < |y| < 2.2$ and at $\sqrt{s} = 510$ GeV from data recorded in 2013 at the PHENIX experiment. In this presentation, the status of the $bb$ production study will be presented.

11:24AM B3.00003 Study of Atmospheric Temperature Variations with Cosmic Ray Flux Measurements  
BEENA MEENA, XIAOCHUN HE, Georgia State Univ — There is a growing need to develop reliable physical models for determining the variations of the effective atmospheric temperature on a global scale in order to systematically study the trend of dynamical changes of the Earth’s atmosphere in real-time. At Georgia State University, we are developing portable, low-cost cosmic ray telescopes and working on establishing an international collaboration that builds a network of cosmic ray detectors around the world for studying the effective atmospheric temperature. One of the key components of this project is to build a statistical model based on a multivariable regression technique using measured cosmic ray muon and neutron flux data to determine the effective temperature. In this talk, we will show the preliminary results of an analysis using cosmic ray data from Yakutsk, Russia and Nagoya, Japan and will compare the predicted effective temperature with the data from the nearby radiosonde measurements.

11:36AM B3.00004 Energy Independent Phase Shift Analyses of Light Nuclear Systems  
TIMOTHY BLACK, University of North Carolina - Wilmington, ROBERT HAUN, CHANDRA SHAHI, FRED WIETFELDT, Tulane University, MICHAEL HUBER, MUHAMMAD ARIF, National Institute of Standards and Technology — Our research group, which has carried out high precision scattering length measurements of the $n + d$, $n + ^{3}$He, and $n + ^{4}$He systems, is now undertaking energy independent phase shift analyses of these systems, as well as the $p + d$ system. The aim of these analyses, which will utilize all extant low energy data for these systems, is to determine scattering lengths, effective range parameters, and shape parameters, as well as spin-mixing parameters, where relevant, in order to help develop uniform NN, 3N and 4N models that also account for charge symmetry and charge independence breaking. Preliminary results will be presented.

11:48AM B3.00005 Power of combining large statistics $\gamma$-ray coincidences and mass and Z identified low statistics $\gamma$ data in the A 100-120 region  
ENHONG WANG, Vanderbilt University — The power of combining high statistics gamma-ray coincidence data and mass and Z identified low statistics gamma-ray data is illustrated by studying neutron rich nuclei in the A 100-120 region from the 4 fold gamma coincidence data following the spontaneous fission of 522 Cf by using Gammasphere, and also from the measurement of the prompt gamma-rays in coincidence with isotopically identified fragments produced by 238U beams on a 9Be target at energies around the Coulomb barrier with VAMOS++ and EXOGAM at GANIL. An excited deformed band was discovered in the spherical ground state of 96Y to indicate the shape coexistence. In 100Y, coexistence of neutron pseudo spin and GM doublet bands have been discovered for the first time. High spin level scheme of 118,119Ag have been completed. Theoretical calculations revealed their oblate deformation. The new 2 gamma vibrational bands in 103,107Mo have been found to fill in the odd A gap of an island of 2 gamma vibrational bands in the A 100 region. Clear evidence for chiral doublet bands in 104Mo has been found. Our work on these nuclei are showing the new avenues that are opened up by combining the two experimental approaches to definitively identify the gamma ray associated with particular isotopes.

12:00PM B3.00006 Geant4 Simulation of Low-Energy X-rays Xoft Machine  
NICOLAS RECALDE, University of South Carolina — In the past decade, miniature X-ray sources developed by Xoft Inc. (an iCad company, Sunnyvale, CA) have become the modality of choice for the treatment of specific cancer lesions. The X-ray spectra of these sources have a typical endpoint of 50 keV. We aim to quantify the energy deposition in matter when using this machine, and one of the first steps is to characterize the X-ray distribution from this source. For that purpose we have done Geant4 simulations of the Xoft X-ray spectrum and compared against precise experimental data obtained at NIST. We found that radiation transport at low energy can be very sensitive to small variations in manufacturing specifications.

Thursday, November 16, 2017 1:30PM - 3:30PM
Session C1 Energy Frontier  
MSU Building Banquet Room A - Brad Cox, University of Virginia

1:30PM C1.00001 Understanding the fundamental nature of the universe using the ATLAS detector at the LHC  
MARK KRUSE, Duke University — After a brief reflection on the accomplishments of the ATLAS experiment from Run 1 of the LHC with proton-proton collisions at 7 and 8 TeV, I will give an overview of results thus far from Run 2, at 13 TeV collision energy. With the exceptional performance of the LHC, the resulting data is pushing the Standard Model of particle physics to its limits, and constraining possibilities for its successor. I will survey the status of searches for some of these possibilities.
2:00PM C1.00002 The CMS Detector Upgrades and Recent Physics Results. PAOLO RUMERIO, University of Alabama — While continuing to collect and analyze LHC collision data to probe the predictions of the Standard Model and look for any sign of new physics, the CMS experiment is also undergoing a first sequence of upgrades of its detector, and establishing the design of the future upgrades for the High Luminosity LHC. In this talk, I will give a summary of the ongoing and future CMS upgrades and summarize a selection of recent CMS physics results.

2:30PM C1.00003 Overview of the Recent ALICE Experimental Results. ADAM MATYJA, University of Tennessee, Knoxville — The ALICE experiment is dedicated to studies of the quark-gluon plasma (QGP), which is created in heavy ion collisions at extreme conditions with very high temperature and energy density. This state of matter was present at the early stage of the universe. The Large Hadron Collider (LHC) accelerator provides the opportunity to recreate this unique state of matter in Pb-Pb collisions, where the properties of nuclear matter can be investigated. Studies of less complex systems like pp or p-Pb collisions provide a reference for heavy ion collisions and allow for studies of cold nuclear matter effects. During LHC Run 1 and Run 2 the ALICE experiment has collected data at center of mass energies ranging from 0.9 TeV to 13 TeV, the highest energy available at the colliding machine. The ALICE experiment also recorded p-Pb collisions at √sNN = 5.02 and 8.16 TeV and Pb-Pb collisions at √sNN = 2.76 and 5.02 TeV. Selected recent results from the ALICE experiment will be shown.

3:00PM C1.00004 Fun with mirror fermions: The search for the origin of neutrino masses at the LHC and beyond. PHAM (P. Q.) HUNG, Department of Physics, University of Virginia, Charlottesville, Virginia 22904 — The seesaw mechanism is the most elegant way to give neutrinos tiny masses, less than O(eV). In a generic model, mν ~ m2D/MR, where mD ~ O(ΛEW ~ 246GeV) is the Dirac mass and MR the mass of right-handed neutrinos, which is generically very large (typically GUT mass scale). Right-handed neutrinos in such models are sterile, i.e. they do not interact with W and Z bosons. (There is absolutely no reason why they should be sterile.) Such a generic scenario makes it impossible to completely test the seesaw mechanism at current and future accelerators. Can one unravel the mysteries of the origin of neutrino masses at the LHC? Yes provided right-handed neutrinos are non-sterile (or fertile). This is what the Electroweak-scale right-handed neutrinos or EW-fertile model set out to accomplish. The seesaw mechanism can be fully tested at the LHC. What are the characteristics and achievements of the EW-fertile model? Its gauge group is still SU(3)c × SU(2)L × U(1)y. It contains mirror fermions with characteristic decay signatures such as displaced vertices. It satisfies electroweak precision data represented by the parameters S, T and U. It accommodates the 125-GeV scalar and, in fact, came up with two radically different solutions, both of which give signal strengths compatible with experiment. The discovery of mirror fermions and νR with masses naturally proportional to ΛEW (displaced vertices, like-sign dileptons,...) and associated scalars at the LHC will completely test the seesaw mechanism and unravel the origin of neutrino masses.

Thursday, November 16, 2017 1:30PM - 3:30PM — Session C2 The 3D Structure of the Hadrons — MSU Building University Banquet Room B - D.

1:30PM C2.00001 The 3-dimensional Structure of the Nucleon1. ALEXEY PROKUDIN, PSU Berks and Jefferson Lab — In my talk I will review the current status of studies of 3D structure of the nucleon. I will pay special attention to recent developments in phenomenology of Transverse Momentum Dependent distributions. Current status of theory and phenomenology and prospects for future will be discussed.

1 This work is supported by the Department of Energy under Contract No.DE-AC05-06OR23177 and by the National Science Foundation under Contract No. PHY-1623454

2:00PM C2.00002 Nucleon Tomography. LATIFA ELOUADHRHILI, Jefferson Lab — A fundamental challenge of modern nuclear physics is to understand the structure of the constituents of nuclear matter, protons and neutrons. The 12 GeV Upgrade of the Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab and the construction of state-of-the-art detector systems make it a unique facility in the world to address this challenge. Electron scattering is a superb experimental tool to study the internal structure of nucleons at differing distance scales, as the resolving power of the probe can be varied. The Generalized Parton Distributions (GPDs) provide the theoretical framework to interpret the experimental data. The CLAS12 detector and continuous wave electron beams of up to 12 GeV energy will enable a collaboration of users’ community from all around the world to perform precise exclusive experiments in a large kinematical regime to effectively engage in nuclear imaging, revealing hidden aspects of its internal structure, and providing insight into quark confinement forces in the nucleon. I will review the landscape of both theory and experiments, and describe the new equipment with a focus on the approved science program for the CLAS12 detector, which will provide a unique capability to study 3D nucleon imaging.

2:30PM C2.00003 The TMD Program at JLab1. ZHIWEN ZHAO, Duke University — The TMD Program at JLab As a part of the general neutron imaging effort, there have been many efforts to access the transverse momentum dependent parton distributions (TMDs) by using the semi-inclusive deep inelastic scatterings (SIDIS) processes. the recently upgraded Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab (JLab) provides golden opportunities to study them in valence quark region. The TMDs describe the three-dimensional, spin-correlated densities of quarks and gluons in the nucleon in momentum space. The corresponding SIDIS measurement requires high intensity and polarization of large kinematic coverage which will be provided by several different detectors. In this talk, I will review the existing SIDIS results from the 6 GeV era and present an overview of the planned JLab SIDIS program at 11 GeV beam energy.

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

3:00PM C2.00004 GPD and TMD measurements at the EIC: Mapping the position and motion of quarks and gluons in nuclear matter. MARKUS DIEFENTHALER, Jefferson Lab — The Electron-Ion Collider (EIC) is envisioned as the next-generation U.S. facility to study quarks and gluons in strongly interacting matter. The broad physics program of the EIC aims to precisely image quarks and gluons in nucleons and nuclei and to reveal the origin of the nucleon spin by colliding polarized electrons with polarized protons, polarized light ions, and heavy nuclei at high luminosity. In my presentation, I will discuss why the EIC is not only the next natural step for our field but also why it has the potential to revolutionize nuclear physics. I will focus on the study of generalized parton distributions (GPDs) and transverse-momentum distributions (TMDs) which allow to map the position and motion of quarks and gluons in nuclear matter.
1:30PM C3.00001 The X-ray population of the Milky Way as seen by NuSTAR. ARASH BODAGHEE, Georgia College & State Univ. NUSTAR GALACTIC SURVEYS TEAM — Launched in 2012, the Nuclear Spectroscopic Telescope Array (NuSTAR; Harrison et al. 2013) is NASA’s newest space telescope devoted to observations in the X-rays (3-79 keV). The NuSTAR telescope consists of dual CCD detectors set 10-m away from an optics bench of incidence-grazing mirrors. Its unprecedented spatial and spectral resolution between 10 and 79 keV makes it a finely tuned instrument for performing surveys of the galactic plane where accreting neutron stars and black holes are plentiful. In this talk, we will present the most detailed maps of the Milky Way’s central regions that have ever been produced in this energy range where we have uncovered around 100 accretion-powered X-ray sources. Detailed studies of the central supermassive black hole Sgr A* and the galactic X-ray population will be discussed, with insights into the accretion physics around a typical pulsating neutron star.

1:42PM C3.00002 An Amplified Standard Model, ANTONIO COLELLA², IBM Retired — The Standard Model (SM) is the gold standard but must be amplified to include the graviton, dark matter, dark energy, and supersymmetry. Four independent theories were amplified without sacrificing their integrities including: superstring, particle creation, Higgs forces, and spontaneous symmetry breaking. Amplifications of superstring theory included: 129 fundamental matter/force particles resided in Planck cubes as closed superstrings; and any object in our universe was defined by a volume of contiguous Planck cubes (It from Qubit concept). Amplifications of particle creation included: An intimate relationship existed between particle creation time and the particle’s temperature (e.g., $W = 10^{-12}$ s and $10^{15}$ K); matter creation began after inflation; by end of matter creation time, only 22 permanent matter/force particles remained. Amplifications of Higgs forces included: Extremely high temperatures caused spontaneous symmetry breaking, not Higgs forces; matter particles and their associated Higgs forces were one and inseparable; and spontaneous symmetry breaking was bidirectional (e.g., beta decay equation). These amplifications were summarized in an Amplified SM figure.

1Reference: Home page www.antonioacollella.com, first article and first video

1:54PM C3.00003 Stellar Black Hole Example of the It from Qubit (IfQ) Concept, ANTONIO COLELLA¹, IBM Retired — Stellar black hole (BH) example of IfQ consisted of volume of contiguous Planck cube information chunks. Four independent theories selectively amplified without sacrificing their integrities: superstring, Higgs forces, stellar BHs, and arrow of time. Superstring amplifications: 129 fundamental matter/force particles resided in Planck cubes as closed superstrings; any object in universe defined by a volume of contiguous Planck cubes; and super force superstring doughnut physical singularities existed at Planck cube’s center at $t = 0$. Higgs forces amplifications: extremely high early universe temperatures caused spontaneous symmetry breaking, not Higgs forces; matter particles and their associated Higgs forces were one and inseparable; spontaneous symmetry breaking was bidirectional (e.g. beta decay equation); and by end of matter creation time, only 22 permanent matter/force particles remained. Stellar BHs amplifications: stellar BHs were both quark star (matter) and associated BH (energy). Arrow of time amplifications: in a subset volume of precursor universe, entropy decreased without negating 2nd Law of Thermodynamics. These amplifications summarized in two BH figures.

1Reference: Home page www.antonioacollella.com first article [superstring (pp. 2-7), Higgs forces (pp. 12-13), stellar black holes (pp. 25-27), and arrow of time (pp. 29-34)] and first video.

2:06PM C3.00004 Dark Matter-Baryonic Matter Radial Acceleration Relationship, EDWARD GREEN, University of North Georgia — Pandres has developed a theory which extends the geometrical structure of a real four-dimensional space-time via a field of orthonormal tetrads with an enlarged covariance group. This new group, called the conservation group, contains the group of diffeomorphisms as a proper subgroup. Using the curvature vector, $C_{\mu}$, we find a free-field Lagrangian density $C^{\mu}C_{\mu} \sqrt{-g}$. Spherically symmetric solutions for both the free field and the field with sources have been derived. The field equations require nonzero stress-energy tensors in regions where no source is present and thus may bring in dark matter and dark energy in a natural way. A simple model for a galaxy is given which satisfies our field equations. This model includes flat rotation curves. We compare our results with recently reported results of McGaugh, Lelli and Schombert which exhibit a new law between the observed radial acceleration and the baryonic radial acceleration. We find a slightly different model which relates these accelerations. In conjunction with our model, the McGaugh, Lelli and Schombert relation imply a new critical baryonic acceleration. This critical baryonic acceleration may be used to predict the radial velocity curve value by using the radius of the bulge.

2:18PM C3.00005 New Source and Test Masses and their Metrology for G Experiments¹, KOFI ASSUMIN-GYIMAH, Mississippi State Univ — Despite a long history of measurements, there are serious inconsistencies in our knowledge of the universal gravitational constant, $G$. The scatter in the measured values could be an indication of the incompleteness of general relativity, the current accepted description of gravity, or due to underestimated biases in the metrology of small forces. The metrology of test and source masses, typically made of high density metals, is of prime importance. There are however, some inherent limitations in the previous evaluations of systematic uncertainties associated with them. We propose to address these by developing high density transparent materials such as $PbWO_4$ for use in the next generation of experiments. This is motivated by the fact that density variation in glass and single crystals are significantly smaller than in metals and can be measured nondestructively. Consequently, we will develop a laser interferometer for the measurement of the internal density gradients of these masses. All components of the interferometer have been purchased and assembled in the Medium Energy Physics Lab at MSU. We will show some preliminary results from a $2 \times 2 \times 12$ cm$^3$ $PbWO_4$ sample.

¹National Science Foundation Grant Number:1707988
2:30PM C3.00006 The Viability of Phantom Dark Energy as a Classical and Quantum Field in 1st-Order FLRW Space\textsuperscript{1}, KEVIN LUDWICK, LaGrange College — In the standard cosmological framework of the 0th-order FLRW metric and the use of perfect fluids in the stress-energy tensor, dark energy with an equation-of-state parameter $w < -1$ (known as phantom dark energy) implies negative kinetic energy and vacuum instability when modeled as a scalar field. However, the accepted values for present-day $w$ from Planck and WMAP9 include a significant range of values less than $-1$. We consider a more accurate description of the universe through the 1st-order perturbing of the isotropic and homogeneous FLRW metric and the components of the stress-energy tensor and investigate whether a field with an apparent $w < -1$ may still have positive kinetic energy. Treating dark energy as a classical scalar field in this metric, we find that it is not as obvious as one might think that phantom dark energy has negative kinetic energy categorically. Analogously, we find that field models of quintessence dark energy ($w > -1$) do not necessarily have positive kinetic energy categorically. We then investigate the same question treating dark energy as a quantum field in 1st-order FLRW space-time and examining the expectation value of the stress-energy tensor for $w < -1$ using adiabatic expansion.

\textsuperscript{1}I am thankful to acknowledge support from the LaGrange College Summer Research Grant Award.

2:42PM C3.00007 Enhancing seismometer performance at low frequencies through tilt-decoupling\textsuperscript{1}, MOHAMMAD AFROUGH, University of Mississippi, CAMILLO OCCHIARI, University of Mississippi and University of Pisa, NIAMKE BUCHANAN, Oxford High School, KATHERINE DOOLEY, University of Mississippi. LIGO COLLABORATION — Although LIGO has detected four gravitational waves so far, people are still conducting research to improve the sensitivity of the detectors in different aspects. In the low-frequency band, one of the main sources of noise is seismic vibration. Lowering the noise level in this band helps us to follow the coalescence of compact binary systems earlier in their transformation and increase the signal-to-noise ratio. It also allows us to detect the merger of more massive objects. Hence, an isolation system is required to reduce the seismic noise. As a part of an active isolation system, inertial sensors play an important role in monitoring the seismic vibration and provide input for the isolation system. However, these sensors have some limitations as they cannot distinguish between tilt and translational motion and at low frequencies (less than 1 Hz), the signal is dominated by tilt motion. We designed and built a suspended seismometer to attenuate the transmitted tilt to the seismometer. We applied a tilt and translational motion to the system and measured the transfer function of the suspended seismometer. We also investigated the effect of air current and temperature gradients on the suspended seismometer by designing a thermal enclosure

\textsuperscript{1}This work is supported by the National Science Foundation under Grant Number 1608922.

Thursday, November 16, 2017 4:00PM - 5:24PM
Session D1 Semicontrolling and 2D Materials MSU Building University Banquet Room A - Mary Ellen Zvanut, University of Alabama

4:00PM D1.00001 Photo-induced EPR spectroscopy of C-doped GaN\textsuperscript{1}, SUBASH PAUDEL, W. R. WILLOUGHBY, M. E. ZVANUT, Univ of Alabama - Birmingham — The Group-III nitride semiconductor GaN is being investigated as an active material in light-emitting diodes and high electron mobility transistors. High-power applications in electronic devices often require semi-insulating substrates, which can be adequately obtained by incorporation of impurities like carbon. We used electron paramagnetic resonance (EPR) spectroscopy to investigate point defects in C-doped GaN. Photo-induced EPR was performed at 3.5 K on 1$\times$10$^{-19}$ cm$^{-3}$ C-doped free-standing GaN substrates grown by hydride vapor phase epitaxy. A broad, isotropic signal having $g_{\perp}$ 1.985 was observed. The intensity of the EPR signal began to decrease at 0.95 +/- 0.05 eV and increase at 2.75 +/- 0.15 eV during illumination with a quartz tungsten halogen (QTH) lamp using constant photon flux. The 2.75 eV threshold is interpreted as the energy required to excite electrons from the defect to the conduction band minimum, whereas the 0.95 eV threshold is interpreted as the energy required to excite electrons from the valance band maximum to the defect indicating a deep level defect. This deep level is assumed to be the cause of the electrical compensation and high resistivity in C-doped GaN.

\textsuperscript{1}The work was supported by the National Science Foundation, NSF/DMR 1606765.

4:12PM D1.00002 EPR studies and consequences of oxygen annealing on the electrical properties of Mg-doped In$_2$O$_3$ thin films\textsuperscript{1}, SUMAN BHANDARI, M. E. ZVANUT, Univ of Alabama - Birmingham — Indium oxide (In$_2$O$_3$) is a transparent conducting oxide that can be thought of as a potential candidate for applications in transparent electronics. Defects in In$_2$O$_3$ thin films are studied using electron paramagnetic resonance (EPR) and their contributions to electrical properties are investigated by Hall measurements. An In$_2$O$_3$:Mg thin film, deposited on r-Al$_2$O$_3$ by plasma assisted molecular beam epitaxy, was annealed for 30 min in O$_2$ from 200 C to 900 C and analyzed by EPR at 300 K. The EPR results show a monotonic decrease in defect concentration with increase in annealing temperature. The isotropic g-value of the defect is 2.0054. An increase in resistivity and decrease in electron concentration were reported by others after O$_2$ annealing of similar samples. The results are consistent with our EPR data and suggest that the defect detected by EPR is an oxygen vacancy. To further understand the material, the effect of O$_2$ annealing on In$_2$O$_3$, doped with different Mg concentrations, will be presented at the conference. The preliminary results show an increase in resistivity and decrease in defect concentration as Mg increases. The data suggest a model that the donors, assumed to be the EPR detected defects, are compensated by the Mg acceptor.

\textsuperscript{1}We are thankful to O. Bierwagen for providing samples and P. Kung for his support in Hall measurements.

4:24PM D1.00003 Ion Migration Studies in 2D Molybdenum Trioxide Thin Flake through Ionic Liquid Gating CHENG ZHANG, PUSHPA PUDASAINI, AKINOLA OYEDELE, ANTHONY WONG, ANNA HOFFMAN, Department of Materials Science and Engineering, University of Tennessee, KAI XIAO, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, DAVID MANDRUS, Department of Materials Science and Engineering, University of Tennessee, THOMAS WARD, Materials Science and Technology Division, Oak Ridge National Laboratory, PHILIP RACK, Department of Materials Science and Engineering, University of Tennessee — Ionic liquid is well known for its ability to electrostatically enhance the carrier densities of devices and thin films. The formation of an electric double layer can electrostatically induced charge carriers and/or intercalate ions in and out of the lattice which can induce a large change of the electronic and optical properties and even crystal structures. We present a systematic study on exfoliated molybdenum trioxide devices regarding the property changes and the underlying ion migration during the biasing process through ionic liquid. A close to nine orders of magnitude modulation of the MoO$_3$ conductivity was obtained via ionic liquid gating. Two types of ionic liquids are involved and rapid on/off switching can be realized through the lithium containing ionic liquid. Secondary ion mass spectrometry investigation is performed which reveals the ion migration details.
4:36PM D1.00004 Graphene superlattices in strong circularly polarized fields: Detecting Berry phase without magnetic field. 
HAMED KOCHAKI KELARDEH, VADYM APALKOV, MARK STOCKMAN, Georgia State Univ — We theoretically explore the electron dynamics of graphene superlattices created by strong circularly-polarized ultrashort pulses. The conduction-band population distribution in the reciprocal space forms an interferogram with discontinuities related to the topological (Berry) index at the Dirac points. One of the fundamental problems of topological physics of graphene is a direct observation of the Berry phase. This is related to the fact that the only realistic possibility of observing this phase is self-referenced interferometry of electronic waves in the reciprocal space. However, the Berry phase is \( \pm \pi \); the self-referenced interferometry doubles it to \( \pm 2\pi \), which does not produce any discontinuities in the interference fringes. The Bragg scattering from the superlattices creates diffraction and which way interference in the reciprocal space reducing the Berry phase and making it directly observable in the electron interferograms. Our finding is an essential step in control and observation of ultrafast electron dynamics in topological solids and may open up a route to all-optical switching, ultrafast memories, and room temperature superconductivity technologies.

4:48PM D1.00005 Ultrafast Electron And Lattice Dynamics. OMADILLO ABDURAZAKOV, AVINASH RUSTAGI, North Carolina State University, JAMES FREERICKS, Georgetown University, ALEXANDER KEMPER, North Carolina State University — The ultrafast dynamics of borosilicate glass has been studied by X-ray radiography and multi-angle energy-dispersive X-ray diffraction to 12.2 GPa using a Paris-Edinburgh (PE) press at Beamline 16BM-B, HPCAT of the Advanced Photon Source. Gold foil pressure markers were used to obtain the sample pressure by X-ray diffraction, while X-ray radiography provided a direct measure of sample volume. The X-ray radiography method for volume measurements at high pressures was validated for a known sample of pure iron. The experimentally measured equation of state of reprocessed borosilicate glass was fitted to a third-order Birch-Murnaghan equation. The bulk modulus of 28.81 GPa obtained from the measured equation of state is in good agreement with the 30.4 GPa value derived from the measured elastic constants. The flotation density of sample decompressed from 12.2 GPa is 2.755 gm/cc and shows an increase in density of 24% as compared to the starting sample.

5:00PM D1.00006 Photoemission signature of excitons. AVINASH RUSTAGI, ALEXANDER KEMPER, North Carolina State University — Angle resolved photoemission spectroscopy (ARPES) is used to investigate the properties of a system both in and out of equilibrium. The signatures of exciton hole states have successfully explained the electronic spectra modifications due to interactions, the signatures of electron-hole bound states i.e. excitons in ARPES measurements requires further study. We theoretically study the signature of excitons on the equilibrium ARPES spectra by evaluating the photoemission intensity of electron from the electron-hole bound state. We apply our results to a simple two-band model for transition metal dichalcogenides (TMDCs) with exciton states described by hydrogenic orbitals and study the effects of exciton Bohr radii and the bound state wavefunction on the photoemission intensity.

5:12PM D1.00007 Equation of State and Densification of Borosilicate Glass under High Pressure. KATHRYN HAM, YOGESH VOHRA, University of Alabama at Birmingham, YOSHIO KONO, HPCAT, Geophysical Laboratory, Carnegie Institution of Washington, PARIMAL PATEL, Ceramics and Transparent Materials Branch, U.S. Army Research Laboratory — The equation of state of borosilicate glass has been studied by X-ray radiography and multi-angle energy-dispersive X-ray diffraction to 12.2 GPa using a Paris-Edinburgh (PE) press at Beamline 16BM-B, HPCAT of the Advanced Photon Source. Gold foil pressure markers were used to obtain the sample pressure by X-ray diffraction, while X-ray radiography provided a direct measure of sample volume. The X-ray radiography method for volume measurements at high pressures was validated for a known sample of pure \( \alpha \)-iron. The experimentally measured equation of state of reprocessed borosilicate glass was fitted to a third-order Birch-Murnaghan equation. The bulk modulus of 28.81 GPa obtained from the measured equation of state is in good agreement with the 30.4 GPa value derived from the measured elastic constants. The flotation density of sample decompressed from 12.2 GPa is 2.755 gm/cc and shows an increase in density of 24% as compared to the starting sample.

Thursday, November 16, 2017 4:00PM - 4:48PM — Session D2 Particle Physics 1
MSU Building University Banquet Room B - Timothy V. Daniels, University of North Carolina Wilmington

4:00PM D2.00001 Construction of Neutron- and Muon-Sensitive Cosmic Ray Detectors. MONTGOMERY STEELE, CAROLA BUTLER, XIAOCHUN HE, Georgia State University — In the study of cosmic rays, there is a strong need for high-quality yet affordable equipment capable of tracking the secondary showers produced by collisions in the Earth’s atmosphere. At Georgia State University, we are engaged in an ongoing project to develop the most efficient possible detector for the study of cosmic rays on the Earth’s surface. Our new detectors are capable of simultaneously detecting muons and neutrons over a wide range of energies using a novel system of scintillating optical fibers coupled to silicon photomultipliers. Our long-term goal is to use these detectors to set up cosmic weather stations across the world to study the impact of cosmic rays at large scales.

4:12PM D2.00002 Studies of \( B^\pm \rightarrow \phi K^{\pm} \) decays from Belle.\(^1\). ALYSSA LOOS, MILIND PUROHIT, University of South Carolina, VISHAL BHARDWAJ, IISER, Mohali, India, BELLE COLLABORATION — We present the status of a study of branching fractions, longitudinal polarization, and CP violation asymmetries in \( B^\pm \rightarrow \phi K^{\pm} \) decays with a sample of \( 772 \times 10^{6} \) BBbar pairs collected by the Belle detector at the KEKB asymmetric energy \( e^+e^- \) collider. Some measurements of these quantities have been made for charged and neutral B meson decays by the CLEO, BaBar, Belle, and LHCb experiments; the values of \( f_L \), for instance, appears to be at variance with expectations. In this presentation we present results from simulations and an estimate of when we can present results using Belle data.

\(^1\)We acknowledge support from the U.S. DOE in the form of a grant to the Univ. of S. Carolina and a Graduate Fellowship for A. Loos under the SCGSR program.
4:24PM D2.00003 Isospin Violation Measurement at the Upsilon(4S) Resonance

ROMULUS GODANG, GEORGE BASSET, University of South Alabama, BABAR COLLABORATION — Isospin violation at the Upsilon(4S) resonance is an important input for many B meson measurements at B Factories. It 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. We partially reconstruct neutral B meson in the semileptonic decay of \( \bar{B} \to D^* \{+/-\} \text{lepton}^- \). We discuss a model independent measurement of the branching fraction of Upsilon(4S) decays to neutral BB pairs based on a data sample of 470 million BB pairs collected at the Upsilon(4S) resonance with the BABAR detector at SLAC.

1The authors would like to thank the BABAR Collaboration. This work was supported in part by the U.S. Department of Energy and the University of South Alabama

4:36PM D2.00004 DSMC Simulations of High Mach Number Taylor-Couette Flow

DR. SAHADEV PRADHAN, Chemical Technology Division, Bhabha Atomic Research Centre, Mumbai- 400085 — The main focus of this work is to characterise the Taylor-Couette flow of an ideal gas between two coaxial cylinders at Mach number \( Ma = U_{y/w}/sqrt{(kb T_{w}/m)} \) in the range 0.01 <\( Ma < 1 \), and Knudsen number \( Kn = 1/\sqrt{(2\pi)} pi d^2 n d (r_2 - r_1) \) in the range 0.001 <\( Kn < 1 \), using two-dimensional (2D) direct simulation Monte Carlo (DSMC) simulations. Here, \( r_1 \) and \( r_2 \) are the radius of inner and outer cylinder respectively, \( U_{y/w} \) is the circumferential wall velocity of the inner cylinder, \( T_{w} \) is the isothermal wall temperature, \( n \) is the number density of the gas molecules, \( d \) are the molecular mass and diameter, and \( kb \) is the Boltzmann constant. The cylindrical surfaces are specified as being diffusely reflecting with the thermal accommodation coefficient equal to one. In the present analysis of high Mach number compressible Taylor-Couette flow using DSMC method, wall slip in the temperature and the velocities are found to be significant. Slip occurs because the temperature/velocity of the molecules on the wall could be very different from that of the wall, even though the temperature/velocity of the reflected molecules is equal to that of the wall. Due to the high surface speed of the inner cylinder, significant heating of the gas is taking place. The gas temperature increases until the heat transfer to the surface equals the work done moving the surface. The highest temperature is obtained near the moving surface of the inner cylinder at a radius of about (1.26 \( r_1 \)).

Thursday, November 16, 2017 4:00PM - 4:48PM

Session D3 Mathematical and Statistical Physics

MSU Building Donoho Lounge - Laura Whitlock, Georgia College

4:00PM D3.00001 Analysis of high-speed rotating flow inside gas centrifuge casing

DR. SAHADEV PRADHAN, Chemical Technology Division, Bhabha Atomic Research Centre, Mumbai- 400085 — The generalized analytical model for the radial boundary layer inside the gas centrifuge casing in which the inner cylinder is rotating at a constant angular velocity \( \Omega_i \), while the outer one is stationary, is formulated for studying the secondary gas flow field due to wall thermal forcing, inflow/outflow of light gas along the boundaries, as well as due to the combination of the above two external forcing. The analytical model includes the sixth order differential equation for the radial boundary layer at the cylindrical curved surface in terms of master potential \( \chi \), which is derived from the equations of motion in an axisymmetric \((r-z)\) plane. The linearization approximation is used, where the equations of motion are truncated at linear order in the velocity and pressure disturbances to the base flow, which is a solid-body rotation. Additional approximations in the analytical model include constant temperature in the base state (isothermal compressible Couette flow), high aspect ratio (length is large compared to the annular gap), high Reynolds number, but there is no limitation on the Mach number. The discrete eigenvalues and eigenfunctions of the linear operators (sixth-order in the radial direction for the generalized analytical equation) are obtained. The solutions for the secondary flow are determined in terms of these eigenvalues and eigenfunctions. These solutions are compared with direct simulation Monte Carlo (DSMC) simulations and found excellent agreement (with a difference of less than 15%) between the predictions of the analytical model and the DSMC simulations, provided the boundary conditions in the analytical model are accurately specified.

4:12PM D3.00002 Construction and Preliminary Investigation of Properties of the Imani Periodic Functions

RONALD E. MICKENS, Clark Atlanta University, Atlanta, GA 30314 — The Imani periodic functions (IPF) are continuous periodic solutions to the Leah functional equation (LFE) \((1) \frac{x^2}{2} + \left( \frac{y}{4} \right) x \tau = \frac{y}{4}, \quad x(0) = 1, \quad y(0) = 0, \quad \text{where} \quad x = x(t) \text{ and } y = y(t), \) and \((2a) \quad x(t + T) = x(t), \quad y(t + T) = y(t), \quad (2b) \quad x(-t) = x(t), \quad y(-t) = -y(t), \) and, \( T \) is a fixed, but arbitrary positive constant. Explicit representations are derived for these functions using nonlinear transformations of the dependent variables. We also obtain several of their mathematical properties. It should be noted that an alternative interpretation of Eq. \((1)\) is that it is the Hamiltonian of a nonlinear oscillator having equation of motion \((3) \quad \frac{d^2x}{dt^2} + x \tau = 0, \quad x(0) = 1, \quad \frac{dx}{dt}(0) = 0, \quad \text{where} \quad y(t) = dx(t)/dt. \) Finally, while all of the solutions to Eq.\((3)\) are periodic, Eq. \((1)\) may have non-periodic solutions.

4:24PM D3.00003 Dynamics of the Hamiltonian \(H(x,y) = |x| + |y|\)

KALE OYEDEJI, Morehouse Coll, RONALD E. MICKENS, Clark Atlanta University — We investigate the classical dynamics of the Hamiltonian \((1) \quad H(x,y) = |x| + |y|, \) and normalize the energy value to be \( H(x,y) = 1. \) The equations of motion are \((2) \quad \frac{dx}{dt} = \frac{1}{\sqrt{2}} y = \text{sgn}(y), \quad \frac{dy}{dt} = -\frac{1}{\sqrt{2}} x = -\text{sgn}(x). \) In addition to proving all solutions are periodic, we also calculate explicitly the exact analytical solutions to Eq. \((2)\). Further, we show that \( x(t) \) and \( y(t) \) have many features in common with the standard trigonometric cosine and sine functions. The work is based on the previous results of Mickens [1]. Reference [1] R.E. Mickens, “Some properties of square (periodic) functions”. Proceedings of Dynamic Systems and Applications 7 (2016), 262-266.

4:36PM D3.00004 Where Is The Equation Solved?

PAUL MACNEIL, Mercer University/School of Engineering — Considerations of solution quality for physically-significant equations often focus on observable quantities such as solution geometry, energy levels, and charge density distribution. The degree to which the equation does or does not balance, i.e., the difference between the left and right hand sides (equation error) of the equation is a mathematical measure of solution quality. The equation error will be a function of the equations independent variables, commonly including space and time. The distribution of the error, and its squared modulus, over these variables, is a quality measure for the solution. Minimization of the squared error modulus (equation error variance) integrated/summed over all allowable values off the independent variables can be used to attempt solution of the equation. These considerations are presented with examples from a simple molecular system. The distribution of equation error is visualized. Numerical experiments compare use of equation error variance with the traditional energy minimization via the variational method. The minimization of equation error variance and energy is performed by Particle Swarm Optimization (PSO). Some characteristics of equation error variance minimization become apparent from the results of these experiments.
the FMI layer and directly measures proximity-induced interfacial magnetism in the top 2 QL (≈2 nm) layer of Bi2Se3 surface of epitaxial Bi2Se3 films. Depth-sensitive polarized neutron reflectometry (PNR) discriminates the magnetism at the surface of TI from the FMI layer and directly measures proximity-induced interfacial magnetism in the top 2 QL (≈2 nm) layer of Bi2Se3 films. Direct x-ray phase retrieval techniques and high-mobility two dimensional electron gases and are directly linked to interfacial atomic-scale structural and chemical reconstructions. To understand and manipulate these emergent properties, we apply synchrotron-based surface diffraction and direct x-ray phase retrieval techniques to determine the atomic structures of crystalline complex oxide interfaces with picometer scale resolution. This talk will focus on how an understanding of the structure-property relationships at interfaces between doped manganites and SrTiO3 can be used to control magnetic ordering and electronic transport in manganite films with thickness on the order of a unit cell.

10:00AM E1.00004 High-Temperature Interfacial Magnetic Order in Topological Insulator - Ferromagnetic Insulator Heterostructures1. VALERIA LAUTER, Oak Ridge National Laboratory — Realization of proximity-induced magnetism on a topological insulator (TI) surface with a ferromagnetic insulator (FMI) provides a route for device applications with novel quantum functionality. We demonstrated a fundamental step towards realization of a high temperature magnetization in a TI-FMI heterostructure. Employing strong TI-FMI exchange coupling we have induced uniform long-range ferromagnetic order onto the surface of epitaxial Bi2Se3 films. Depth-sensitive polarized neutron reflectometry (PNR) discriminates the magnetism at the surface of TI from the FMI layer and directly measures proximity-induced interfacial magnetism in the top 2 QL (≈2 nm) layer of Bi2Se3; that is generated by the short-range exchange interaction at the interface with EuS. The interfacial spin polarized state persists up to room temperature, above the Tc of the EuS. The interfacial magnetic resonance on the large spin-orbit interaction channel of the TI surface is found to greatly enhance the magnetic ordering temperature. Due to the short-range nature of the ferromagnetic exchange interaction, the time-reversal symmetry is broken only near the surface of the TI, while leaving its bulk states unaffected [1]. The TI ferrimagnetism is observed reproducibly in a variety of bi-layer samples with different combinations of thicknesses, providing a mechanism to control this effect. The analysis of polarized neutron off-specular scattering (OSS) that arises from lateral in-plane inhomogeneities, probes correlations of lateral inhomogeneity with a length scale of ≈0.1-10μm. These findings of locally-induced ferromagnetic order on the TI surface extending over macroscopic areas without impurity doping open the door for an energy efficient topological control mechanism for future spin-based technologies.


1Work supported by the Scientific User Facilities Division, Office of Basic Energy Sciences, and the US Department of Energy, by the Laboratory Directed Research and Development Program of Oak Ridge National Laboratory
8:30AM E2.00001 They Won’t All Grow Up to Be You: Preparing Students for Diverse Careers, LAURIE MCNEIL, University of North Carolina at Chapel Hill — The Joint Task Force on Undergraduate Physics Programs (J-TUPP) was formed in response to a growing awareness in the physics community that undergraduate physics majors pursue a wide range of careers after graduation, with very few ending up employed as physics professors. The task force was charged to identify the skills and knowledge that undergraduate physics degree holders should possess to be well prepared for a diverse set of careers, and to provide guidance on how physicists could revise the undergraduate curriculum to improve the education of a diverse student population. Our report (issued in October 2016) is the result of the task force’s reviews of employment data, surveys of employers, and reports generated by other disciplines, as well as meetings with physicists in selected industries and interviews with recent physics graduates employed in the private sector. As part of our study we also identified exemplary programs that provide models of how physics departments can ensure that all of their students are well prepared to pursue a wide range of career paths. I will summarize and illustrate the findings and recommendations contained in the task force’s report.

9:00AM E2.00002 Physics and hard disk drives- an industrial career perspective, STEVEN LAMBERT, American Physical Society — Hard disk drives are marvels of technology. Each drive shipping today includes magnetic tunnel junctions to read data, thermal expansion actuators to precisely adjust head-disk spacing to about 1nm, and data tracks only 70nm wide. An army of physicists, engineers, and materials scientists are responsible for a continuing stream of innovations that have made hard drives the essential enabler for data storage in “the cloud”. Hard disk drive companies are just one of the numerous industries where physicists make essential contributions. I will use experiences from my 27 years developing magnetic recording technology in Silicon Valley to illustrate what it’s like for a physicist to work in industry. I will highlight the skills that help to enable success in the private sector, and some of the challenges of transitioning from academia to industry.

9:30AM E2.00003 Prepare all students for success, SUSAN BLESSING, Florida State University — Over the course of several years, the Florida State University Physics Department implemented course, advising, and support changes to better prepare students to succeed as majors in the department and in the future. I will discuss the changes and the evidence we have that they are working.

10:00AM E2.00004 Career Preparation in the Undergraduate Curriculum, BRAD CONRAD, American Institute of Physics — Physics and Astronomy programs are a critical component of the STEM pipeline within the US and resources exist to assist departments, advisers, and students alike with undergraduate student career preparation. Through effective recruitment and preparation of undergraduate students, undergraduate physics programs have the potential to increase both the size and diversity of the STEM workforce. This talk will present data illustrating the full range of careers pathways that Physics and Astronomy undergraduate students can follow, detail how Departments can most effectively prepare their students for the full range of career options available to them, and highlight valuable resources for students, faculty advisers, and department leaders. This data driven talk will outline recent data, resources for Departments, and best practices.

Friday, November 17, 2017 8:30AM - 10:30AM – Session E3 Accelerator-based Dark Sector Searches
MSU Building Donohoo Lounge - Alexander Somov, Jefferson Lab

8:30AM E3.00001 Accelerator-based Light Dark Sector Searches, BERTRAND ECHENARD, California Institute of Technology — Elucidating the nature of dark matter is one of the central challenges in fundamental physics. While WIMP searches have been driving experimental efforts during the last decades, a growing interest in light (sub-GeV) dark matter has recently emerged. Such possibilities could arise naturally if the dark matter is part of a dark sector neutral under all Standard Model forces. This talk will review search strategies for light dark sector at accelerators, discuss recent results from the BABAR and Belle collaborations, and briefly introduce a new proposal, the Light Dark Matter eXperiment.

9:00AM E3.00002 Sub-GeV Dark Matter Searches with Neutrino Detectors at Proton Beam Sources, ROBERT COOPER, New Mexico State Univ, MINIBOONE-DM COLLABORATION — There is overwhelming cosmological evidence that there exists a gravitationally interacting dark matter, yet its microscopic properties remain a mystery. After decades of searching, deep underground detectors have not definitively observed dark matter interactions directly. On the other hand, direct detection experiments do not constrain dark matter models below about a GeV, and there is a rich set of sub-GeV dark matter models can be directly accessed with accelerators. In one class of models, accelerators produce dark matter via new sub-GeV mediators (e.g., dark photons), and then the dark matter is subsequently detected by large neutrino detectors. The MiniBooNE detector, which ran for a decade measuring short baseline neutrino oscillations, was used in the first dedicated sub-GeV dark matter search with a proton beam in 2014 at Fermilab. An 8-GeV proton beam was directed to a steel beam dump to reduce neutrino backgrounds, and the results of this run will be presented. On the same beam, there are new liquid argon time-projection chambers being built for the short baseline neutrino program, and these new detectors offer exciting opportunities for dark matter searches in future beam dump running. The projected sensitivity of these new detectors will also be discussed.

9:30AM E3.00003 Searching for dark photons at Jefferson Lab, HOLLY SZUMILIA-VANCE, Jefferson Lab — Dark photons are a proposed new vector force carrier which could interact with the Standard Model via kinetic mixing and decay visibly to lepton pairs or invisibly. The search parameter space for such a particle is described by its mass and coupling strength to the Standard Model. Visible searches look for a bump of excess events in the invariant mass spectrum of reconstructed lepton pairs whereas invisible searches look for evidence of a dark photon in the reconstructed missing mass spectrum. Dark photons could be the leading interaction between the Standard Model and the hidden sector. Jefferson Lab is an ideal search facility for dark photons due to its high intensity electron beam. This talk covers the current status of the ongoing experimental program at Jefferson Lab to search for signatures of dark photons. The following experiments will be discussed: the A Prime Experiment (APEX) in Hall A, the Heavy Photon Search (HPS) in Hall B, the DarkLight Experiment in the Low Energy Recirculator Facility and the proposed Beam Dump Experiment (BDX). Both APEX and HPS have taken data previously and have approved future running. The status and running of DarkLight and the experimental reach of the BDX experiment will be discussed. These experiments contribute to a comprehensive search for evidence of dark photons with masses up to 1 GeV in both the visible and invisible decay hypotheses with a range of couplings to the Standard Model that allow for searches with both short and long-lived dark photons. This talk summarizes the physics and impact of Jefferson Lab experiments.
10:00AM E3.00004 The JLab Eta Factory (JEF) experiment at Jefferson Lab\textsuperscript{1}, SIMON TAYLOR, Jefferson Lab — The GlueX spectrometer is a large acceptance spectrometer installed in Hall D at Jefferson Lab with good coverage for both charged and neutral particles. In particular photons in the forward direction are detected using the Forward Calorimeter, an array of lead glass blocks. The main physics program is to search for evidence for hybrid mesons. The recently-approved JLab Eta Factory (JEF) experiment extends the GlueX physics program to study rare decays of \(\eta\) mesons with a particular emphasis on the \(\eta \rightarrow \pi \pi\) channel. In addition to probing \(O(p^4)\) terms in chiral perturbation theory, this channel can be used to search for evidence for lepto-photonic dark matter. A potential extension to the Standard Model posits a dark gauge boson (\(E\)) that couples predominately with quarks and can be observed in the \(\eta \rightarrow \eta E, E \rightarrow \pi \pi\) decay chain. The JEF program also plans to search for \(C\)-violating/\(P\)-conserving decays of the \(\eta\) meson. In order to achieve the requisite resolution to observe these rare channels, this experiment calls for an upgrade to the existing GlueX Forward Calorimeter. After a brief description of the GlueX detector, I will focus on the JEF program with a particular emphasis on the \(E\)-boson search and I will discuss plans for the future.

\textsuperscript{1}This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics under contract DE-AC05-06OR23177.

Friday, November 17, 2017 11:00AM - 12:36PM

Session F1 Superconducting and Strongly Correlated Materials  MSU Building University Banquet Room A - Divine Kumah, North Carolina State University

11:00AM F1.00001 Features of Charge Density Wave Energy Gap and Electronic Dispersion of 2H – TaS\textsubscript{2} and Other Layered Transition Metal Dichalcogenides,\textsuperscript{1} KAPILA WIJAYARATNE, J. ZHAO, Univ of Virginia, J VAN WEZEL, Univ of Bristol, C. MALLIAKAS, Northwestern Univ, U. CHATTERJEE, Univ of Virginia — We present Angle Resolved Photoemission Spectroscopy (ARPES) study of 2H – TaS\textsubscript{2}, a canonical incommensurate Charge Density Wave (CDW) material, and compare to similar layered transition metal dichalcogenides such as 2H – NbSe\textsubscript{2}. Similarities were observed in the preferential appearance of CDW energy gap in the vicinity of some specific high symmetry points on the Fermi surface, the particle-hole asymmetry of this gap and the existence of the pseudogap behavior above CDW transition temperature. However, in contrast to 2H – NbSe\textsubscript{2}, where the gap opens up only in specific momentum locations in the vicinity of high symmetry points, we observed a non-zero gap for all momentum locations for the case of 2H – TaS\textsubscript{2}. Since the conventional Fermi surface nesting model was unable to explain these similarities and differences, we use a tight binding model with emphasis on orbital selectivity and strong electron-phonon coupling. Further analysis of the electronic dispersion showed pronounced many body renormalization in the system and revealed the phononic mechanism behind momentum and temperature dependent features of the band structure. We suggest that this model can be generalized for a broader class of incommensurate charge density wave materials.

\textsuperscript{1}Supported by NSF

11:12AM F1.00002 Identifying a forward scattering superconductor through pump-probe spectroscopy, ANKIT KUMAR, Department of Physics, North Carolina State University, STEVEN JOHNSTON, Department of Physics and Astronomy, The University of Tennessee, ALEXANDER KEMPER, Department of Physics, North Carolina State University — Understanding the mechanism behind high temperature superconductivity has been one of the challenges in condensed matter physics. The particular momentum structure of the electron-boson coupling plays a crucial role in the formation of Cooper pairs, which can lead to the enhanced superconductivity. One such example is electron-phonon interaction that is peaked in the forward direction. This interaction has been suggested as an essential ingredient for enhanced superconductivity observed in FeSe monolayers on STO substrates. We study the superconducting state of Nb based superconductors (Nb, NbZr, and NbCN) in thin film form (thicknesses from 25-100 nm) to look for the claimed hysteresis from the vortex model put forward by Glazman in 1986. Hysteresis has been observed, and the degree can be varied by the sweep rate of the current (from 20-200 mA/s). We can tell this is not a thermal hysteresis as the sweep up peak does not change, but only the sweep down peak. For slow sweep rates (\(\approx 7\) mA/s), we observe oscillations in the Transverse voltage vs current as the current is decreased. The open question is exactly how to compare this hysteresis to that predicted by Glazman.

\textsuperscript{1}This work was supported by the US Department of Energy through Grant No. DE-FG02-99ER45763.

11:24AM F1.00003 Superconductivity and Electrical transport in NbTiN Films, NAHID SHAYESTEH MOGHAADDAM, PhD Student, CHARLES DEAN TEAM, STACY VARNER TEAM, MILIND KUNCHUR TEAM — In this work, we systematically investigate the superconducting properties of Niobium Titanium Nitride (NbTiN) films with different geometries, which at low temperature remain superconducting. NbTiN films with a few nm thickness are widely used in devices such as superconductor-insulator-superconductor (SIS) mixers, superconducting cavities and resonators and superconducting nanowire single-photon detectors (SNSPD). In all these applications, films of varying dimensions are required to achieve optimal performance. The initial thickness of our samples was 125 nm deposited on Silicon substrate. We change the width/length of our samples using lithography and ion milling. We measure and analyze the thickness and width dependence of various superconducting properties of these films. This work was supported by the US Department of Energy through Grant No. DE-FG02-99ER45763.

\textsuperscript{1}This work was supported by the US Department of Energy through Grant No. DE-FG02-99ER45763.

11:36AM F1.00004 Transverse Voltage in Superconducting Films: Hysteresis, PHILLIP BROUSSARD, ROMY VEKONY, Covenant College — Transverse voltages have been observed in many superconducting films near their transition temperatures. Explanations have ranged from vortex motion, to inhomogeneity, and even anyons. We have looked at a variety of Nb based superconductors (Nb, NbZr, and NbCN) in thin film form (thicknesses from 25-100 nm) to look for the claimed hysteresis from the vortex model put forward by Glazman in 1986. Hysteresis has been observed, and the degree can be varied by the sweep rate of the current (from 20-200 mA/s). We can tell this is not a thermal hysteresis as the sweep up peak does not change, but only the sweep down peak. For slow sweep rates (\(\approx 7\) mA/s), we observe oscillations in the Transverse voltage vs current as the current is decreased. The open question is exactly how to compare this hysteresis to that predicted by Glazman. 

MSU Building University
11:48AM F1.00005 Pressure effects on the superconductivity of Tl-2223 crystals\textsuperscript{1} . A O IJADUOLA, Department of Physics, University of North Georgia, R SHIPRA, Department of Physics and Astronomy, Vanderbilt University, A S SEFAT, MSTD, Oak Ridge National Laboratory — This study investigates the application of high pressure on the superconducting properties of a thallium-based cuprate namely Tl$_2$Ba$_2$Ca$_2$Cu$_3$O$_{10+\delta}$ (Tl-2223). The superconducting transition temperature ($T_c$) and the critical current density ($J_c$) were studied by applying 0.8 GPa of pressure. The pressure was applied in a piston-cylinder-cell (PCC), using Pb as manometer and Daphne 7373 oil as the pressure transmitting medium. For estimating the $J_c$, we used the Bean critical state formula on the magnetic hysteresis curves obtained at 10 K and 20 K. Both the $T_c$ and $J_c$ shifted with pressure, clearly indicating that pressure is another tool to control properties of quantum materials.

\textsuperscript{1}This research was supported in part by the Higher Education Research Experience for Faculty Program at Oak Ridge National Laboratory.

12:00PM F1.00006 Flux Vortex Explosion in Superconductors . CHARLES DEAN, MILIND KUNCHUR, University of South Carolina, Columbia, Q L HE, H LIU, J WANG, R LORTZ, I K SOU, William Mong Institute of Nano Science and Technology, UNIVERSITY OF SOUTH CAROLINA, COLUMBIA TEAM, WILLIAM MONG INSTITUTE OF NANO SCIENCE AND TECHNOLOGY COLLABORATION — Flux vortices are a very interesting phenomenon in condensed matter physics. A flux vortex (fluxon) is a quantized amount of magnetic flux that is contained within a swirling super-current. They undergo many curious effects and various regimes. We investigated an interfacial superconductor and observed a transition in the current-resistance and temperature-resistance which indicates Likharev vortex explosion. This explosion occurs as the coherence length within the material becomes greater than the size of the sample itself. Effectively, this chokes the super-current and causes the vortex to grow and then explode when it exceeds the bounds of the material.

12:12PM F1.00007 Synthesis of Ruddlesden-Popper Strontium Iridate Epitaxial Thin Films , PEYTON NANNEY, JUNYI YANG, JIAN LIU, University of Tennessee Knoxville — We investigated the growth conditions conducive to synthesize Ruddlesden-Popper type Sr$_2$IrO$_4$, Sr$_3$Ir$_2$O$_7$, and Sr$_2$Ir$_2$O$_7$ epitaxial thin films via pulsed laser deposition (PLD). Many factors influence the thermodynamic interactions of the deposition and therefore, determines the material phase that is created. Through a systematic review of these growth conditions, we constructed a growth phase diagram that maps out conditions that enable stable formation of strontium iridate phases. We synthesized these phases with a single Sr$_2$IrO$_4$ target and by varying the O$_2$ chamber pressure and the substrate temperature. These films allow for the analysis of magnetic properties of the material through vibrating sample magnetometry (VSM) and other methods. Our findings demonstrate the control of the thermodynamic stability of different epitaxial layered structure of the complex Ruddlesden-Popper family.

12:24PM F1.00008 High pressure structural parameters and equation of state of osmium to 207 GPa\textsuperscript{1} . CHRISTOPHER PERREAULT, University of Alabama at Birmingham, NENAD VELISAVLJEVIC, Los Alamos National Laboratory, YOGESH VOHRA, University of Alabama at Birmingham — The most incompressible transition metal osmium (Os) has been studied under high pressure. There is significant interest in Os because of the structural anomalies attributed to topological transitions in the Fermi surface for valence electrons in the hexagonal close-packed phase. We report on measurements of structural parameters and equation of state on Os metal to a pressure of 207 GPa at ambient temperature using platinum as a pressure standard. We obtained angle-dispersive X-ray diffraction data at a synchrotron source with closely spaced pressure intervals to observe any discontinuities or anomalies in the axial c/a ratio at high pressures. Rietveld refinements of X-ray diffraction data show a slowly varying axial ratio (c/a) with a broad minimum at 75 GPa. Our data do not provide any evidence of anomalous behavior in the c/a ratio in Os at 25 or 150 GPa as have been reported in previous studies. Our experimental results are in agreement with theoretical calculations that do not predict any anomalous behavior in c/a ratio in Os under extreme conditions. We present an equation of state for Os to 207 GPa (V/V$_0$ = 0.761) at ambient temperature and compare our results with the previously published data.

\textsuperscript{1}This material is based upon work supported by the National Science Foundation under Grant No. DMR- 1606862.

Friday, November 17, 2017 11:00AM - 12:12PM — Session F2 Particle Physics II MSU Building University Banquet Room B - Dr. Romulus Godang, University of South Alabama

11:00AM F2.00001 Higher-order corrections for $t \gamma$ production with anomalous couplings\textsuperscript{1} . MATTHEW FORSLUND, NIKOLAOS KIDONAKIS, Kennesaw State Univ — We present calculations of higher-order soft-gluon corrections for $t \gamma$ production with anomalous $t$-q-$\gamma$ couplings. We include NLO and NNLO soft-gluon corrections, and present results for the total cross sections at various LHC energies. We provide NLO and NNLO K-factors that show the importance of these corrections compared to leading-order results.

\textsuperscript{1}This material is based upon work supported by the National Science Foundation under Grant No. PHY 1519606.

11:12AM F2.00002 A High Efficiency Cosmic Ray Veto Detector for the Mu2e Experiment\textsuperscript{1} . CHARLES JENKINS, University of South Alabama, MU2E COLLABORATION — The Mu2e Experiment, at the Fermi National Accelerator Laboratory, will search for the coherent, neutrinoless conversion of stopped muons into electrons, a charged lepton flavor-changing process highly suppressed and hence undetectable in the Standard Model. Many scenarios for physics beyond the Standard Model predict small but observable rates. The sensitivity of this experiment is a factor of 10\textsuperscript{4} improvement over the current limit. One source of background is cosmic rays that can produce one event per day that would look like a muon to electron conversion. A Cosmic Ray Veto that surrounds the Mu2e spectrometer will be used to identify and reject such cosmic-ray induced events. It must have an overall efficiency of 99.99% over an area of some 330 m$^2$. A description of the Cosmic Ray Veto, its anticipated performance, and status will be presented.

\textsuperscript{1}US DoE; NSF; Italian Istituto Nazionale Fisica Nucleare; Science & Technology Facilities Council, UK; Ministry of Education & Science, Russian Fed; Thousand Talents Plan, China; Helmholtz Association, Germany; EU Horizons 2020 Research; Fermilab
with respect to signal efficiency and background rejection. Another goal is to find optimal selection cuts to identify proton interactions that seeks to measure how protons, pions, and other particles interact in liquid argon. One goal of this work is to improve the calibration of the Time of Flight (TOF) and momentum measurement systems to reduce the systematic uncertainties in the TOF and momentum scales. Calibrating the 

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We analyze the behavior of the three-loop cusp anomalous dimension and its component functions. Its value as the cusp angle \( \theta \rightarrow 0 \) is analytically determined by utilizing the properties of harmonic polylogarithms and their relation to other functions. Approximations are given in heavy quark speed \( \beta \) for both two-loop and three-loop expressions, and are optimized over the range \( 0.3 < \beta < 0.8 \). Linear approximations are also given in \( \theta \) which are very effective for \( \theta > 5 \).

1This material is based on work supported by the National Science Foundation under Grant No. PHY 1519606.

RESULTS FROM LArIAT BEAMLINE AND PROTON SELECTION STUDIES. . DEREK WALKER, Louisiana State University, LARIAT COLLABORATION — LArIAT (LArTPC In A Test beam) is an R&D LArTPC that needs to measure how protons, pions, and other particles interact in liquid argon. One goal of this work is to improve the calibration of the Time of Flight (TOF) and momentum measurement systems to reduce the systematic uncertainties in the TOF and momentum scales. Calibrating the photomultiplier tubes (PMTs) of the TOF system reduced the systematic uncertainty in the TOF to 0.75%. A second method, based on fitting the mass peaks of the particles, corroborates the TOF values found by fitting the PMTs directly. This second method also yields an estimate on the momentum calibration, finding that the momentum was measured \((3.4^{+1.5}_{-1.5})\) too high. It also found a data-driven constraint on the systematic uncertainty in the momentum of about 1.5%. Another goal is to find optimal selection cuts to identify proton interactions that produce charged pions. Cuts include selecting on the momentum and TOF of the particles to identify incoming protons and details on what secondary tracks are produced in order to identify when protons interact to produce pions. These cuts will be tested to see how they perform with respect to signal efficiency and background rejection.

11:48AM F2.00005 Subluminal Magnetic Monopole Search with NO\(\nu\)A , MARTIN J. FRANK, University of South Alabama, NOVA COLLABORATION — The existence of the magnetic monopole has eluded physicists for centuries. The NO\(\nu\)A far detector (FD), used for neutrino oscillation searches, has the additional capability to search for magnetic monopoles at subluminal velocities. With a surface area of over 4,000 m\(^2\) and a location near the earth’s surface, the 14 kT FD provides us with the unique opportunity to explore an area of magnetic monopole phase space previously inaccessible to underground experiments. We have designed a novel data-driven triggering scheme that continuously searches the FD’s live data for monopole-like structures. At the offline level, the largest challenge in reconstructing monopoles is to reduce the 140,000 Hz speed-of-light cosmic ray background. In this talk, I will present the trigger algorithm that we employ and the offline reconstruction algorithm that will be used for the first NO\(\nu\)A monopole search.

1Department of Energy-High Energy Physics

Friday, November 17, 2017 11:00AM - 12:00PM – Session F3 Atomic, Molecular, and Optical Physics MSU Building Donohoo Lounge - John Yukich, Davidson College

11:00AM F3.00001 Energy flow of electric dipole radiation between parallel mirrors , ZHANGJIN XU, HENK F. ARNOLDUS, Mississippi State University — We have studied the energy flow patterns of the radiation emitted by an electric dipole located between parallel mirrors. It appears that the field lines of Poynting vector can have very intricate structures, including many singularities and vortices. The flow line patterns depend on the distance between the mirrors, the distance of the dipole to one of the mirrors and the angle of oscillation of the dipole moment. For the simplest case of a dipole moment oscillating perpendicular to the mirrors, the flow line structure becomes more complicated, with many vortices in the pattern, and tiny loops near the dipole. We have also investigated the locations of the vortices and singularities, and these can be found without any specific knowledge about the flow lines. This provides an independent means of studying the propagation of dipole radiation between mirrors.

11:12AM F3.00002 Measuring Core Polarizability Of \(^{87}\)Rb Using RF Spectroscopy Of Rydberg States , SETH BERL, CHARLES SACKETT, THOMAS GALLAGHER, Univ of Virginia — The core electrons make a significant contribution to the total electric polarizability \(\alpha\) of large atoms like Rb. If the core contribution can be determined accurately, the remaining valence contribution to \(\alpha\) provides constraints on the wave function and matrix elements of the valence electron, which can be useful for interpreting experiments such as parity violation or radiation shifts in atomic clocks. We report here on a direct measurement of the core polarizability based on radio-frequency spectroscopy of Rydberg states with large angular momentum. With an anticipated accuracy in \(\alpha\) approaching 0.01 atomic units, the residual uncertainty will be negligible in the most sensitive applications. The measured value can also be compared to high-precision theoretical calculations to test many-body techniques.
11:24AM F3.00003 Atom Pairing in Optical Superlattices1, JAYAMPATHI KANGARA, CHINGYUN CHENG, SAEED PEGAHAN, ILYA ARAKELYAN, JOHN THOMAS, Department of Physics, North Carolina State University, JETLAB TEAM — We study the pairing of fermions in a one-dimensional optical superlattice of tunable double-well potentials using radio frequency spectroscopy. The observed spectra reveal the coexistence of two types of atom pairs with different symmetries for their center of mass wave functions. Our measurements are in excellent quantitative agreement with the predicted spectra comprising hundreds of discrete transitions, with symmetry-dependent initial state populations and transition strengths. Our work provides an understanding of the elementary pairing states in a superlattice, paving the way for new studies of strongly interacting many-body systems.

1Primary support for this research is provided by Division of Materials Science and Engineering, the Office of Basic Energy Sciences, Office of Science, U.S. Department of Energy.

11:36AM F3.00004 Observing spin-energy correlation in weakly interacting Fermi gases.1, SAEED PEGAHAN, JAYAMPATHI KANGARA MUDIYANSELAJE, ILYA ARAKELYAN, JOHN E THOMAS, North Carolina State University, JET LAB TEAM — Active manipulation of electron spin and spin current can be used to transport information with low dissipation and for creating quantum-entangled states. We study the formation of spin-energy correlations in a very weakly interacting Fermi gas of 6Li contained in an optical trap with a spin-dependent potential. In the experiments, a uniform cloud containing a coherent superposition of spin states is created by radio-frequency pulse. After 800 ms, we observe spontaneous spatial separation of the spin-up and spin-down density profiles, for both quantum-degenerate and thermal Fermi gases. These results are explained by a collision-less mean-field model of spin-energy correlation. We also determine the temperature dependence of the magnetic field at which the s-wave scattering length vanishes and spin segregation ceases, providing new constraints on models of the molecular potentials.

1Physics division of the Army research office

11:48AM F3.00005 Laser Spectroscopy of Atomic Gadolinium, . UPENDRA M. ADHIKARI, CLAYTON E. SIMIEN, Univ of Alabama - Birmingham — Lanthanide elements are of interest because of their potential for investigating next generation optical clock transitions, novel non-S ground state ultracold collisions, and the physics of quantum degenerate dipolar gases. We present our results using laser spectroscopy to measure the transition shifts and Zeeman spectra for potential laser cooling transitions of atomic gadolinium. These results will allow us to implement laser cooling and trapping of atomic gadolinum.

Friday, November 17, 2017 1:30PM - 3:30PM — Session G1 Precision Tests of Low Energy QCD MSU Building University Banquet Room A - Liping Gan, University of North Carolina Wilmington

1:30PM G1.00001 Low Energy Tests of QCD1, JOSE GOITY, Hampton University and Jefferson Lab — This talk will present a summary of key tests of QCD at low energy. These include decays that test the axial anomalies, and symmetry breaking corrections to those decays, the scattering lengths in \( \pi - \pi \) scattering and in \( \pi - N \) scattering, and the \( \sigma \) terms. Features of violations of SU(3) symmetry in baryons are also discussed.

1Work supported by DOE Contract No. DE-AC05-06OR23177 under which JSA operates the Thomas Jefferson National Accelerator Facility, and by the National Science Foundation grants PHY-1307413 and PHY-1613951.

2:00PM G1.00002 PrimEx II Results: Precision Measurement of the Neutral Pion Lifetime1, ILYA LARIN, Univ of Massachusetts Amherst — The PrimEx experiments in Hall B at Jefferson lab were aimed to perform a precision measurement of the \( \pi^0 \to \gamma \gamma \) decay width via Primakoff effect. A combination of a state-of-the-art high resolution lead tungstate hybrid electromagnetic calorimeter and a tagged photon beam offered a great advantage in reducing experimental uncertainties. The published result from the first (PrimEx I) experiment has 2.8% accuracy. The second (PrimEx II) experiment with several times more statistics than the PrimEx I and an improved systematics was aimed to achieve a better than 2.0% precision. An updated PrimEx II result will be presented.

1 The project is supported by NSF MRI PHY-0079840, RFBR 15-02-07740.

2:30PM G1.00003 A Precision Measurement of the \( \eta \) Radiative Decay Width via the Primakoff Effect, ALEXANDER SOMOV, Jefferson Lab — The GlueX detector in the experimental Hall-D at Jefferson Lab provides a unique capability to perform a measurement of the \( \eta \to \gamma \gamma \) decay width via the Primakoff effect with the precision significantly better than all existing collider and Primakoff results. The experiment will measure differential cross sections of \( \eta \) mesons at forward angles on a liquid hydrogen and \( ^4\)He targets using a beam of tagged photons, which will be used for the extraction of the decay width. The measurement is essential for the determination of the fundamental properties such as the ratios of the light quark masses and the \( \eta-\eta' \) mixing angle, and will provide an important test of chiral symmetry breaking in QCD. The experimental results will also allow to significantly reduce uncertainties on partial widths of all other \( \eta \) decays. We will give an overview of the PrimEx-D physics program and experimental setup.

3:00PM G1.00004 Measuring the Charged Pion Polarizability in the \( \gamma \gamma \to \pi^+\pi^- \) Reaction1, DAVID LAWRENCE, Jefferson Lab — A new measurement of the charged pion polarizability \( \alpha_\pi - \beta_\pi \) is approved to run at Jefferson Lab using the GlueX detector in experimental Hall D. The charged pion polarizability ranks among the most important tests of low-energy QCD presently unresolved by experiment. Analogue to precision measurements of \( \rho(\pi^0(770)) \) production. An additional detector will also be constructed to help distinguish \( \pi^+\pi^- \) and \( \mu^+\mu^- \) events. An update on the status of the experiment will be given.

1DOE Office of Science Contract DE-AC05-06OR23177
DOUGLAS HIGINBOTHAM, Jefferson Lab — Many methods have been used throughout the years to extract the proton radius from electron scattering data. I will summarize both the experimental results and the various techniques used to extract the proton radius. In particular, I will show how for a given set of data the extracted proton radius depends on the technique used to make the extraction and show how machine learning regression techniques can be applied to the problem.

2:00PM G3.00002 Current Results of the PRad Experiment at JLab1. MAXIME LEVILLAIN, North Carolina AT State University, PRAD COLLABORATION — The latest measurements of the proton radius through muonic hydrogen Lamb shift show a discrepancy of about 7σ from a global analysis of standard hydrogen Lamb shift and elastic ep-scattering. In order to understand this proton radius puzzle, the PRad experiment, that was designed through an independent method, successfully performed in June 2016, taking elastic ep and Møller-scattering data with rich statistics in a wide Q^2 range including very low momentum transfer (Q^2 ∈ [10^{-4}, 10^{-1}] GeV^2) with very accurate angle and energy measurements to minimize the systematic uncertainties to achieve a sub-percent precision. After briefly reminding the framework around this proton radius puzzle and how the specific setup of the PRad experiment was designed to improve the previous measurements on elastic ep-scattering cross-sections, using a high efficiency and high resolution calorimeter (HyCal) and a high resolution GEM detector, the presentation will focus on the data analysis and the extraction of ep scattering cross-section normalized by the well known Møller cross-section, to finally show the latest physics results from the 2.2 GeV data.

1The PRad experiment is supported in part by NSF MRI award PHY-1229153
2:30PM G3.00003 The Muon proton Scattering Experiment (MUSE) at the Paul Scherrer Institute1. STEFFEN STRAUCH, University of South Carolina — While consistent results for the charge radius of the proton have been extracted from elastic electron-scattering data and through the spectroscopy of atomic hydrogen, high-precision studies of muonic hydrogen found notably smaller values for the charge radius. This so-called proton-radius puzzle raises questions ranging from experimental and methodological issues to physics beyond the standard model. The puzzle certainly calls for new measurements. The Muon proton Scattering Experiment (MUSE) at the Paul Scherrer Institute (PSI) will provide elastic scattering data off the proton with electron and muon beams of positive and negative charge in a four-momentum-transfer range from 0.002 to 0.08 GeV2. Each of the four sets of data will allow the extraction of the proton charge radius; in combination, the data sets positive differences of the electron and muon interactions and additionally two-photon exchange effects. The experiment is presently being commissioned at PSI. An overview of the experiment will be presented.

1Supported in parts by the U.S. National Science Foundation: NSF PHY-1505615

3:00PM G3.00004 The JLab recoil polarization measurements of the proton form factors ratio GEp/GMp, CHARLES PERDRISAT, Retired — A series of experiments initiated at the then new CEBAF electron accelerator in Newport News Virginia in the late nineties, resulted in unexpected results, changing significantly our understanding of the structure of the proton. These experiments used a relatively new technique to obtain the two form factors of the proton, polarization. An intense beam of highly polarized electrons with energy up to 6 GeV was made to interact with protons in a hydrogen target, and the resulting polarization of the recoiling protons was obtained from a second interaction in a polarimeter. After a short introduction I will introduce the subject of elastic electron scattering, describe some of the apparatus required for such experiments, show results and then give a brief outline of several theoretical considerations to put the results in a proper perspective.

Saturday, November 18, 2017 8:30AM - 10:30AM — Session J1 Physics at ORNL MSU Building University Banquet Room A - Chang-Hong Yu, Oak Ridge National Laboratory

8:30AM J1.00001 Search for time-reversal violation with the neutron electric dipole moment at the Spallation Neutron Source, KENT LEUNG, North Carolina State University — The existence of a permanent electric dipole moment (EDM) for a fundamental particle, such as the neutron, would provide a new source of time-reversal violation in our physical laws. Time-reversal violation is equivalent to charge-parity (CP) violation via the CPT theorem. Several orders of magnitude larger CP violation beyond that currently observed and predicted in the standard model of particle physics is required to explain the matter over anti-matter dominance of our Universe. The nEDM at SNS experiment will provide a sensitivity around two orders of magnitude better than the current world limit. Our experiment will utilize the FNPF cold neutron beam facility to produce ultracold neutrons inside our measurement cells to be stored and studied for around a thousand seconds. Various unique properties of 0.4 K superfluid helium and hyper polarized 3He atoms in our cryogenic apparatus will be exploited to study the precession of the neutron spins in the presence of a large electric field to unprecedented accuracies. The motivation, description, and updates of our “flagship” nuclear physics experiment will be given in this talk.

9:00AM J1.00002 First Results from the MAJORANA DEMONSTRATOR, DAVID C. RADFORD, Oak Ridge National Laboratory — The MAJORANA DEMONSTRATOR experiment has been operating since October 2016 inside a clean room 4850 feet underground in the Sanford Underground Research Facility in Lead, SD. The aim is searching for neutrinoless double beta (0νββ) decay in 76Ge using 29.7 kg of detectors made from germanium enriched to 88% in that isotope. If observed, 0νββ decay will prove that the neutrino and the anti-neutrino are identical and that leptons are not their own antiparticles. It will also provide hints about how the Big Bang produced more matter than it did antimatter. The primary goal of the MAJORANA DEMONSTRATOR is to show that backgrounds can be reduced to a value low enough to justify a large 0νββ experiment using 76Ge. More than six months of data from the DEMONSTRATOR have been analyzed, and initial results for the background index will be presented, together with an outlook for the future sensitivity reach of the experiment. Future prospects for LEGEND, a new collaboration formed with the goal of fielding a tonne-scale 76Ge 0νββ experiment, will also be discussed.

9:30AM J1.00003 PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment1, JAMES MATTA2, Oak Ridge National Laboratory — The PROSPECT experiment is designed to probe short-baseline neutrino oscillations and precisely measure the 235U reactor antineutrino spectrum. Using a ~4-ton segmented 9Li-loaded liquid scintillator detector, PROSPECT will probe the sterile neutrino best fit region to 4σ within one year of operation at distances of 7-12 meters from the High Flux Isotope Reactor (HFIR). Additionally, the measurement of the 235U spectrum at 4.5%/√E will address the 4-6MeV spectral bump observed in recent measurements by the θ13 experiments. This talk will discuss the design, experimental program, backgrounds, and discovery potential of PROSPECT.

1 This material is based upon work supported by the U.S. Department of Energy Office of Science, High Energy Physics and under Cooperative Research and Development Agreement (CRADA) NFE-17-06899 between Yale University and UT-Battelle, LLC.

2on behalf of the PROSPECT collaboration

10:00AM J1.00004 Neutrinos at the Spallation Neutron Source1, JASON NEWBY, Oak Ridge National Laboratory — The neutrinos produced at the Spallation Neutron Source are ideally suited for a set of exploratory and high-precision neutrino physics measurements due to the accelerator’s intensity, pulsed-structure, and proton beam-energy. The Oak Ridge National Laboratory recently converted a service corridor only 20 meters from the SNS target into a dedicated neutrino laboratory capable of supporting ton scale neutrino physics measurements due to the accelerator’s intensity, pulsed-structure, and proton beam-energy. The recently converted a service corridor only 20 meters from the SNS target into a dedicated neutrino laboratory capable of supporting ton scale neutrino physics measurements due to the accelerator’s intensity, pulsed-structure, and proton beam-energy. The Oak Ridge National Laboratory presently commissioned the four neutrino detectors. The COHERENT experiment is the first to take advantage of this new capability at ORNL with the deployment of four neutrino detectors. The first installed instrument was a 14kg CsI detector that recently completed two years of SNS exposure to make the first observation of coherent neutrino nuclear scattering. This most frequent of all neutrino interactions was predicted over forty years ago, but had eluded observation due to enormous experimental challenges. This basic interaction now provides a new tool to address a host of physics topics including electromagnetic properties, searches for physics beyond the standard model, and nuclear form factors. The experimental features of this new capability at ORNL will be presented. The recent first-observation measurement and the anticipated results from currently operating detectors will be discussed.

1Research sponsored by the Laboratory Directed Research and Development Program of Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U. S. Department of Energy.
9:00AM J2.00002 QCD spectrum and resonance decay widths from lattice QCD1, COLIN MORNINGSSTAR, Carnegie Mellon University — Recent progress in calculating the hadron spectrum in lattice QCD is described. Recent calculations of various resonance decay widths using new techniques in lattice QCD are also presented. The latest studies can incorporate multiple decay channels and multiple partial waves.

1Work supported by NSF grant PHY-1613449.

9:30AM J2.00003 Spectroscopy Results with Polarization Observables in Vector Meson Photoproduction at CLAS1, PRIYASHREE ROY, University of Michigan/Florida State University — Understanding the baryon spectrum is key to comprehend the underlying dynamics of quark-gluon interactions in baryons. Due to the broad and overlapping nature of baryon resonances, identifying them is very challenging, particularly above 1.7 GeV c.m. energies. Therefore, in addition to unpolarized cross sections, polarization observables are necessary to isolate resonance contributions from other interference terms. These high-mass excited states are predicted to have strong couplings to final states involving a heavier meson, such as the vector mesons $\omega$ and $\rho$. The photoproduction of these final states have mostly remained unexplored, but their study can significantly contribute towards establishing nuclear resonances. I will present results on polarization observables extracted from a comprehensive analysis of $\omega$ and $\pi^+\pi^-\pi^0$ photoproduction reactions off a proton using a polarized beam and a FROzen Spin Target at Jefferson Laboratory. The experiment used the CLAS spectrometer and covered c.m. energies up to 2.5 GeV. Many of these observables are first-time measurements, thus substantially augmenting the world database of polarization observables for these reactions. I will also present results of a partial-wave analysis within the BnGa framework that is based on this new CLAS data.

1This work is supported by DOE DE-FG02-92ER40735

10:00AM J2.00004 Hadron Spectroscopy and JPAC Activities, ANDREW JACKURA, Indiana University, Joint Physics Analysis Center (JPAC) — I will discuss aspects of hadron spectroscopy and the Joint Physics Analysis Center’s (JPAC) role in the development of modern analysis tools. JPAC is a joint effort between theorists, experimentalists, and phenomenologists who work together to develop models and analysis tools for the next generation of high-precision, high-statistics data.

Saturday, November 18, 2017 8:30AM - 10:30AM — Session J3 Fundamental Symmetries MSU Building Donohoo Lounge - Nadia Fomin, University of Tennessee

8:30AM J3.00001 Frontiers and Perspectives in Low-Energy Fundamental Symmetry Tests1, SUSAN GARDNER, Univ of Kentucky — Low-energy experiments can identify physics beyond the Standard Model (SM), through either the observation of an unexpected breaking of its symmetries or that of a significant departure from a precise SM prediction. I will focus on the former, drawing a suite of examples from the precision frontier, including studies of hadron decays and searches for permanent electric dipole moments, and show how they, taken in aggregate, can speak to a bigger picture.

1S.G. acknowledges partial support from the U.S. Department of Energy under contract DE-FG02-96ER40989

9:00AM J3.00002 Probing the Weak Interaction with Neutron Beta Decay, LEAH BROUSSARD, Oak Ridge National Lab — The neutron has proven to be an excellent tool for studying the fundamental forces of nature. Studies of the free neutron’s decay into a proton, electron, and antineutrino can give us our most precise understanding of the charged weak interaction of quarks and allows us to search for hints of new physics and interactions missing from the Standard Model of Particle Physics. The next generation of experiments to measure the lifetime and angular correlations in neutron beta decay faces significant challenges to push to even higher precision and stronger limits. I will give an overview of the motivation and history of neutron beta decay, and discuss how the cutting edge experiments today are approaching these challenges.

9:30AM J3.00003 Precision Measurement of the Proton’s Weak Charge, DAVID S. ARMSTRONG1, William and Mary — The QWeak collaboration has used parity-violating elastic electron-proton scattering at very low momentum transfer to precisely measure the proton’s weak charge. The weak charge is cleanly predicted within the Standard Model, with minimal theoretical uncertainty. Thus, this measurement provides an avenue for a sensitive search for beyond-the-Standard Model (BSM) physics. The final results for the weak charge will be presented, as well as the extracted values of the vector weak couplings of the up and down quarks, and the weak mixing angle. We will also discuss implications for BSM physics at the multi-TeV energy scale.

1(QWeak Collaboration)
10:00AM J3.00004 A Modern Measurement of the Neutron Lifetime, Using Ultra-cold Neutrons in a Magneto-Gravitational Trap, CHEN-YU LIU, Indiana University Bloomington — The precise value of the mean neutron lifetime plays an important role in nuclear and particle physics and cosmology. It is a key input for predicting the ratio of protons to helium atoms in the primordial universe and is used to search for new physics beyond the Standard Model of particle physics. There is a 3.9 standard deviation discrepancy between neutron lifetimes measured by counting the decay rate of free neutrons in a beam (887.7 \pm 2.2 \text{s}) and by counting surviving ultracold neutrons stored for different storage times in a material trap (878.5 \pm 0.8 \text{s}). I will describe the UCNtau experiment, which is designed to eliminate loss mechanisms present in previous trap experiments by levitating polarized ultracold neutrons above the surface of an asymmetric storage trap using a repulsive magnetic field gradient so that the stored neutrons do not interact with material trap walls and neutrons in quasi-stable orbits rapidly exit the trap. As a result of this approach and the use of a new in situ neutron detector, the lifetime reported here 877.7 \pm 0.7 (\text{stat}) +0.3/-0.1 (\text{sys}) \text{s} is the first modern measurement of neutron lifetime that does not require corrections larger than the quoted uncertainties.

Friday, November 17, 2017 4:00PM –
Session W1 Poster Session Health Science 314 - Nadia Fomin, University of Tennessee

W1.00001 Myoelectrically Controlled, 3D Printed Prosthetics, KATHERINE CROSBY, ANDREW RHODES, ELI OWENS, Presbyterian College — For this project, we developed a low-cost prosthetic hand using surface mounted myoelectric sensors and 3D printing. The loss of a limb can be a traumatic experience for a person, but prosthetics can restore the functionality of the limb, and confidence to the user. However, insurance often does not cover the cost of prosthetics, and entry-level prosthetics can cost over $10,000. This motivates the need for low-cost prosthetics. We have designed and built a low-cost, highly-functional, myoelectrically controlled, 3D printed prosthetic. We use surface electrodes paired with a signal processing circuit of our design to sense healthy muscle contractions. We then use the electrical signal from the healthy muscles to naturally control the prosthetic hand. The circuit uses multiple electrodes to differentially measure independent muscle contractions. The muscle contraction signals are compared to a reference point on the elbow where little to no muscle movement is made. We use machine learning to help the controller modify the movement based on user input during a startup routine. This startup routine learns the users muscle habits and modifies variables in the code to make the muscular profile unique to the user.

W1.00002 Mid-IR Spectroscopy of Dried Serum Samples: An Application for Colitis Prescreening, HEMENDRA GHIMIRE, KELUM PERERA, A. G. UNIL PERERA, Georgia State Univ — At present, colonoscopy/ileoscopy and small bowel follow through are considered as gold standard for IBD tests. Despite their unequivocal benefit for the IBD tests, compliance rates of eligible population for prescreening is very small due to discomfort, expense, and risk of complications. Developing a minimally invasive and cost-effective prescreen strategy is thus critical. We present ATR-FTIR spectroscopy of serum with appropriate data handling frameworks can be used for reliably screen experimental colitis. The study on experimental colitis models: interleukin 10 knockout mouse, and dextran sodium sulfate-induced of colitis mouse while employing collagen-induced arthritis models, TLR-5 knockout models of metabolic diseases as control, emphasizes the diagnostic potential of this technique for the prescreening. Absorbance values of the different spectral bands, hierarchical clustering and integral values of the component bands by curve fitting, show significant differences (p-value <0.05) between spectra representing control and colitis mice. The preliminary result hints us the potential application of technique while diagnosing ulcerative colitis and Crohn’s Disease and to monitor during treatment.

1Army Research Office; Air Force Office of Scientific Research; Molecular Basis of Disease Program at GSU

W1.00003 3D Registration in a Virtual Reality Simulator for Neurosurgical Instruction, TED DORFUEILLE, Mercer University Department of Computer Science, RICHARD ROWE, Georgia Neurosurgical Institute, ANDREW POUNDS, Mercer University Department of Computer Science — Virtual Reality and computer graphics techniques have been used since their inception in numerous medical professions and it has long been thought that the technology would be ideal for training simulations. A recent review article noted that simulators for neurosurgery containing completely immersive environments and realistic touch response were particularly lacking. This project attempts to utilize commercial gaming headsets with a mechanical haptic feedback device to simulate surgery in an immersive environment with touch feedback. The focus of the current research is the use of 3D registration techniques and basis set transformations to map the space of the 3D models in the VR environment to the physical models and surgical instruments that might be in the hands of the operator.

1Partially funded through the QEP “Research that Reaches Out” initiative of Mercer University.

W1.00004 Thermodynamical and Biochemical Analysis of Antipyretics Used for Fever Reducing Agents, SEOJIN PARK, RICHARD KYUNG, Choice Research Group — Antipyretics are substances used in fever reducing agents. In this paper, thermodynamical and stereochemical aspects of several types of antipyretics that can be used as a fever reducing agent are studied. This research uses computational chemistry to calculate the thermodynamic stability of various fever reducing agents in order to identify whether the ingredients are of safe use for pharmaceutic products. The research uses the chemical software to find the optimized molecular geometry and calculate theoretical enthalpy of each compound models. The computer program uses DFT (Density Functional Theory) and UFF (Universal Force Field), which are used to optimize each model. The optimization configuration energy of all the molecules is collected in order to examine the relative stability of each chemical compound. It is known that the less thermodynamic enthalpy needed to stabilize the compound, the more stable the compound is. Calculations show that enthalpies of some compounds converge fast with significantly less thermodynamic enthalpy, indicating that they are relatively stable and are suitable to use as a biochemical compound in fever reducing agents.
**W1.00005** Molecular sensitivity and selectivity of metal nanoparticles decorated graphene as ‘smart’ surface-enhanced Raman scattering (SERS) platforms. SANJU GUPTA, A. BANASZAK, T. SMITH, Western Kentucky University, Bowling Green, KY 42101 — Graphene-mediated surface-enhanced Raman scattering (G-SERS) is a recent phenomenon that produces clean and reproducible Raman signals of chemical molecules with significantly enhanced intensity. Since G-SERS relies on a chemical mechanism and therefore it shows molecular sensitivity and selectivity. We developed graphene-nanomaterials, GFNs, decorated with coinage silver and gold nanoparticles for detection of methylene blue (MB) and rhodamine 6G (R6G) probes in view of optical and biological importance. The results illustrate that silver and gold nanoparticles immobilized on GFNs enhanced the Raman signal, in general, and as cascaded amplification of on multilayer architecture, larger than those on the metal nanoparticles without graphene. Additionally, the sensitivity can be tuned by controlling the size of nanoparticles. Moreover, highly-sensitive graphene-nanoparticle sensors are capable of molecular detection over 10 pM to 100 microM concentration. The G-SERS enhancement is discussed in terms of graphene-metal nanoparticle interactions leading to local interfacial hybridization and polarization. 2. molecular conformation of analyte on nanoparticle-graphene functionalities, and 3. charge transfer and exchange or sharing of charges between analyte and nanoparticles decorated graphene-metal nanoparticle interactions experiencing chemical enhancement. Optimized metal nanoparticle-graphene electronic properties are determined from density functional theory (DFT) calculations.

**W1.00006** Observation of a Stable Optical Spring Without a Cavity<sup>1</sup> BENJAMIN LANE, JONATHAN CRipe, Department of Physics & Astronomy, Louisiana State University, Baton Rouge, Louisiana, BAYLEE DANZ, Department of Physics, Brigham Young University-Idaho, Rexburg, Idaho, THOMAS CORBITT, Department of Physics & Astronomy, Louisiana State University, Baton Rouge, Louisiana — The current generation of gravitational wave detectors utilize high power lasers to reduce the shot noise within an interferometer. This high power creates a significant radiation pressure that couples the laser fields and the mechanical motion of the test masses opto-mechanically. This opto-mechanical coupling gives rise to an optical spring that changes the resonance of the interferometer, and thus should be studied. In this experiment, we present the observation of a stable optical spring without the use of an optical cavity. We use a Michelson-Sagnac interferometer with a GaAs microresonator as a common/end mirror. Our measurements were done using input powers of 50 mW, 100 mW, 200 mW, and 363 mW and show that the shift of the optical spring frequency as a function of input power is in excellent agreement with theoretical predictions. We also show that the optical spring can keep the interferometer stable and locked without the use of external feedback.

<sup>1</sup>This work was supported by the National Science Foundation CAREER grant PHY-1150531.

**W1.00007** High Energy Follow-up Study of Gravitational Wave Transients . BRANDON BARKER, University of Tennessee — As second-generation gravitational wave interferometers, such as Advanced Virgo and Advanced LIGO, reach their design sensitivities, a new lens into our universe will become available. Many of the most violent and energetic events in the cosmos, in particular the merger of compact objects and core collapse supernovae, are sources of gravitational waves and are also believed to be connected with Gamma Ray Bursts. Joint observations of electromagnetic and gravitational wave signals will provide an ideal opportunity to study the physics of these transient events and their progenitors. In particular, gamma ray observatories such as Fermi, coupled with precise sky localization, will be crucial to observe the high energy electromagnetic counterparts to gravitational wave signals. We constructed joint binary neutron star and gamma ray burst detection rate estimates using an analysis pipeline and report on the results of this analysis.

**W1.00008** Obtaining Force Uncertainties via Entropic Gravity and Generalized Uncertainty Principle<sup>1</sup>, ANDREW DYE, JEFFERY SECREST, Armstrong State University — In quantum mechanics the notion of force tends to not be considered. However, utilizing various forms of the generalized uncertainty principle and the framework of entropic gravity, a force-position uncertainty relationship has been obtained. This allows for the investigation into the quantum nature of gravitational phenomena in both relativistic and non-relativistic contexts.

<sup>1</sup>The authors would like to thank Armstrong State University for financial support thru the Undergraduate Research grant.

**W1.00009** Examination of Five Dimensional Bianchi Type-I FLRW Models<sup>1</sup>, ANDREW GOETZ, JEFFERY SECREST, Armstrong State University — Einstein’s field equations for a five dimensional Bianchi type-I cosmological model were considered. The fifth dimension was a compactified dimension inserted into our model as described by Kaluza-Klein theory. Time dependent gravitational and cosmological constants were used for this model. The five dimensional universe was modeled on the equation of state of a perfect fluid, this equation of state being $p = \rho \omega$ with $0 \leq \omega \leq 1$. Various forms of the cosmological constant were examined. From this a variety of solutions were obtained and the physical significance of each solution was discussed.

<sup>1</sup>The authors would like to thank Armstrong State University for its financial support through the UR grant.

**W1.00010** Highlights from the INTEGRAL Spiral Arms Monitoring Program, SEAN ANTONIUK, QUINTON DZURNY, ARASH BODAGHEE, Georgia College & State Univ, ISA COLLABORATION COLLABORATION — We describe the scientific objectives and highlights from 4 years of high-cadence monitoring of the inner spiral arms of the Galaxy in X-rays (3-100 keV). The INTEGRAL Spiral Arms (ISA) program (12.5 ks per observation for a total of 1.2 Ms per year) complements the successful Galactic Bulge (GB) program by extending the monitored regions to the Inner Perseus/Norma Arm tangents on one side of the GB, and the Scutum/Sagittarius Arms on the other. These fields feature a high density of obscured high-mass X-ray binaries (HMXBs), including Supergiant Fast X-ray Transients (SFXTs), as well as other hard X-ray emitting sources (e.g. microquasars, low-mass X-ray binaries, and magnetars) that INTEGRAL is well-suited to finding thanks to its large field of view and angular resolution at high energies even in crowded regions of the sky. Mosaic images and source light curves in 2 energy bands for ISGRI and JEM-X are provided to the community at isa.gcsu.edu permitting rapid dissemination of results which enable prompt follow-up of interesting events. The ISA project represents the cornerstone of our ongoing study of transient and variable hard X-ray populations in the Milky Way.

**W1.00011** Photometry of High-Redshift Gravitationally Lensed Type Ia Supernovae<sup>1</sup>, ANASTASIA HAYNIE, Univ of South Carolina — Out of more than 1100 well-identified Type Ia Supernovae, only roughly 10 of them are at $z>1.5$. High redshift supernovae are hard to detect but this is made easier by taking advantage of the effects of gravitational lensing, which magnifies objects in the background field of view. Gravitational lenses magnify cosmic objects by a factor of $\gamma^2$, where $\gamma$ is the magnification factor. For Type Ia supernovae, the luminosity is $L \propto \gamma^4$, making them observable out to much higher redshifts. Studying high-redshift supernovae like SN Neba is an important step towards creating cosmological models that accurately describe the behavior of dark energy in the early Universe. Recent efforts have been focused on improving photometry and the building and fitting of preliminary light curves.

<sup>1</sup>Magellan Grant - University of South Carolina
W1.00012 Stability and Concurrence of an Entangled Theta State Qubit in a Reissner-Nordstrom Spacetime. KEITH ANDREW, BENJAMIN THORNBERRY, ERIC STEINFELDS, Physics and Astronomy, Western Kentucky University — We consider the construction of an X state density matrix for an open Dirac system in a curved spacetime manifold with geodesic structure given by the Reissner-Nordstrom metric. Using an asymptotic Minkowski Hadamard-CNot gate configuration we construct a maximally entangled Bell state density matrix. This system is generalized using a Theta State Qubit representation and coupled to an environmental thermal background given by the cosmic microwave background distribution and located in a Reissner-Nordstrom (RN) space-time. The RN spacetime corresponds to a static spherically symmetric charged mass distribution with an outer Event Horizon and an inner Cauchy Horizon. The metric structure of the horizons is a function of the mass and charge distribution of the system. By applying a Bogoliubov transformation in Kruskal coordinates to the entangled state and a filter, which undergo a weak measurement in a region near the horizon while being exposed to the RN Hawking radiation, we can express the qubit density matrix as a function of temperature. We plot the Concurrence as functions of mass and charge to determine the parameter range that lead to the decay and eventual destruction of the entanglement of the qubit state.

W1.00013 Comparing the spatial distributions of HMXBs and star-forming regions in the Small Magellanic Cloud. RYAN AGNEW, QUINTON DZURNY, ARASH BODAGHEE, Georgia College and State University — The Small Magellanic Cloud (SMC) is a satellite galaxy of the Milky Way. Thanks to its relative proximity, 234 massive stellar clusters are easily resolved with modern telescopes as are 72 byproducts of these nurseries: so-called high-mass X-ray binaries (HMXBs) which are systems comprising a massive star paired with a collapsed star such as a neutron star or black hole. However, a direct link between an HMXB and its parent cluster is not immediately clear except in rare cases. The purpose of this study is to determine the proximity of these two related populations by performing a statistical analysis of their spatial distributions as observed in the SMC. Our study represents the first ever application of the two-point correlation function to the populations of another galaxy. A significant correlation has been found, and these results provide clues to the evolution of massive stars such as the magnitude of the natal kick received by the HMXB during the supernova, and the time that elapses between the supernova and accretion phases of the HMXB.

W1.00014 An Atmospheric Column Model Coupled to Surface Adsorption for Martian Methane Production in Gale Crater Using JSC-1 Martian Simulant with Metallic Sulfates. KEITH ANDREW, ERIC STEINFELDS, Physics and Astronomy, Western Kentucky University, KRISTOPHER ANDREW, Physics and Astronomy, University of Kentucky, MELINDA THOMAS, Physics and Astronomy, Western Kentucky University, ALICIA PESTERFIELD, Department of Chemistry, Western Kentucky University, QUINTON LINEBERRY, Applied Physics Institute — We consider an atmospheric column model with solar UV forcing and competitive Langmuir, Freundlich, and BET adsorption based reactions at the atmosphere-surface interface to investigate methane generation on Mars. By combining Curiosity rover data, with the Mars Climate Database 5.2 and lab measurements of JSC-1 Martian Regolith Simulant we model the near surface adsorption reaction pathways linked to methane production. The effects of freezing point depression from metallic hydrated sulfates and a Clausius-Clausius mixed state phase give rise to subsurface liquid interactions that add to the Bloom model of deliquescence and biogenetic sources for methane. We numerically solve an integro-differential equation for methane production that can be cast as a Volterra Equation Column Model yielding subsurface production of methane that is moderated by the local daily and seasonal variations of solar radiation. We find that there are reasonable values for the geochemical reaction rates as functions of local temperature, solar radiation, humidity, partial pressure, and soil granularity to produce methane levels that compete with biogenic extremophile based sources.

W1.00015 Pre-Merger History of Illustris-Simulated Galaxy Pairs. ALICE JACQUES, SPENCER SHORTT, KIERNAN REISING, DONOVAN DOMINGUE, Georgia College — In this work, we analyze the history of 24 simulated major-merger galaxies including star formation and mass growth with emphasis on morphological type dependencies. Pairs were identified as major-merger galaxy candidates (mass ratio < 2:5) within the Illustris simulation; with the goal of comparing them to observations of SDSS-2MASS selected galaxy pairs and visually classifying their morphology. Approximately 7000 total galaxies fit within our mass range with 356 candidate pairs reduced by separation, mass, and relative velocity criteria to a final sample of 24 simulated physical pairs at various stages of pre-merger galaxy interaction. Illustris masses and star formation are presented across the simulation snapshots in an effort to understand the pre-paired history of observationally selected analogs.

W1.00016 Constraining Extinction due to Dust in Distant Galaxies. ALEXANDER KIRBY, VARSHA KULKARNI, University of South Carolina — Extinction due to interstellar dust is a ubiquitous phenomenon that dims and reddens the light of background objects. As such, it is essential to apply extinction corrections to observations of distant objects in order to deduce their properties. Since the discovery of interstellar extinction in 1930, astronomers have developed a fairly detailed understanding of the interstellar dust in the Milky Way and other Local Group galaxies, especially the Magellanic Clouds. However, studies of extinction by dust in galaxies beyond the Local Group have been limited. In this work, we seek to generate better constraints on dust extinction in other galaxies in order to improve corrections for observations of objects that lie beyond them. As such, we are constructing spectral energy distributions (SEDs) for quasars/active galactic nuclei whose lines of sight go through foreground galaxies at lower redshifts. We will describe our compilation of archival optical, UV, and IR spectroscopic and photometric data from various observatories. Using the SEDs compiled from these data, and fitting the underlying continuum of the background quasar/AGN, we will estimate dust extinction curves for each foreground galaxy, and compare those with extinction curves in the Milky Way and the Magellanic Clouds.

W1.00017 Fermi-LAT daily monitoring observations of the microquasar Cygnus X-1. STEPHEN HOOD, AUSTIN WALDRON, ARASH BODAGHEE, Georgia College and State University — A microquasar is an accreting compact object (such as a neutron star or a black hole) with relativistic jets. These are much smaller versions of quasars which are supermassive black holes occupying the centers of large galaxies. Their smaller size enables them to vary on short timescales of hours to days, compared with months to years for quasars. Therefore, microquasars are important tools for studying the physics of matter in extreme electromagnetic and gravitational fields. While they are expected to emit across the electromagnetic spectrum, only a handful of microquasars have ever been detected in gamma-rays and these detections are rare and short-lived. In this study, we analyzed over eight years of gamma-ray observations of a well-known microquasar called Cygnus X-1 as gathered by the Fermi space telescope. Our study continues the daily monitoring previously introduced in Bodaghee et al. (2013) with new data extending from 2012 to 2016. The purpose of the study is to confirm previous gamma-ray outbursts of Cygnus X-1, and to detect new candidate outbursts (a dozen of which were found). Detection of gamma-ray emission from microquasars is important for understanding particle acceleration in the jet, and for constraining leptonic/hadronic emission models.
W1.00018 Determining the 3D Orientation of High Velocity Clouds by Monte Carlo Modeling, KRISTY SAKANO, Univ of NC - Chapel Hill — The star formation history of the Galaxy suggests continual gas accretion. Some of this star formation may appear in the form of high velocity clouds (HVCs). The origin of HVCs is still debated. One crucial ingredient in this puzzle is the generally unavailable trajectory information. Yet, many of the compact HVCs show clear signs of interaction with the background halo medium. We present a method to determine the 3D velocity vector of compact HVCs. The method is based on a HVC’s background halo medium. We present an efficient algorithm to determine the 3D orientation of compact HVCs. With this method, Galactic halo gas dynamics as traced by compact HVCs can be mapped.

W1.00019 Applications of Neutrosophic Quadruple Algebraic Structures, FLORENTIN SMARANDACHE, University of New Mexico, A. A. A. AGBOOLA, Federal University of Agriculture Abeokuta, B. DAVAZV, Yazd University — A Neutrosophic Quadruple Number is a number of the form: $NQ = (a \pm bT + cI \pm dF)$, where $a$, $b$, $c$, $d$ are real or complex numbers, while $T$ = truth, $I$ = indeterminacy, and $F$ = falsehood. For each $NQ$, a is called the determinate part of $NQ$, while $bT + cI + dF$ the indeterminate part of $NQ$. A Preference Law, with respect to $T$, $I$, $F$, we may define on the set of neutrosophic quadruple numbers. For example, let’s say $T < c < F$. With respect to this preference law, we define the Absorbance Law for the multiplications of $T$, $I$, and $F$, in the sense that the bigger one absorbs the smaller one (or the big fish eats the small fish); for example: $TT = T$ (absorbs itself), $TI = I$ (because $I$ is bigger), $FT = F$ (because $F$ is bigger), and so on. The addition and subtraction of neutrosophic quadruple numbers are defined as: $(a_1 \pm b_1 T + c_1 I + d_1 F) + (a_2 \pm b_2 T + c_2 I + d_2 F) = (a_1 + a_2) \pm (b_1 + b_2) T + (c_1 + c_2) I + (d_1 + d_2) F$; $(a_1 \pm b_1 T + c_1 I + d_1 F) - (a_2 \pm b_2 T + c_2 I + d_2 F) = (a_1 - a_2) \pm (b_1 - b_2) T + (c_1 - c_2) I + (d_1 - d_2) F$. While multiplication $(a_1 \pm b_1 T + c_1 I + d_1 F)(a_2 \pm b_2 T + c_2 I + d_2 F)$ is defined as in classical multiplication of polynomials, but taking into consideration the above absorbance law when multiplying the $T$, $I$, $F$ among themselves. Various neutrosophic quadruple algebraic structures and their applications are studied on the set of $NQ$s.

W1.00020 Linear Dependencies in Friction Stir Welding Conditions, JEREMIAH P SIMMONS, WILLIAM R LONGHURST, Austin Peay State Univ — Friction stir welding is a solid-state process that joins materials using heat generation to soften the material to a state of plastically deformation, and mechanical forces to consolidate the materials. The origin of HVCs is still debated. One crucial ingredient in this puzzle is the generally unavailable trajectory information. Yet, many of the compact HVCs show clear signs of interaction with the background halo medium. We present a method to determine the 3D velocity vector of compact HVCs. The method is based on a HVC’s background halo medium. We present an efficient algorithm to determine the 3D orientation of compact HVCs. With this method, Galactic halo gas dynamics as traced by compact HVCs can be mapped.

W1.00021 Plasma Characterization in Magnetron Sputtering, SPENCER LOVELADY, KENDAL MCDONALD, Georgia College and State University — Magnetron sputtering is a technique used for semiconductor thin film deposition. A plasma is generated during the sputtering process. Study of the plasma is important in order to understand the deposition process and to have a better reproducibility of thin film deposition. We used optical emission spectroscopy as the primary plasma diagnostic tool. Ocean Optics HR 4000 high resolution spectrometer was used within the wavelength range of 200 nm to 1100 nm. The intensity ratio of Argon 750 nm and Argon 751 nm lines were further investigated to determine the effects of different deposition parameters such as deposition pressure and deposition power. Trends in the excitation temperature corresponding to the deposition power and deposition pressure will also be discussed.

W1.00022 The Development of a Retina Controlled Prosthetic Device for Human Augmentation, BRIAN SKOGLIND, JACOB BREWER, HAUKE BUSCH, Georgia College — We are using LabVIEW to design and build a retina controlled prosthetic limb that can be used to help augment individuals with disability. Due to the recent wars, there has been an increase in injured veterans returning with the need of a prosthetic limb. Traditionally, prosthetic limbs have been passive devices; our design works to create a more active and adaptive device. The primary objective of LabVIEW is to control a prosthetic limb that is an original artificial limb. Currently we are in the process of 3D printing a prosthetic hand and testing different materials to find a material strong yet flexible enough to act as joints. We are also working on taking visual input from the camera into LabView. The prototype will be controlled through Virtual Instruments (VIs) and a National Instruments device called, MyRIO. Other applications of this research can be implemented into wheel chair operations with individuals with more severe disabilities.

W1.00023 Supercapacitance Capabilities On a Submarine, ZACHARY GALBERD, JOSEPH CUMINGS, LUKE WALSH, KENNETH ADAMAS, HANI ALSHARIF, HAUKE BUSCH, Georgia College — Throughout history submarines have shaped the way wars have been fought and changed our understanding of fluid dynamics. In the past, an idea has been used to increase the velocity of torpedoes in Chinese and Russian Submarines, called supercavitation. An example of this is the Russian VA-111 Shkval/ torpedo. The idea being that if your submarine is traveling at a certain velocity underwater, and you are expelling a gas out of the nose cone region, thus creating a boundary layer, you will be “flying” in that new medium. This allows a torpedo to travel at faster speeds making any evasive actions of the targeted submarine or surface vessel extremely difficult. The purpose of our project is to explore the benefits and limitations of supercavitation. This information will then be implemented into a submarine to hopefully decrease its drag and increase its speed and efficiency. The obstacles we are facing include, finding ways to effectively create a boundary layer in the nose cone region suitable for submarine designs to travel through water. We are currently creating a rail and arm system to test different nose cone sections for use in a drag water tank.

W1.00024 Electrical and Optical Properties of Sputtered Aluminum-doped Zinc Oxide, DANIEL SEXTON, Georgia College & State Univ — Transparent conducting oxides (TCO) are used in opto-electronic devices. This study investigates properties of Aluminum doped Zinc Oxide (AZO) as a possible TCO candidate for solar cells. AZO thin films were deposited using RF magnetron sputtering in the presence of argon and oxygen. The properties of AZO films deposited under different deposition parameters including pressure, power and temperature were characterized using UV/Vis spectroscopy, Hall-Effect measurement and four point probe measurements. Further, optical emission spectroscopy was used to correlate the properties of the deposited thin films to the behavior of the plasma during sputtering. Trends in transmittance, mobility, band gap, resistivity, and carrier density under different deposition parameters will be presented along with the correlation of these properties to the plasma behavior.

W1.00025 The Real Valued Jαm Derivative, S. KYLE CASTLEBERRY, BENNETT HALLER, SHARON CARECCIA, RALPH H FRANCE III, Georgia College — In continuation of the work presented by Pearson et al. at SESAPS 2016, we have made progress on the Jαm Derivative. Previously, we had used Wolfram Alpha to graphically analyze the derivative, but its results were incomplete. The natural logarithm of complex numbers, which occur twice in the calculations of the Jαm derivative are multivalued, with Wolfram Alpha choosing one particular value. We will present a more general case and show that a particular choice of values for these logarithms produces completely real results.
W1.00026 Assessment of the Biocompatibility of the Iron Oxide Nanoparticles Treating Cancer Disease Using Computational Simulation, JOO HEE LEE, RICHARD KYUNG, Choice Research Group — Bio-metals such as copper, zinc, iron, and manganese have been widely used as prominent materials for medical applications including clinical treatment such as treating cancer disease. In the past, iodine and transitional metal oxides have been used in nanoparticles for cancer detection but some of them showed harmful effects to the body. In this research, the efficiencies of magnetic nanoparticles such as iron oxide compounds used the detection of the CTC (Circulating Tumor Cells) are modeled using computer software and explained through the compounds electron structure. Gamess is a program that allows performing such computations for a compound. It takes an input file of a defined format and converts it into an output describing the molecule and the reaction. Chemcraft and Avogadro are another programs that take the output from Gamess and expresses it as a model. These programs show the optimized geometry energy levels and they fully determines the theoretical values of the structures atomic properties. These computational programs were used to complement each other to produce a result that is useful to see the outcomes.

W1.00027 Mechanical and Stability Analysis of the Hand Truck Using Physical and Numerical Calculations, DANIEL LEE, RICHARD KYUNG, Choice Research Group — As an alternative to a traditional forklift or tailgate loader, the hand truck serves as a quick and easy solution for lifting, carrying, and loading small materials as well as goods, using the principle of the lever to multiply forces. Today’s forklifts and hand trucks are lighter and easier to use. They also include features such as automatic uploading and brake devices. However, there are still many ways to improve hand trucks and make them more comfortable and efficient. Present research includes mechanical and stability analysis of the hand truck. To ensure structural stability and to figure out whether the internal forces in the materials are tensile or compressive, our research focused on setting up equilibrium equations and calculating the forces on each links and members of the hand truck. In addition, we presented an analytical method to determine the static forward, rear, and lateral stability of the hand truck on a tilting platform. The weight and dimension of the goods, along with the location of the center of gravity, were shown as the factors affecting the stability. The objective of the second part of the presented research was to determine the extent of the effect of load positions on the hand truck stability.

W1.00028 Bio-fluid Analysis in the Microfluidic Channels in the Organ-On-a-Chip Systems, JAEHYUK LIM, RICHARD KYUNG, Choice Research Group — Organ-on-a-chip (OOC) systems are microfluidic 3D models of human tissue and organs. This system allows stimulation of various biological and physiological mechanisms of the human body. The organ-on-a-chip system has displayed a strong potential for use in personalized medicine and drug screening. Such a breakthrough can substitute traditional methods such as the conventional planar and static cell cultures, and therefore, reduce the use of animal models. The organ-on-a-chip system replicates the function of the organ on a smaller scale, which not only reduces time and cost invested into experiments, but also produces better results. The organ-on-a-chip system is a valuable tool in further studying the functional properties, pathological states, and development of organs. This OOC system displays a laminar flow scheme. The laminar scheme has slow flow rate and higher fluid viscosity, resulting in a small Reynolds number. This paper assumes the laminar flow scheme from the small dimensions of the microfluidic cell culture chip. This study examines the flow of the microfluidic channels in the OOC systems, and the consequences of altering pressure and velocity in these channels.

W1.00029 Sound Speed and Chromatic Scales in Granular Materials, SYDNEY BLIN, ELI OWENS, Presbyterian College — Granular materials are collections of athermal, macroscopic particles that behave unlike other more traditional materials. In particular, sound propagation through granular materials is not well understood. For this study, we send sound through a uniform, granular material composed of airsoft BB’s. We then measure how the sound travels through the granular material with buried piezoelectric sensors. One important feature of a granular material is its speed of sound; which we measure by sending a pulse of sound through the granular material and recording the time delay between two piezoelectric sensors separated by 10 cm. We are then able to measure the time of flight and the sound speed. We repeat these sound speed measurements for different particle configuration and find that the distribution of sound speeds is consistent with prior measurements of interparticle force, confirming that the speed of sound scales with interparticle force. Additionally, we investigate the material’s response as we move through the musical chromatic scale. This work will lead to a better understanding of granular acoustics supporting the development of technology that utilizes granular acoustics for tasks such as non-destructive testing and probing of granular materials.

W1.00030 The Effect of Grain Shape on Confined Granular Flows, SALEM WRIGHT, ELLEN D’AMICO, ELI OWENS, Presbyterian College — Granular materials are collections of macroscopic particles, such as corn, rice, and peas. Grain silos store granular particles and are subjected to irregular force build-up, which can have catastrophic results. It has long been observed that the pressure at the bottom of a silo is screened as the silo is filled. We studied the force build-up on the side-walls of grain silos from materials of different aspect ratios, specifically corn, peas, and rice. The model silo used in the experiment was constructed out of sheet metal pipe 120 cm in length and 15 cm in diameter held in place by a frame constructed of 80/20 aluminum. Four force sensors were evenly spaced vertically at the bottom of the silo and used disks of sheet metal approximately 2.5 cm in diameter screwed into the sensors internal load cells to evenly distribute the applied force. The fill height was approximately 100 cm from the bottom of the silo. Our work found that rice exhibited more irregular force build-up than peas and corn. This work will allow us to better understand the behavior of confined granular flows with respect to grain shape and will provide insight into design methods for grain silos, as well as assist with understanding grain shapes effect on natural phenomena like avalanches.

W1.00031 Percolation Threshold from a Giant Subgraph of a Twitter Based Nodal Graph, KEITH ANDREW, MORGAN TAYLOR, PHILLIP WOMBLE, Physics and Astronomy, Western Kentucky University, KARLA ANDREW, Cyber Defense Laboratory, KAY OPALENIK, Information and Library Science, Southern Connecticut State University, CRAIG COBANE, Political Science, Western Kentucky University — We find the critical edge value $p$ which almost surely determines the percolation threshold for a minimal giant subgraph of a host graph $G$, using the Lu Subgraph Percolation Theorem for a Twitter based social media graph. We determine the linear time dependence of the exponent of the degree distribution function for the resulting giant subgraph. This time rate of change is compared to the rate of change for the corresponding centrality eigenvalues within the Giant Subgraph and to external edges that connect to nearby clusters. The greatest rates of change are coupled to the Parts of Speech (POS) Indicators for selected memes with topic specific verb and adjective bigrams. The differences between these values and the Percolation Centrality are used as indicators of graph activity and are modeled to generate a global graph entropy used to capture the large scale connected complexity of the graph. We explicitly calculate these values for the Twitter activity related to the example of information tweeted from topics on Banned Books for the Handmaids Tale and government focused cluster subgraphs in a Tweet-Retweet graph.
W1.00032 Efficient Coupling of Acoustic Power into Granular Materials, BRANDON MORROW, ELI OWENS, Presbyterian College — Granular materials are made up of a collection of distinct, macroscopic particles such as a pile of sand. When these particles are packed together, they create a heterogeneous distribution of forces inside the granular material. This heterogeneous force distribution is not very well understood, and contributes to non-linear, highly dissipative, sound propagation. In order to maximally couple sound into a granular material, we seek a coupling device to impendence match with the granular material. An example of a coupling device that works in air is the cone on a speaker. Current methods of probing granular materials involve sending high energy waves, where most of the energy is lost through dissipation. Finding a coupling device would allow deeper non-destructive probing at lower energy than currently available. To analyze the effects of each coupling device on the acoustic power, we buried piezoelectric sensors in sand to determine the amplitude directly below, and at an angle from the source. During our measurements, we swept the frequencies from 10Hz-10kHz in order to observe the effect of the coupling device on the amplitude at different frequencies within our system. This allowed us to find a coupling device that produces the highest amplitude for the lowest driving energy.

W1.00033 Design of the FIU Ion Propulsion Engine (FIPE), STEPHEN REYSEZ, None — Long duration space flights will at some point require an efficient engine to withstand the depths of space and time. Chemical rockets are the power house engines used to bring payloads into low-Earth orbit (LEO), maneuver satellites, and among other tasks. Another type of engine utilizes the electromagnetic forces of charged particles to create thrust instead of controlled explosions. These engines are dubbed ion or hall-effect thrusters. Both differ in their techniques for accelerating charged propellant gas by either using charged grids or orthogonal magnetic fields to couple particles as a pseudo-grid near the exhaust. For this research we focused on the ion or gridded acceleration method and set out on designing a thruster that utilizes easy construction and dismemberment in outer space. An important part of this research was on the materials that were to be used for constructing a model of the engine for experimentation and examination of its efficiency. The design is also described in detail by CAD drawings of the final design of the engine. The engine is the first to be designed and eventually built at Florida International University and thus is named the FIU Ion Propulsion Engine (FIPE).

W1.00034 The role of the dynamic plasmapause in outer radiation belt electron flux enhancement and three-belt structure formation, MARGIE BRUFF, University of North Carolina at Chapel Hill, ALLISON JANYES, University of Iowa, HONG ZHAO, Lab for Atmospheric and Space Physics, Boulder CO — Plasma waves inside and outside the Earth’s plasmasphere can lead to loss or acceleration of high energy outer radiation belt electrons. Early studies found an apparent correlation on long time scales between the observed inner edge of the outer radiation belt and the simulated innermost plasmapause location. Recent work using high resolution satellite data has revealed a more complex relationship. The aim of this project was to provide a systematic study of the dynamics of the plasmapause compared to the outer belt MeV electrons. We used REPT electron flux and EFW derived density data from the Van Allen Probes. We found that the location of peak flux was consistently outside the innermost location of the plasmapause at enhancement times, with an average standoff distance $\Delta L = 1.0 \pm 0.5$. This is consistent with current chorus enhancement models and previous chorus wave observations. We also identified “three-belt” structure events where a second outer belt formed. We found a repeated pattern of plasmapause dynamics associated with specific changes in electron flux required to generate and sustain these structures. This study is significant toward understanding how the plasmasphere under differing conditions can shield Earth from or worsen the impacts of geomagnetic activity.

W1.00035 Polymeter Construction for Measurement of Polarization in GRBs, ROARK HABEGGER, DAN REICHART, Univ of NC - Chapel Hill — The purpose of this project is to construct an autonomous polarimeter and attach it to an also autonomous telescope at Cerro Tololo Inter-American Observatory in the Chilean Andes. The polymeter consists of two half-wave plates and two beam-splitting cubes, one for each of V and I band polarimetry. Eight pictures (four polarization angles times two cameras) are acquired and processed for each polarization measurement. Once integrated with the telescope, the instrument will automatically slew to Gamma-Ray Bursts (GRBs) localized by NASA’s Swift spacecraft, and make polarization measurements in both bands. This will allow us to confirm that GRBs are driven by strong, and highly ordered, magnetic fields in their first few minutes.

W1.00036 Examining Harmonic Motion in TeachSpins Torsional Oscillator (TO1-A), APRIL GARRITY, ALEXANDER JÖYCE, SETHFIELD SMITH, Francis Marion University — TeachSpins Torsional Oscillator (TO1-A) was used to conduct a variety of experiments related to harmonic motion. Various aspects of this were investigated, including the phase relationship between motion and angular velocity, the dependence of the period of oscillation on the moment of inertia by adding brass quadrants, and the independence of tension on period of oscillation by adjusting the torsion constant of the wire. This device can be used for further experiments including magnetic torque, damping, and driven oscillations.

W1.00037 Subjective Dilation-Time, FLORENTIN SMARANDACHE, University of New Mexico — For two observers, in two moving referential frames at different speeds, each one sees a time dilation different from the other time dilation (or time-dilation symmetry). But these are clearly subjective time dilations, not an objective time dilation. These symmetric time dilations cannot be simultaneously done in practice; it is absurd. The proponents of the Theory of Relativity assert that the so-called black hole is so powerful, that even the time itself is brought to a stop. But this looks very much as science fiction, since the objective time goes on anyway.

W1.00038 Laser Interferometry and Precision Measurements, NICHOLAS TOMLINSON, ARDEN LESLEY, MICHAEL DOUCETTE, DR. R. S. SMITH, Francis Marion University — A basic Michelson Interferometer was built using a 633 nanometer Helium-Neon Laser along with mirrors, a beamsplitter and a photodiode detector placed on the optical breadboard of a Newtonian Labs Laser Interferometry apparatus. One of the mirrors contains a Piezoelectric Transducer that is used to move the mirror with an applied voltage. Electronic signals output from the apparatus were analyzed using a Tektronix TBS 1052B 50 MHz 1GS/s Dual Channel Digital Oscilloscope. Various methods were utilized to determine the minimum displacement that the interferometer could measure. Results on the order of a picometer were obtained.

W1.00039 Below Threshold Dielectric Recombination for $B^{2+}$ and $C^{2+}$, A. B. NEMER, S. D. LOCH, M. S. PINZDOLA, Auburn University — Below threshold dielectric recombination is investigated for $e^+ + B^{2+}(1s^22s^22p^3d) + B^+(1s^22p^5d)$ and for $e^+ + C^{2+}(1s^22s^22p^6) + C^+(1s^22s2p5d)$. Relativistic atomic structure (GRASP) calculations are used to calculate energies and wavefunctions. Relativistic distorted-wave (AUTOSTRUCTURE) calculations are used to calculate radiative and autoionization rates. The dielectric recombination rate coefficients were then used to make a synthetic spectrum for use in plasma diagnostics. Photoionized cold plasma temperature and abundance diagnostics are chiefly important for astrophysical applications that currently suffer from vast discrepancies.
W1.00040 Double Ionization of He using UV and IR Laser Pulses\textsuperscript{1} , M. S. PINDZOLA, G. M. LAURENT, Auburn University, J. P. COLGAN, Los Alamos National Laboratory — A time-dependent close-coupling method is used to calculate the multiphoton double ionization of He using a combination of UV and IR laser pulses. Momentum space wavefunction densities, as well as single and triple differential probabilities, calculated for the two and three photon double ionization of He using a UV laser pulse are compared with those in the presence of an additional IR laser pulse.

\textsuperscript{1}Work supported in part by grants from NASA and DOE

W1.00041 Electron Impact Single and Double Ionization along the Fe Isonuclear Sequence\textsuperscript{1} , S. D. LOCH, M. S. PINDZOLA, Auburn University — Electron-impact single and double ionization cross sections for Fe, Fe+, Fe+2, Fe+3, and Fe+4 are calculated using a combination of perturbative distorted-wave and non-perturbative time-dependent close-coupling methods. The single ionization cross section includes contributions from outer subshell direct ionization and excitation-autoionization. The double ionization cross section includes contributions from direct double ionization as well as from inner subshell direct ionization and excitation-autoionization. The cross sections for single and double ionization are compared with crossed-beams measurements.

\textsuperscript{1}NASA and DOE

W1.00042 Using an Atomic Molecular Optics Laboratory for Undergraduate Research and Mentoring of Physics Students in Georgia , MATTHEW DALLAS, HAUKE BUSCH, Georgia College — An Atomic and Molecular Optical (AMO) Physics research lab is an excellent tool to train and mentor undergraduate students in advanced laboratory techniques. Students gain valuable basic experience in experimental designs, data acquisition techniques, working with high precision optical equipment, building electronics, and working in the machine shop. The current project is building and testing an enclosure for the diode laser to reduce sound and vibrational interference. In addition, we are developing and evaluating a new, more compact laser cavity which is 3D printed. Previously completed projects involved building a temperature controller, current supply circuit, machining the laser mount, milling the vacuum chamber mounts to support the chamber, and machining the Helmholtz coils for the chamber, which are being used to trap the atoms in a Magneto Optical Trap (MOT). This included designing, building, and baking out the vacuum chamber, constructing a trap for the Rb in the chamber, and building the lasers for a saturation-absorption system that is used to probe the 5\textsuperscript{2}S\textsubscript{1/2} \rightarrow 5\textsuperscript{2}P\textsubscript{1/2} hyperfine energy transitions of the Rb-85 atom. These energy transitions have been used to frequency-lock a diode laser to trap Rb-85 atoms and then cool them to ultra-low temperatures. The atom cooling will permit observation and measurement of the fundamental properties of atoms. This lab has mentored and supported over twelve undergraduate students in the last seven years, resulting in students becoming HS Teachers, and joining Ph.D. and engineering programs.

W1.00043 Magnetic field structure in laser photodetachment to the first excited state of the O atom\textsuperscript{1} , JOSEPH MARTIN, HANNAH THIGPEN, JOHN YUKICH, Davidson College — Photodetachment spectroscopy for ions such as S\textsuperscript{−} and O\textsuperscript{−} has been examined in previous experiments for detachment to the ground state of the neutral atom. In many of these experiments, structure in the cross section due to Zeeman and cyclotron transitions has been resolved. Our current experiment examines a transition to the first excited state of the O neutral in an attempt to detect similar cyclotron and Zeeman structure. The apparatus in the experiment includes a Penning ion trap which creates, traps and stores the O\textsuperscript{−} ions, and a single-mode, tunable, amplified diode laser. Although the overall transition is much weaker than transitions to the ground state of the neutral, we have observed cyclotron structure in detachment to the 3\textsuperscript{P}\textsubscript{1} excited state. It is anticipated that analysis of the data will yield a measurement of the 2\textsuperscript{P}\textsubscript{1/2} \rightarrow 3\textsuperscript{P}\textsubscript{1} electronic transition energy.

\textsuperscript{1}Work supported by Davidson College and the American Chemical Society Petroleum Research Fund

W1.00044 Spatiotemporal Properties of Solid State Harmonics\textsuperscript{1} , CHRISTOPHER ABADIE, MENGXI WU, METTE GAARDE, Louisiana State University - Baton Rouge — As shown by recent experiments, high-order harmonics can be generated in a transparent crystal by a high intensity infrared laser beam. We investigate the spatial and temporal properties of such harmonics by calculating the harmonic spectrum at many different points in space spanning the laser focus and then transforming to the far field. Each harmonic spectrum is calculated by solving the time-dependent Schrödinger equation for an electron in a periodic potential to find the laser-driven electron current that gives rise to the harmonic radiation. We find two distinct contributions to the harmonic radiation in the far-field distribution, and by using a spatial filter we isolate the central contribution. After performing a back-transformation to the near-field, we find that the filtered integrated spectrum is much cleaner than the original as it shows stronger peaks at odd harmonics. We find that the spatial filter also works as a temporal filter, so that the sub-cycle harmonic time profile after filtering is dominated by one burst of light per half-cycle of the laser field. Our results suggest that many of the techniques used to control the spatiotemporal properties of high order harmonics from gases can also be applied to harmonics from solids.

\textsuperscript{1}National Science Foundation Grant No. PHY-1403236

W1.00045 A novel algorithm for Velocity Map Imaging systems\textsuperscript{1} , GEOFFREY HARRISON, JOHN VAUGHAN, BROCK HIDLE, GUILLAUME MARC LAURENT, Auburn University — In this work, we report a novel algorithm to reconstruct the three-dimensional (3D) momentum space picture of any charged particles collected with a Velocity Map Imaging system from the two-dimensional (2D) projected image captured by a detector.\textsuperscript{2} The method uses the proper analytical two-dimensional projection function to retrieve the 3D distribution. The meaningful angle-correlated information is first extracted from the raw data by expanding the 2D image with a complete set of Legendre polynomials. Both the particle’s angular and energy distributions are then retrieved from the expansion coefficients. The algorithm is simple, easy to implant, fast, and does not require any initial guess for the 3D distribution. In addition, our procedure explicitly takes into account the pixelization effect in the measurement.\textsuperscript{3}

\textsuperscript{1}This work was supported by the Chemical Sciences, Geosciences and Biosciences Division, Office of Basic Energy Sciences, Office of Science, US Department of Energy and the National Science Foundation under Grant No. DE-SC0017984


\textsuperscript{3}G. Harrison, J. Vaughan, B. Hidle, and G. M. Laurent, A simple algorithm for Velocity Map Imaging system, submitted
W1.00046 Microprocessor-based control system for cooling and trapping $^6$Li atoms

LEVI SALYARDS, JONATHAN JEFFREY, Georgia Inst of Tech, ANDREW S. BLOUNT, The Pennsylvania State University, YUN LONG, COLIN PARKER, Georgia Inst of Tech — We present an electronic control system for laser cooling and trapping experiments. The system is responsible for all signal generation and timing used to generate a magneto-optical trap (MOT) of $^6$Li, and for subsequent optical trapping and imaging. Our system is capable of driving acousto-optical modulators (AOMs), controlling magnetic fields, stabilizing laser intensities, and operating cameras, all of which are synchronized to a sub-microsecond interval. This improves upon other systems by incorporating a feedback element to the AOM (which allows laser intensity stabilization), by centralizing control to one computer, and by allowing simultaneous adjustment of all devices in the control system. Having a centralized control system permits us to both manage the atomic trap and physically, manipulate the beam from a single computer. Our control system is realized by pairing a microprocessor with each electronic device, allowing the user to tune system parameters quickly and efficiently. Communicating with the microprocessors is a two-step process. We first use TCP/IP communications to transmit to an Ethernet-capable microprocessor, which then uses serial UART communications to disseminate commands to the individual devices. Finally, we have developed a user interface that streamlines the process of controlling an experiment and removes the need for users to program a sequence.

A.S.B. acknowledges support from the NSF REU Program under DMR-1560165.

W1.00047 The Hyperfine Structure of Rubidium

FABIOLA DIAZ, CHARLES HARRILL, MARY MULLHOLLAND, DR. R. SETFIELD SMITH, Francis Marion University — An external cavity diode laser (ECDL) was used to provide a very narrow range of laser wavelengths near 780 nm in order to study the structure of rubidium (Rb). The absorption spectrum of Rb was measured. This spectrum was subject to Doppler-broadening of the spectral lines. A technique known as Saturated Absorption Spectroscopy was employed to eliminate the effects of Doppler-broadening and to obtain a high resolution spectrum for Rubidium. The setup, operation, and performance of this system was described.

W1.00048 Plasmon tuning via the conductivity tensor

MORGAN LABALLE, MAXIM DURACH, Georgia Southern University — Metallic structures with corrugated surfaces have applications in a variety of research areas. As these structures are very important, it is essential that their properties be well understood. However, the solutions to Maxwell’s Equations in corrugated structures are difficult to determine. Thus, an alternative, simpler approach to solving this structure would be very advantageous. We have developed such an approach by modeling the corrugated surface as a thin film with an optical conductivity. When light is incident upon a metal-air interface, the electromagnetic fields are able to form a surface plasmon wave that possesses a shorter wavelength than light in free space. Our model’s boundary conditions allow us to describe the k-vector of the wave with the film’s optical conductivity. After a thorough investigation of the dependence of the k-vector on this conductivity, we have determined that the k-vector can take values greater than or equal to zero. Those values correspond to various tuned plasmon waves. By matching one of these waves with those produced in experiments, we are able to more fully investigate the properties of corrugated metal-dielectric interfaces.

W1.00049 Solar Spectral Irradiance and Surface Ozone Changes at Carrollton, Georgia during the Great American Eclipse on August 21, 2017

CHARLES ZANDER, University of West Georgia, K. TENNAKONE, Department of Physics and Astronomy, Georgia State University, AJITH DESILVA, Department of Physics, University of West Georgia, SHEA ROSE, Department of Geosciences, University of West Georgia, AUSTIN KERLIN, Department of Physics, University of West Georgia — Measurements of solar spectral irradiance and surface ozone at the University of West Georgia, Carrollton, during the Great American eclipse on August 21$^{st}$, 2017, indicated changes in spectral irradiance and ozone surface concentration. The integrated spectral irradiance in defined wavelength ranges in the ultraviolet (300 – 390 nm) and visible (391 – 700 nm) reached a minimum at the maximum obscuration (~95%) of the sun, whereas in an infrared range (701 – 1040 nm) reached a maximum. The method of analysis of observational data vividly displayed this effect originating mainly due to limb darkening. In the surface ozone measurement, a minimum in ozone concentration occurred thirty minutes after the instant of maximum obscuration. The observation is explained as a result of the kinetics of photo-chemical creation of ozone and its photo-chemical and non-photochemical degradation.

W1.00050 Analytic Solution to a Three-Level Optical Pumping System with Constant Coefficients

WILLIAM DULANEY, TYLER DULA, JULIA HINDS, Appalachian State Univ — In the process of developing a new senior-level laboratory experience in atomic phosphorescence, a lack of consistency has been noted in the literature for the room-temperature radiative lifetime associated with the emission of the R-lines of Cr$^{3+}$ in ruby. Much of the existing work on the metastable $^2$E term that gives rise to the R-lines focuses on the fluorescence decay of these lines. Here the excitation of the metastable population as a function of time is investigated to supplement an understanding of these radiative transitions. In an attempt to identify an appropriate parent population for the metastable terms during the excitation phase, the dynamical system is approximated as three-energy levels in Cr$^{3+}$ in ruby: a ground state, a “pump” excited state, and a metastable state. Assuming a constant optical pumping rate and natural decay rates for the pump and metastable energy levels, three coupled first-order, linear, differential equations have been deduced for the observed population dynamics for the three states in response to optical excitation. The analytical and numerical solutions of these equations are presented here with preliminary comparisons to experimental data for the radiative excitation and de-excitation of the metastable levels in Cr$^{3+}$ in Ruby.

W1.00051 Absolute cross section measurements using relative pressure in a gas cell for 1.0 – 5.0 keV argon.

STEVEN BROMLEY, DANIEL FOX, CHAD SOSOLIK, JIM HARRISS, JOAN MARLER, Clemson Univ — As a benchmark for theoretical studies on charge exchange interactions, we measured the charge exchange cross sections of interactions between fast ions and neutrals. A Bayard-Alpert gauge in the high vacuum regime provides relative pressure measurement of the injected target gas. Utilizing the beam attenuation method in the gas cell, we present absolute charge exchange cross sections for the interaction Ar$^+$ + Ar in the energy range 1.0–5.0 keV consistent with other published work. Future experiments will use the gas cell for measuring singly and highly charged ion-neutral cross sections and producing high energy neutral beams with particle flux between 18 – 85 x 10$^{10}$ s$^{-1}$.

W1.00052 Transfer of Momenta from Chiral SPP’s onto Electrons

MIGUEL RANGEL, None — In recent discovery, it is known that the plasmonic drag effect is due to the absorption of momentum from the surface plasmon polariton [SPP] and its transfer to electronic metal plasma, which leads to current. Similarly, one could expect that absorption of angular momentum of light should lead to circular currents. We believe that the most convenient structure to study this absorption of SPP angular momentum and the corresponding currents is metal nanowires. To find the chiral currents induced by propagation of chiral SPPs in metal nanowires, we will solve the corresponding Maxwell’s equations in this structure and using this electromagnetic field distribution, we have found the forces acting on electrons and the resulting currents. After considering the multiple different modes of propagation in a 1D optical wave, we have found the transfer of momentum per unit time from the plasmonic fields onto the electrons in the wire.
Manuscript title: W1.00053 Progress Towards Charge Exchange with Highly Charged Ions

Clemson Univ, STEVE BROMLEY, CHAD SOSOLIK, JOAN MARLER, Clemson University — Highly charged ions (HCIs) are an integral component of atomic and molecular physics, in part because their compressed size and strong electric fields make them relevant to various areas of study, including quantum electrodynamics (QED). In addition, HCIs are often formed in conditions of extreme temperature or pressure, such as those found in astrophysics. These characteristics of HCIs increase the difficulty of HCI production in a laboratory setting compared to singly charged ions or neutral atoms, making HCIs less explored than other phenomena. Using HCIs created at the Clemson University Electron Beam Ion Trap (CUBIT), we will study interactions between highly charged ions and neutral particles. A gas cell has been constructed in order to measure charge exchange cross-sections of these interactions. Results from measurements made with the gas cell will be presented along with ideas for further development of the system. These studies on HCIs will assist in studies pertaining to QED and astrophysics, and will also result in additional understanding of the structure and nature of HCIs themselves.

1 EPSCoR/IDeA program

Manuscript title: W1.00054 Kinetics and Possible Mechanism of Photoinduced Optical Effects in Germanium Selenide Thin Films

U.S. Naval Academy, UCHENNA UBEH, JOE BERSSON, TAMARA ISAACS-SMITH, MICHAEL BOZACK, SARIT DHAR, RYAN COMES, Auburn University, KYLE NOORDHOEK, JIAN LIU, Univ of Tennessee, Knoxville — Magnetic frustration is an important phenomenon that challenge the fundamental theory of how spins should be aligned in a crystal lattice structure. To study this phenomenon further, a compound that exhibits this kind of frustrated lattice has been synthesized. While interesting magnetic properties are seen in a repeating pattern of corner sharing triangles that is difficult to produce in a laboratory setting and more difficult to find in the natural world.

Manuscript title: W1.00055 Probing Surface Defects and Electronic Reconstruction on Nb-Doped SrTiO₃ Substrates

Auburn University, WILL BOWERS, Auburn University, PATRICK GEMPERLINE, Xavier University, PATRICK GEMPERLINE, Xavier University, KAREL PALKA, MIROSLAV VLCEK, University of Pardubice, ROMAN GOLOVCHAK, ANDRIY KOVALSKIY, Austin Peay State Univ, UNIVERSITY OF PARDUBICE RESEARCH TEAM TEAM, AUSTIN PEAY STATE UNIVERSITY GLASS TEAM TEAM — Thin films of chalcogenide glasses are attractive materials for various optical applications due to their transparency in IR region, high refractive index and numerous photoinduced optical effects. In order to fully take advantage of these unique properties the mechanisms of light interaction with the glassy matrix and in-situ time dependent behavior of structure and optical properties under irradiation must be further studied. Thermally evaporated films of GeSe₂ were prepared and their photoinduced kinetics were studied as a function of temperature and incident wavelength. It was found that the films underwent both transient and non-transient changes in the optical transmittance. Non-transient changes manifested as photo-bleaching while transient changes manifested as photodarkening. Furthermore, the changes were found to follow a stretched exponential curve. The quantitative kinetic parameters, tau and beta, as well as the index of refraction, of the photoinduced optical changes have been evaluated and related to the different mechanisms of the photostructural transformations.

1 NSF grant DMR-1409160

Manuscript title: W1.00056 The Required Response of a Surface Current of a Superconducting Sphere to an External Magnetic Monopole - found via an Analytical Extension of the Method of Images

Eric Steinfelds, Keith Andrew, Western Kentucky University — Although magnetic monopoles have been highly elusive from discovery, it has not been possible to dismiss the existence of magnetic monopoles (i.e., ‘monopoles’) on quantum and classical grounds. One way to measure sensitive to detect obscure monopoles of the microscopic scale. In service to these efforts in basic science, we show a potential advantage in using superconductive spheroids to detect magnetic monopoles. Such round detectors are to be of microscopic or nanoscopic scale. When a monopole travels close to one of these detecting spheres, a Meisner (Ms') surface current will form and increase as the monopole approaches. This escalation of Ms' current can be detected either with sensitive ammeter based electronic monitoring of the sphere or by subtle R.F. wave detections of the R.F. waves which are generated consequentially to the escalated currents. We have formulated to 1st and 2nd order precision the response of Ms' surface current on such a superconducting detection sphere to an external Magnetic Monopole. We used an analytical extension of the method of images compounded with the satisfying of the so called No-“Flux” Boundary Condition, which is used by academic engineers for heat transfer [1].

[1] Online lecture material from Dartmouth College; Thayer School of Engineering of Dartmouth College; Course: “ENGS 43: Environmental Transport and Fate”, taught by B. Cushman-Roisin; http://thayer.dartmouth.edu/d30345d/courses/engs43

Manuscript title: W1.00057 Synthesis and Observation of 2-Dimensional Frustration in a Tripod Kagome Lattice

Auburn University, KYLE NOORDHOEK, JIAN LIU, Univ of Tennessee, Knoxville — Magnetic frustration is an important phenomenon that challenge the fundamental theory of how spins should be aligned in a crystal lattice structure. To study this phenomenon further, our group plans to synthesize a new family of compounds that exhibit frustration in a tripod kagome lattice. This lattice is comprised of a repeating pattern of corner sharing triangles that is difficult to produce in a laboratory setting and more difficult to find in the natural world. However recently, a compound that exhibits this kind of frustrated lattice has been synthesized. While interesting magnetic properties are seen in polycrystalline samples, a single crystalline sample is necessary for fully exploiting the two-dimensional magnetic interactions. Thus, we explore the possibility of growing epitaxial thin films and heterostructures by Pulsed Laser Deposition (PLD). To begin, we will first be growing a layer of (YTO) onto a Yttria-Stabilized Zirconia (YSZ) substrate. We have experimented with this growth already using a range of temperatures above 700°C, only after having treated the YSZ substrates. In addition to these beginning growths, we have also begun treatment of the YTO crystal which involves the polishing of the crystal with a specialized lubricant. This is done to produce the flattest possible surface in which we can grow our final film on. Lastly, we have been able to calculate the lattice parameter of the corresponding YTO crystal. Throughout the processes, the topography of the samples is being monitored using the Atomic Force Microscope (AFM) while the phase is monitored using X-ray Powder Diffraction (XRD).

1 EPSCoR/IDeA program
Spectral threshold extended photoresponse in asymmetrical p-GaAs/AlGaAs heterostructure-based infrared detectors. Dilip Chauhan, A. G. Unil Perera, Department of Physics and Astronomy, Georgia State University, Atlanta, Georgia, 30303, USA, Lianhe Li, Li Chen, Edmund H. Linfield, School of Electronic and Electrical Engineering, University of Leeds, Leeds LS2 9JT, United Kingdom — The spectral photoresponse threshold $\lambda_0$ of a semiconductor photodetector is conventionally determined by $\lambda_0 = h c / \Delta$, where $\Delta$ is the minimum energy gap of a material, or the interfacial energy gap of a heterostructure. In addition, the $\Delta$ at the material interface is the key parameter to determine the dark current and noise levels of the detector. Therefore, lowering the $\Delta$ to detect longer spectral region will have a trade-off with increased noise levels.

Here, we present infrared detection in very-long-wavelength infrared (VLWIR) in a detector designed with a $\Delta$ for mid-infrared (MIR) region, in p-GaAs/AlGaAs heterostructures. Specifically, a detector designed with $\Delta = 0.40$ eV ($\lambda_0 = 3.1$ m) showed an extended wavelength threshold up to 68 m, 45 m, and 60 m, under positive, zero, and negative biases respectively, at 5.3K. The dark current, however, was seen to correspond to $\Delta = 0.40$ eV, which was confirmed by a fitting obtained using a 3D carrier drift model.

This work was supported in part by the U.S. Army Research Office under Grant No. W911 NF-15-1-0018, and in part by National Science Foundation (NSF) under Grant No. ECCS-1232184.

Salt-Assisted Ultrasonicated De-aggregation and Advanced Electrochemistry of Detonation Nanodiamond. Sanju Gupta, B. Evans, A. Henson, Western Kentucky University — Nanoparticles in dry powder state form agglomerates thus reducing surface energy and accessibility of diamond core impacting technological advancement. In this work, we investigated a facile, cost-effective and contaminant-free salt-assisted ultrasonic de-agglomeration method for detonation nanodiamond, NDs. Utilizing ultrasound energy to break apart two different sourced and thermally treated nanodiamond mesoscale aggregates in sodium chloride and sodium acetate salts, this technique produced aqueous slurry of isolated or single-digit (<10 nm) stable colloidal dispersions by virtue of ionic interactions and electrostatic destabilization. Moreover, the technique is well-suited for materials engineering (composites, lubricants) and biomedical (bio-labeling, biosensing) applications. We characterized microscopic structure and performed advanced electrochemistry by immobilizing processed NDs on boron-doped diamond to study surface redox chemistry, determine surface potential (or Fermi level), carrier density and to image electrocatalytic activity by scanning electrochemical microscopy and the results are compared to those untreated aggregated nanodiamond particles. The findings are discussed in terms of surface functionality and defect sites that give rise to surface states within bandgap. These surface states may serve as electron donors (or acceptors) depending upon bonding (or antibonding) character suitable for various electrocatalytic redox processes.

Nanoparticles-grafted functionalized graphene coated with nanostructured polyaniline layered nanocomposites for high-performance biosensors. Sanju Gupta, R. Meeke, Western Kentucky University, Bowling Green, KY 42101 — The challenge remains to develop (chemical, electrochemical and biological) sensors from nanocomposites with broader electrical conductivity, molecular sensitivity and specificity. We report the design and synthesis of scalable, metal nanoparticles-grafted functionalized graphene overcoat with nanostructured polyaniline nanocomposites and elucidate their high-performance as advanced biosensors. The versatility of the nanocomposite performance was corroborated by altering the size, area density and morphology of electropolymerized gold and silver nanoparticles (NPs) on the nitrogenated functionalized graphene (NFG) as well as the density of electropolymerized polyaniline (PANI) onto NFG. Gold and silver NPs are selected due to their higher electrical conductivity, facile synthesis, easier processability and scalability. The critical modification of architectures (NFG/Au or AuNP/PANI) on FTO electrodes increased the conductivity of the electrodes significantly and reduced the charge transfer resistance dramatically while investigating electrochemical properties. The high-performance biosensing application is demonstrated for the detection of ascorbic acid (AA) over electroactive components interfering species commonly found in blood serum samples, with enhanced sensitivity over a range of detection thereby determining limit of detection. These nanocomposites are applicable for electrocatalysis, energy systems as well as enriching biofuel cell development.

Binary gas mixture in a high speed channel. Dr. Sahadev Pradhan, Chemical Technology Division, Bhabha Atomic Research Centre, Mumbai- 400085 — The viscous, compressible flow in a 2D wall-bounded channel, with bottom wall moving in the positive $x-$ direction, simulated using the direct simulation Monte Carlo (DSMC) method, has been used as a test bed for examining different aspects of flow phenomenon and separation performance of a binary gas mixture at Mach number $Ma = (U_{w} / \sqrt{\gamma k_B T_{w}} / m)$ in the range $0.1 < Ma < 30$, and Knudsen number $Kn = 1/\sqrt{\gamma (2 \pi m k_B T_w)^{3/2} \sqrt{\pi d^2 n_d H}}$ in the range $0.1 < Kn < 10$. The generalized angular spectral reflectance calculation which includes the fifth order differential equation for the boundary layer at the channel wall in terms of master potential $\chi$, is derived from the equations of motion in a 2D rectangular $(x-y)$ coordinate. The starting point of the analytical model is the Navier-Stokes, mass, momentum and energy conservation equations in the $(x-y)$ coordinate, where $x$ and $y$ are the streamwise and wall-normal directions, respectively. The linearization approximation is used (Pradhan & Kumaran, J. Fluid Mech -2011; (Kumaran & Pradhan, J. Fluid Mech -2013)), where the equations of motion are truncated at linear order in the velocity and pressure perturbations to the base flow, which is an isothermal compressible Couette flow. Additional assumptions in the analytical model include high aspect ratio ($L >> H$), constant temperature in the base state (isothermal condition), and low Reynolds number (laminar flow). The analytical solutions are compared with direct simulation Monte Carlo (DSMC) simulations and found good agreement (with a difference of less than 10%), provided the boundary conditions are accurately incorporated in the analytical solution.

Multiphonon Raman spectroscopy and optical properties for graphene-family nanomaterials: Role of surface functionality on electronic and phonon density of states. B. Evans, A. Henson, R. Meeke, Western Kentucky University, Physics Dept. Bowling Green, KY, N. Dimakis, Department of Physics, The University of Texas-Rio Grande Valley, TX 78539 — We report optical and lattice vibrational properties of a range of graphene-family nanomaterials using UV-visible absorption, photoluminescence excitation, PLE and micro-Raman spectroscopy (RS) techniques. Various functionalized graphene nanomaterials include few layer graphene oxide, reduced graphene oxide, graphene quantum dots and three-dimensional graphene aerogel scaffolds and their nitroglycerine derived counterparts. RS provides a powerful technique for probing the electronic, optical and vibrational properties of graphene-family nanomaterials. Dynamic nanoscale structural characterization revealing collective atomic/molecular motions and localized vibrations. The role of oxygen epoxy ($\sigma$-O-C, carbonyl, C=O) and nitrogen (pyridinic and graphitic/pyrrolic) functionalities and corresponding bonding configurations with quantum size effects are emphasized in view of understanding physico-chemical properties for biosensing and water desalination. While first- and second-order phonon modes are analyzed in terms of Raman intensity, band position (intrinsitic mechanical strain) and intensity ratio (structural disorder, number defect density), distinct localized $\pi$ electronic states were found in PLE spectra reflecting carbon atoms around oxygenated and nitrogenated species. The origin of these states is discussed based on experimental findings and DFT exemplifying structural evolution.
W1.00063 Enhancement of Thermoelectric Performance of Lead Chalcogenides: PbTe, PbSe and PbS, Due To Temperature Dependent Light and Heavy Hole Valence Band Convergence.1 KAPILA WIJAYARATNE, J. ZHAO, Univ of Virginia, C. MALLIAKAS, Northwestern Univ, U. CHATTERJEE, Univ of Virginia — Among many other interesting properties, Lead Chalcogenides are known for their remarkable thermoelectric performance. We have conducted temperature dependent Angle Resolved Photoemission Spectroscopy (ARPES) study of the electronic structures of Lead Chalcogenides, PbTe, PbSe and PbS. Our observations provide direct evidence for the existence of light-hole upper valence bands and so far undetected heavy-hole lower valence bands in these materials. An unusual temperature dependent relative movement between these bands was detected. This movement leads to a monotonic decrease in the energy separation between their maxima with the increase of temperature. This phenomenon is referred to as band convergence and is believed to be the driving factor behind extraordinary thermoelectric performances of Lead Chalcogenides at elevated temperatures.

1Supported by NSF, DOE and the Jefferson Trust at University of Virginia

W1.00064 Preparing Attractomically Flat Substrates for Oxide Film Synthesis1, KEVIN KLEINER, CLAYTON FREDERICK, JIAN LIU, University of Tennessee Knoxville — Substrates with Perovskite oxide structures (A0B2O3) provide a useful base surface for growing artificial oxide layers through pulsed laser deposition (PLD). As-received substrate crystal pieces (10 x 5 x 0.5 mm3) start with mixed termination as well as rough and possibly contaminated surface structures, but certain laboratory procedures can clean and treat the substrate to prepare for growth. This methodology has been applied to SrTiO3 (001) (STO), NdGaO3 (001) (NGO), GdScO3 (001) (GSO), and TbScO3 (001) (TSO) substrates, and the resulting surface maps are analyzed at the micron level using atomic force microscopy (AFM). The results reveal that extended air annealing (temperatures > 1,000°C) most effectively removes terrace roughness and renders the step heights close to 0.4 nm for each substrate. Once the films are synthesized on a treated substrate, their unique electrical, magnetic, and functional properties can be studied with further experiments.

1University of Tennessee Knoxville Department of Physics and Astronomy

W1.00065 Shining X-Ray Light on the Volume Collapse Phenomenon of Cerium Metal, BRANDON SCOGGINS, Department of Physics, University of North Georgia, BILUAN CHEN, YANG DING, Center for High Pressure Science and Technology Advanced Research, CHENG-CHIEN CHEN, Department of Physics, University of Alabama at Birmingham — Elemental rare-earth metals exhibit intriguing properties arising from strong correlation effects due to partially filled f-electron shells. Of particular interest is the volume collapse phenomenon observed under high pressure conditions. In this study, we perform calculations including hybridization effects and atomic multiplet interactions to model recent high-pressure X-ray Raman measurements on Ce metals. We find that the X-ray measurement after the volume collapse is compatible with a Kondo screening scenario. However, direct 4f-4f hopping in the Mott-Hubbard model also provides a small screening channel.

W1.00066 Algebraically Determining Rigid Unit Modes1, SHAE MACHLUS, Florida State University — Application-critical properties of crystals are often either inhibited or permitted by rigid unit modes (RUM’s). RUM’s are tilting patterns in crystal lattices that displace atoms, and they signify structural phase transitions between polymorphs of a given crystal. Previous efforts have been made to identify RUM’s in several important materials classes. Strategies have been employed such as ball-and-string simulations, phonon-frequency calculations, and trial-and-error searches. But no methodology has been as simple or exhaustive as the algebraic approach developed by Prof. Branton Campbell’s group at Brigham Young University during the past year.

1NSF Grant: PHY-1431454

W1.00067 Cadmium Telluride Solar Cell Simulations Using SCAPS, RYLAN GORDON, SPENCER SHORTT, HASITHA MAHABADUGE, Georgia Collage & State University — The most prevalent thin-film solar cell in industrial production is the cadmium telluride (CdTe) Solar Cell. The role of cadmium sulfide (CdS) as the n-type buffer layer in CdTe solar cells is well studied. However, CdS limits the transmission of photons due to its higher bandgap. The work done in this project investigates the possibility of replacing CdS with magnesium doped zinc oxide. We simulated the effect of the optimal ratio of elemental composition, thickness of the layer, and the doping level, on efficiency of the solar cell, using SCAPS, a one dimensional, efficieent solar cell simulator [1]. The simulation results and plans for the experimental study will be presented. [1] M. Burgelman, P. Nollet and S. Degrave, “Modelling polycrystalline semiconductor solar cells”, Thin Solid Films, 361-362, 527-532 (2000)

W1.00068 Multilayer photodetectors with different sized TiO 2 nanoparticles for highly efficient Dye Sensitized Solar Cells. ZACHARY PATTERSON-GOSS, University of West Georgia, K. H. HETTIARACHCHI, Rajarata University of Sri Lanka. L. DAVID BROOKS, LANDEWATTE DESILVA, University of West Georgia, T. M. W. J. BANDARA, Rajarata University of Sri Lanka — Dye Sensitized Solar cells (DSSCs) are low cost, ecofriendly emerging alternative to photovoltaics. We prepared a series of multilayered photo-anodes for DSSCs which contained different sized TiO 2 nanoparticles. The casting of thin films was done by incorporating of spin coating technique. In DSSCs, TiO 2 films were sensitized with N719 dye complex. Polyacrylonitrile thin films was done by incorporating of spin coating technique. In DSSCs, TiO 2 films were sensitized with N719 dye complex. Polyacrylonitrile — Application-critical properties of crystals are often either inhibited or permitted by rigid unit modes (RUM’s). RUM’s are tilting patterns in crystal lattices that displace atoms, and they signify structural phase transitions between polymorphs of a given crystal. Previous efforts have been made to identify RUM’s in several important materials classes. Strategies have been employed such as ball-and-string simulations, phonon-frequency calculations, and trial-and-error searches. But no methodology has been as simple or exhaustive as the algebraic approach developed by Prof. Branton Campbell’s group at Brigham Young University during the past year.

W1.00069 Properties of Quartic Mass Shells, THOMAS MULKEY, Georgia Southern University, MAXIM DURACH, Department of Physics, Georgia Southern University — If one compares different metamaterials from a common prospective, it appears that they can propagate a large variety of waves, depending on their individual properties. Specifically, one can control the shape of the mass shell for photons in the bulk metamaterials, modifying from the spherical shell to ellipsoidal and hyperbolic in hyperbolic metamaterials. Additionally, one can change the state of the photons by adding or combining birefringence and chirality. However, we are interested in an unknown material that supports photonic waves with a desired mass shell and desired spin state distribution over the mass shell. From this set of photonic waves, we can find a set of 36 material properties, which such a material should have. Of particular note are the unique mass shells characterized by multivariate quartic equations. These mass shells represent novel metamaterials, and will be the topic of discussion in this poster. The discussed properties of these mass shells include asymptotic behavior, K near zero behavior, and non-trivial photonic spin. Mapping these mass shells will assist in the direct engineering of metamaterials propagating the appropriate optical waves for various situations.

1College of Undergraduate Research, Georgia Southern University
W1.00070 Quantum Many-Body Theory: Tensor Network Approach and Applications to Information Compression

GEORGE DAVILA, EDUARDO MUCCIOLI, University of Central Florida — Tensor Networks may be used to describe the entanglement spectrum of Quantum Many-Body (QMB) systems in a manner which tells us about the entanglement between subsystems without loss of the description of the entire system. One such approach for 1D entanglement in gapped systems is the Matrix Product State (MPS) approach. While MPS-derived algorithms give us the entanglement spectrum for a QMB system, they similarly describe the singular value spectrum, corresponding to various patterns, in more general data sets. The MPS representation of any given set of data will therefore tell us about underlying structures in the data. Data sets which contain dominant patterns (i.e., localized subsystems) are compressible. Random sets (i.e., thermalized systems) are, to the contrary, incompressible. Not only can compressible systems be stored more compactly, but they also have a polynomial number of degrees of freedom and thus may be constructed (or deconstructed) via a finite quantum circuit array in polynomial time. Here we construct MPS representations for samples of DNA. We show that individual genes are relatively randomly structured and that one can exploit the properties of DNA so as to compress combinations of samples from multiple members of a given species.

W1.00071 Characterization of Magnetic Anisotropy in Pt/Co/MgO Thin Films

NOWSHERWAN SULTAN, Georgia College & State University, AASHISH SUBEDI, SAJIB SAHA, University of Nebraska, HASITHA MAHABADUGE, Georgia College & State University, SHIREEN ADENWALLAH, University of Nebraska — The anisotropy of a ferromagnet refers to the preferred direction of magnetization. Very thin films of Cobalt (Co) with thicknesses below about a nanometer display perpendicular magnetic anisotropy, a tendency for the magnetization to point out of the plane of the film. However, this is dependent on both the underlying seed layer and the capping overlayer. The anisotropy of Co films capped with MgO on Pt seed layers may be altered with thermal annealing. Here, we investigate changes in magnetic anisotropy as a function of the thickness of Cobalt and the effects of annealing. We find that both lower thicknesses of Cobalt and annealing shift the preferred magnetic anisotropy to the out of plane direction.

W1.00072 Experimental Studies of Transport Properties of Novel Amorphous Fe-Tb-Dy-O Thin Films

ALEXANDRA WATERS, TATIANA ALLEN, Univ of Tennessee, Chattanooga, HUMAIRA TAZ, RAMKI KALYANARAMAN, Univ of Tennessee, Knoxville — Novel amorphous material Fe-Tb-Dy-Oxide shows a remarkable combination of very high optical transparency, electrical conductivity, and Hall mobility. Material properties can be tuned by changing the R-value, the atomic ratio of iron to the two lanthanides, during the deposition. This makes the material a potential candidate for a wide range of applications in energy conversion, electronics, photonics, and spintronics. This work focuses on the transport properties of the samples with R-values between 6 and 12, which correspond to 8 - 14 % of lanthanides in the iron oxide matrix. Films were grown by ion beam evaporation, then some films were annealed in various environments. Electrical resistivity, Hall Effect, and magnetoresistance were measured in the Van-der-Pauw geometry at T=300 K in magnetic fields up to 13 kGs. The samples were heated to 700K, while resistivity and Hall Effect were monitored in-situ. After the samples cooled to T=300K, the transport properties were re-measured. This protocol was repeated for as long as the electrical contacts of a given sample remained linear. We will discuss the effect of the initial annealing on the sample properties as well as the evolution of the transport properties of as-deposited samples as a result of the thermal cycling.

W1.00073 Solution processed multilayers of Alq3 molecules and TiO2 nanoparticles for hybrid Bragg mirror

SARAHNA NAZARET, AMBER ETHERIDGE, AJITH DESILVA, Univ of West Georgia — Tris (8-hydroxy) quinoline aluminum (Alq3) is a small-molecule-based organic compound with a low index of refraction. It has been widely used as a superior material for organic light emitting diodes. Colloidal titanium dioxide (TiO2) is constructed of inorganic nanoparticles having a very high index of refraction. They have been commonly used in thin-film optics. Multilayer structures of Alq3 molecules and TiO2 nanoparticles are successfully fabricated from solution process and using spin coating techniques. A structure consisting of alternating organic/inorganic layers exhibited the properties of a distributed Bragg reflector (DBR). The peak of the reflectivity for the constructed DBR was chosen as 530 nm, at which the emission of Alq3 occurred. For this device, the reflectivity over 90% can be obtained with as few as five periods of the structure. Fabrication process and optical properties of the structure are presented.

1Financial support from following programs is acknowledged: Georgia-Alabama LSAMP, UWG SEEP Undergraduate Research and Mentoring Program and UWG SRAP.

W1.00074 Design of Graphene Oxide UV-cut filter with visible spectrum transmittance optimized via thin-film interference

JEREMY LOW, Univ of NC - Chapel Hill — The geometry dependence of transmittance spectra in Graphene Oxide films is shown by thin-film interference in the UV-Vis spectrum. This effect has been shown to increase transmittance of a desired wavelength in the visible spectrum while decreasing transmittance in the UV-Vis spectrum at one-half the original wavelength. This effect can be controlled across the UV-Vis spectrum by modifying the mean thickness across the GO film. Furthermore, it is shown that this can be utilized to design Graphene Oxide films that have high transmittance in the visible spectrum while blocking nearly 100% of UV radiation.

W1.00075 Kinetics Study of Photo-Induced Optical Effects in Solution-based Arsenic Selenide Thin Films

MARIA WHITE, JOSHUA ALLEN, JONATHAN BUNTON, BRYAN GAITHER, MEGAN MCCRACKEN, JUSTIN OELGOETZ, ROMAN GOLOVCHAK, ANDRIY KOVALSKIY, Austin Peay State University — Spin coated chalcogenide thin films have different structural and chemical properties than the films obtained by traditional methods such as thermal evaporation or sputtering. The solution-based method provides lower sensitivity of glass matrix to the influence of bandgap and superbandgap light. This property is very useful for non-linear optical applications based on high transparency of these materials in infrared spectral region. As2Se3 spin coated thin films were obtained by chemical dissolution of bulk arsenic selenide glasses in ethylenediamine. The influence of preparation conditions, especially the annealing temperatures at the final stage of thin films synthesis, on in-situ kinetics of photodarkening (bleaching) at various energies and intensities of UV-Vis light was studied. It was found that at certain annealing conditions only transient photoinduced effects can be obtained by eliminating metastable kinetic component.

1NSF RUI grant DMR-1409160 at Austin Peay State University, NASA Tennessee Space Grant Consortium, Lehigh University Collaborators Dr. H. Jain and T. Ignatova, and Austin Peay State University Physics Department for this opportunity.
W1.00076 Characterization and Modeling of Behavior of Metamaterials as Shielding Against Directed Energy Weapons¹, RICHARD MATTISH, Bob Jones University, DRAGOSLAV GRBOVIC, Naval Postgraduate School — In modern warfare, high-power microwave (HPM) weapons are a very real threat. Metamaterials, materials that gain their properties from their geometry or design rather than from their constituent materials, have unique absorption properties that can be tailored to desired frequencies. Our research makes use of finite element modeling as well as experimental measurements to evaluate the performance of various shield geometries constructed out of metamaterials as shields against microwave radiation. Special emphasis is given to using experimental measurements to refine and validate the finite element model so that we can accurately predict the performance of new shield geometries.

¹Funded by the Office of Naval Research

W1.00077 Studying Mechanical Resonance with a Michelson Interferometer¹, ARDEN LESLEY, MICHAEL DOUCETTE, SETH SMITH, Francis Marion University — A Michelson Interferometer was used to study mechanical resonance in a magneto-dynamically driven harmonic oscillator. One of the arms of the Michelson Interferometer was comprised of a mirror that was attached to the harmonic oscillator. As the oscillator vibrated, this caused changes in the interference by altering the path length difference between the interferometer’s arms. When the oscillator reached a resonant frequency, this caused large increases in the amplitude of the vibration. The dependence of the resonant frequency of the mass of the harmonic oscillator was measured and the results were compared to predictions from theory.

¹Francis Marion University Real Grant

W1.00078 Key Encryption Through Quantum Optics, MADISON DURRANCE, ZACHARY GALBERD, ABBEY SAVAGE, TRISTAN CABRERA, HAUKE BUSCH, Georgia College — Cryptography has been around since the dawn of human civilization to send private messages for commercial, military, and political purposes. Some of the most important ciphers are the Vigenère cipher, the enigma, and the more modern RSA. Because of the development of the internet, private encryption has also become increasingly more important. The weakest link of encryption is the key creation and key distribution. A key is needed to encrypt and decipher codes and is needed by both the user and sender. A solution to this problem is the generation of quantum key distributions. In our experiment, we are now trying to send and receive coded messages through photons after we build our quantum key distribution apparatus. The device will be secured against any form of eavesdropping because of the Heisenberg uncertainty principle. We will be able to know immediately if someone is listening in and if our key is compromised.

W1.00079 Imaging Laser-Excited Blue LEDs, RUIMING CHEN, COLLIN EPSTEIN, TIM GROERER, Davidson College, YONG ZHANG, University of North Carolina at Charlotte — Blue LEDs are known for their critical role in producing white light, since high-energy blue light is required to generate a spectrum of lower-energy light. In this experiment, we capture and analyze images of the optical emission from a blue LED under different temperatures and excitation conditions. Under non-uniform laser excitation, previous research has shown that light is emitted from areas without direct excitation. We call this phenomenon ELPE: Electro-Luminescence due to Photo-Excitation. Through further investigation, we find that LED drop (reduced device efficiency at high excitation) is only present in the ELPE from the non-excited area. At lower excitation levels, our theoretical model shows that heat loss is faster and more detrimental in the laser-excited region. These results provide important clues to the internal mechanisms that impede the performance of blue LEDs.

W1.00080 Concurrent MultiPhoton microscopy and Magnetic Resonance Imaging (COMPMRI)¹, REBECCA DITUSA, Cornell University — Functional/Magnetic Resonance Imaging (f/MRI) systems have aided in medical research through the use of large field-of-view (FOV) imaging. However, high resolution, small FOV imaging would enhance the ability to analyze systems on a smaller, cellular scale. Two-photon microscopy has been used for deep-image small FOVs without a surgical procedure but simultaneously achieving an MRI scan is difficult. Although scanning separately is achievable, it lacks the ability to definitively correlate events between scans due to the difference in time. In order to image a small and large FOV concurrently, a microscope constructed out of MRI-safe material is needed. To achieve this parameter, piezoelectric materials are used. They are MRI compatible and by using multiple orientations, motion in more than one dimension is possible.

¹This work was primarily supported by the Cornell Center for Materials Research with funding from the NSF MRSEC program (DMR-1120296).

W1.00081 Volumetric Visualization Of X-RAY Phase Contrast Computed Tomography. COLLIN EPSTEIN, Davidson College, Sandia National Laboratories, DANIEL BOYE, Davidson College, RYAN GOODNER, KYLE THOMPSON, AMBER DAGEL, Sandia National Laboratories — X-ray phase contrast imaging (XPCI) utilizes the wave properties of X-rays to create high-contrast radiographs of objects consisting of low-density materials that yield low-contrast, uninformative images. Combining XPCI with computed tomography (CT) enables the collection of high-contrast volumetric data of those low-density objects. We investigate the possibilities of rendering and examining the resulting data using three-dimensional (3D) visualization techniques and virtual reality (VR).

W1.00082 Application of New Low Cost Technology for 2d-Flow Bound Resonance Method for Measurement of Fluid Flow,¹, KEN MCGILL, ABIGAIL SAVAGE, AIDAN BURLESON, CAIN GANTT, JOSHUA MOORE, KYLE COOLEY, STEPHEN CAVE, Georgia College & State Univ — Proof of principle of the 2d-flow bound resonance method for measurement of fluid flow was established 2014. Devices employed for the measurement included 16 8-channel sample and hold Analog to Digital Converters (ADC), and 16 8-channel amplifiers. These devices were purchased in 2004. New devices available contain both the ADC and amplifier, and are available for much lower cost. The new devices are less defined for the application of 2d-flow bound resonance method for measurement of fluid flow. This presentation discusses the method for using current technology for 2d-flow bound resonance method for measurement of fluid flow.

¹GCSU

W1.00083 Refinement of Production Grade Biodiesel, KEN MCGILL, CAMPBELL AXT, SYDNEY NINNEMAN, ROBERT HUGHLY, JILLIAN TURNER, Georgia College & State Univ — The modified Burton method for the thermal hydrogen-cracking of peanut oil has been investigated in the McGill Research Group since 2009. The successful and reliable production of biodiesel has been achieved since 2014. A hydrocarbon with viscosity similar to Production Grade Diesel will work in modern diesel engines. The current product has a viscosity significantly lower than production grade diesel. The starting material has a viscosity significantly higher than Production Grade Diesel. Current research is investigating methodologies to mix starting material and product to achieve target viscosity.
W1.00084 Volumetric Radiography of Watermarks

- Ryan Stempert, Daniel Boye, Physics Department, Davidson College — We explore the use of the volumetric radiography provided by Digitome in viewing watermarks on paper that are not visible to the unaided eye. The Digitome process uses multiple 2D radiographs taken from different perspectives to generate a user-defined plane of view. The x-ray source has a broadband spectrum generated, typically, from a 40keV electron beam incident upon a tungsten target. Transmission radiographs are captured with a digital radiography plate in communication with a computer. A watermark is a thinner, less dense area within a sheet of paper created by the manufacturer and usually visible by holding the paper up to the light. However, when the paper is mounted to an opaque material, this practice becomes impossible unless the mounting is removed, which can result in damage to the paper. Often, mounted paper and paintings on wood or canvas are not flat. We employed the Extended Depth of Field ImageJ plugin to aid in viewing non-planar objects. By optimizing acquisition and imaging parameters, we are able to discern watermarks through upwards of 40 mils of opaque mounting material, even beneath a layer of text.

1Digitome is the registered trademark of the Digitome Corporation. We wish to thank Varex for use of the 2530HE digital imaging plate which made our low-energy exams possible.

W1.00085 Graphene-based novel formulations as large-area nanofiltration membranes and mesoporous capacitive deionization electrodes for water desalination

- A. Abdul-Hakim, B. Evans, S. Gupta, Western Kentucky University, Bowling Green, KY 42101 — In this work, we developed large-area nanofiltration membranes using 1) shear aligned discotic nematic phase of graphene oxide and 2) holey graphene with narrow hole size distribution via controlled catalytic oxidation. We also prepared interconnected network of mesoporous graphene-based electrodes to achieve optimal desalination during capacitive deionization (CDI) of brackish water, attributed to higher specific surface area, electrical conductivity, good wettability of water, environmentally safe, efficient pathways for ion and electron transportation, as potential successor of current filtration membranes. The pressure driven transport data on highly ordered, continuous, thin films of multi-layered graphene oxide and holey graphene is expected to demonstrate faster transport for salt water, higher retention for charged and uncharged organic probe molecules with hydrated radii above 5Å as well as modest retention of mono- and di-valent salts for 150 nm thick membranes. The highly ordered graphene nanosheets and nanoscaled porous graphene in the plane of the membrane make organized, molecule-hugging cylindrical and spherical channels, respectively, thus enhance the permeability and hydrodynamic conductivity. The results illustrate that both the macro and nanoscale pores are favorable for enhancing CDI performance by buffering ions to reduce the diffusion distance from external electrolyte to the interior surfaces and enlarging surface area.

1NASA KY EPSCoR, KSEF-RDE

W1.00086 Infinity to Mesoscopic Systems through Single Molecular Magnets

- Herry Abdul-Hakim, Faculty of Mechanical Engineering - University of Maranatha - Bandung, P. Swantoro, Former Vice President Director of PT. Kompas-Grmedia — Since mesoscopic evolve stochastic system, the infinites abuse can be prevented by took

W1.00087 Studying High-dimensional Supersymmetry Models with Neural Networks

- Alexander Karbo, Michelle Kuchera, Davidson College — This research project investigated the feasibility of using neural networks to more easily study high-dimensional supersymmetry models, using the phenomenological Minimal Supersymmetric Standard Model (pMSSM) as the test case. Facilities such as the Large Hadron Collider are currently conducting experiments to search for evidence of physics beyond the Standard Model (BSM); supersymmetry is one of these candidates. Direct methods of searching for evidence of supersymmetry models are intractable due to computational limitations. Bayesian Neural Networks (BNNs) were used to generate predictions directly from a point in the pMSSM parameter space without needing to simulate particle collisions. This work focused on predicting cross-sections resulting from 13TeV proton-proton collisions. The training data was generated fusing the SUSY-HIT and Prospino codes. Once trained, the BNN provides a function for high-energy physicists to more readily explore the parameter space of the pMSSM and other BSM models.

W1.00088 Magnetic Field Measurements for the Search for Mirror Matter

- Shaun Vavra, Ben Chance, Ben Ryzolt, Yuri Kamyshkov, Joshua Barrow, The University of Tennessee, Leah Broussard, Oak Ridge National Laboratory, Neutrino Oscillation Group team — The mirror matter hypothesis is a relatively new idea which extends the Standard Model with an exact copy of itself. Interactions with this new sector of matter are seldom, save for gravity; thus, it becomes a viable dark matter candidate. Mixing interactions between the two sectors can lead to neutral particle oscillations, including neutrinos, which can oscillate back and forth dependent upon magnetic strength and alignment. Thus, control of environmental magnetic fields is important to test for this novel theory and possibly infer the existence of a dark sector. Using modern, portable, inexpensive commercial hardware, and open source software, characterizations of the ambient magnetic field and preparations for a full-scale experiment are underway at the HFIR facility at ORNL. Our work is a crucial first step in the measurement of the magnetic fields pertinent to our future experiment. We hope to make full scale magnetic field control systems soon.

1Department of Energy-High Energy Physics
2Senior Undergraduate Researcher
3Senior Undergraduate Researcher
4Former Postdoctoral Fellow
5Professor of Physics
6Graduate Research Assistant
7Wigner Research Fellow
8UTK Division of High Energy Physics
W1.00089 Neutron-Antineutron Oscillation and Annihilation on C-12 at the European Spallation Source. CHARLES LADD, YURI KAMYSHKOV, BEN RYBOLT, JOSHUA BARROW, The University of Tennessee, ELENA GOLUBEVA, The Institute for Nuclear Research, Moscow, THE EUROPEAN SPALLATION SOURCE COLLABORATION — In the Standard Model, baryon and lepton number (B, L) are conserved. However, Sakkharov showed that in the early universe violation of B was a requirement to explain the matter-antimatter asymmetry. One type of B violation being focused on at the ESS is that of neutron-antineutron oscillation (n—→̅n), a ∆B = 2 process, thus showing that baryon number is not conserved. The ESS aims to search for n—→̅n at a soon-to-be constructed, high-intensity neutron beamline. There, if n—→̅n occurs, the neutron will travel down the beamline, oscillate into an antineutron, and hit a target of carbon nanofoil; this is similar to a previous search at the ILL in Grenoble. On this nanofoil, annihilation to mesons would occur with individual carbon nuclei, those mesons being collected on a high-resolution detector. Currently, MC data generation and analysis is underway for the ESS collaboration with the aid of E. Golubeva, hoping to properly model the appropriate nuclear interactions. For purposes of validation and verification, this work provides a detailed overview of antinucleon-antinucleon annihilation properties. It is important to study such generated data in order to make more definite predictions of the efficiency for the detection of n—→̅n.

1Department of Energy-High Energy Physics

W1.00090 3D Printing Plastic Scintillators, MADISON DURRANCE, NICOLAS MERINO, NOWHERWAN SULTAN, RALPH FRANCE, SHARON CARCECCIA, Georgia College & State University — We are continuing our work from last year of developing cost-effective 3D printed scintillators. There are various methods for manufacturing scintillators, but unfortunately many of these methods involve the costly machining of crystal materials. We plan to reduce this cost by attempting to manufacture plastic scintillators using a 3D printer. The challenges of this project are in printing completely transparent objects and successfully integrating an organic, scintillating molecule into plastic (T-Glase, a type of PET). We have had success in printing with PET filament, the same polyester used in disposable plastic bottles. Upon successful clear prints and efficient chemical doping of PET plastic with naphthalene, we intend to use recycled water bottles to manufacture our own scintillating fiber.

W1.00091 Sensitivity of stellar electron-capture rates to parent neutron number: A case study on a continuous chain of twenty Vanadium isotopes, G.W. HITTM, Department of Physics & Engineering Science, Coastal Carolina University, P.O. Box 261954 Conway, SC 29528, USA, S.S. GUPTA, Indian Institute of Technology Ropar, Nangal Road, Rupnagar (Ropar), Punjab 140 001, India, R.G.T. ZEGERS, R. TITUS, C. SULLIVAN, B. A. BROWN, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824, USA, A.L. COLE, Physics Department, Kalamazoo College, Kalamazoo, Michigan 49006, USA, S. SHAMS, Department of Applied Mathematics & Sciences, Khalifa University, Abu Dhabi 127788, UAE — Gamow-Teller (GT) strength distributions (B(GT)) in electron-capture (EC) daughters stemming from the parent ground state are computed with the shell-model in the full pf-shell space, with QRPA in the formalism of Krumlinde and Moller and with an Approximate Method for assigning an effective B(GT). These are compared to data available from decay and charge-exchange (CE) experiments across titanium isotopes in the pf-shell from A=43 to A=62, the largest set available for any chain of isotopes in the pf-shell. The present study is the first to examine B(GT) and the associated EC rates across a particular chain of isotopes with the purpose of examining rate sensitivities as neutron number increases. EC rates are also computed for a wide variety of stellar electron densities and temperatures providing concise estimates of the relative size of rate sensitivities for particular astrophysical scenarios. This work underscores the need for CE experiments in inverse kinematics on neutron-rich nuclei at future RIB Facilities.

W1.00092 Development of a CompCal Calorimeter for the eta-Primakoff Experiment at JLab, NICHOLAS STERLING, University of North Carolina Wilmington, GLUEX COLLABORATION — The eta-Primakoff experiment (E12-10-011) is aimed to perform a precise measurement of the eta radiative decay width via the Primakoff effect in Hall D to determine the light quark-mass ratio and the eta-antimeuon mixing angle. In addition to using the standard GlueX apparatus, a compact, high resolution electromagnetic calorimeter (CompCal) is being developed at the University of North Carolina to control the experimental systematic uncertainty by detecting the electron Compton scattering in parallel to the physics production. In order to investigate the possibility of adding a scintillating hodoscope in front of CompCal for the charged particle identification, I performed Monte Carlo simulations to study two primary quantities of interest, namely, the back splash from CompCal and the electromagnetic background rate. The result of this study will be presented.

1This project is supported by NSF PHY-1506303 award.
2undergraduate student

W1.00093 Unlocking Neutrinoless Double-Beta Decay through Radon Deposition, ANDREW DUNTON, University of South Carolina, MAJORANA COLLABORATION — In our universe, there is a preponderance of matter over antimatter. Neutrinoless double-beta decay would serve as a potential mechanism by which this phenomenon, called the asymmetry of matter and antimatter, occurs. In a single beta decay, a proton decays into a neutron and releases a beta particle (electron) and an electron neutrino. In a theoretical double-beta decay, two protons would decay, and two electrons would be released, but no neutrinos would be detected. This would mean the electron neutrino is its own antiparticle, a Majorana particle. In order to observe this phenomenon, one requires a large collection of nuclei, prone to beta decay far away from any potential sources of interference. Thus, the MAJORANA experiment consists of 40kg of Germanium buried undergrounded and encased in lead shielding. One of the potential background interference sources is alpha radiation from radon gas, which permeates the earth and air around us. Its interference levels in the first trial runs of the experiment were much higher than expected, and so reducing radon’s presence has become a priority. In order to do this, we must understand how it attaches itself to various materials and in various conditions, and how best to remove it.

W1.00094 Extraction of unpolarized TMD widths using collinearity criteria with HERMES multiplicities in semi-inclusive deep-inelastic scattering, MASON ALBRIGHT, Pennsylvania State University — Using a Gaussian ansatz for the transverse momentum dependence of unpolarized transverse momentum dependent (TMD) functions, we analyze HERMES multiplicities in semi-inclusive deep-inelastic scattering (SIDIS). We discuss the importance of data selection in constraining the fit, with, in particular, we implement for the first time new collinearity criteria that allow us to better separate the current and target fragmentation regions. We compare our parameters to previous extractions in order to better interpret our results. We also give an outlook on what impact this criterion can have on on-going and future experiments.

Friday, November 17, 2017 6:30PM - 7:00PM –
Session X1 SESAPS Awards, Poster Prize, Public Lecture, Banquet MSU Building Magnolia Ballroom - Liping Gan, University of North Carolina Wilmington
The proton and neutron, known as nucleons, are the fundamental building blocks of all atomic nuclei and make up essentially all the visible matter in the universe, including the stars, the planets, and us. The nucleon itself has a complex internal structure, and both theory and technology have now reached a point where human is capable of exploring the inner dynamics and structure of nucleons and nuclei at the sub-femtometer distance, which is expected to lead to a new emerging science of nuclear femtography. In this talk, I will demonstrate that the newly proposed Electron-Ion Collider (EIC) will be the most powerful tomographic scanner able to precisely image quarks and gluons inside the proton and nuclei. It is also a precision microscope that allows us to see and explore the dynamics binding quarks and gluons together to form hadrons. The EIC will address the most compelling unanswered questions about the elementary building blocks of the visible world to take us to the next frontier of the Standard Model of physics.