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Monday, March 10, 2008 11:15AM - 1:03PM –
Session B40 SPS: SPS Undergraduate Research and Outreach I Morial Convention Center 232

11:15AM B40.00001 Summer 2007: My SPS intern experience and working with ComPADRE[1] ANDREW COUGHLIN, Society of Physics Students — For the summer of 2007 I was enrolled in the Society of Physics Students Internship program hosted by the American Institute of Physics in College Park, Maryland. My time at was spend working for the American Physical Society outreach department. My primary task was to expand and maintain Physicstogo.com which is part of the ComPADRE group of outreach websites funded by the National Science Foundation. More specifically, I searched for materials to add to the website, cataloged citation information, and updated the biweekly magazine portion of the website. Work experience was not the only thing gained from this internship. As a group of 8 interns we attended an event on Capitol Hill, met with members of congress, and toured nearly every monument and museum in the area. The 2007 SPS internship was an amazing opportunity and a summer memory that will remain with me for the rest of my life.

[1]Society of Physics Students

11:27AM B40.00002 Demonstrating Levitation and Suspension of a Superconductor on a Magnetic Track[1] , CHARLES P. STREHLOW, M.C. SULLIVAN, Ithaca College — The suspension and levitation of superconductors by permanent magnets is one of the most fascinating consequences of superconductivity, and a wonderful instrument for generating interest in low temperature physics. We present a novel classroom demonstration of the levitation/suspension of a superconductor over a magnetic track that maximizes levitation/suspension time, separation distance between the magnetic track and superconductor as well as insulator aesthetics. A theoretical explanation of the levitation/suspension and a simple mathematical model of the lateral restoring forces are discussed.

[1]Supported by NSF Grant DMR-0706557.

11:39AM B40.00003 Comprehensive study on deformation of metal samples based on measurements of temperature, in-plane displacement and stress-strain characteristics , JOHN GAFFNEY, CHRISTOPHER SCHNEIDER, SANICHIRO YOSHIDA, Southeastern Louisiana University — We have studied the dynamics of deformation of metal samples. Our efforts are directed at finding some correlation between the stage of deformation (elastic, plastic, pre-fracturing stage, etc) and changes in properties of the sample such as the change in temperature across the surface, the stress strain characteristics, and the in-plain displacement on the sample surface. To study this, we simultaneously applied three independent data collection systems; a tensile machine to obtain the stress strain curve, an optical interferometer to study both the vertical and horizontal displacement of the surface, and two thermistors to obtain a continuous temperature reading as the sample deformed. With two thermistors, we were able to study how the temperature changed in different locations on the surface of the sample.

11:51AM B40.00004 Low-temperature calorimeter for magnetocaloric-effect measurements in high magnetic fields , TRAVIS MILLER[1], YASUMASA TAKANO, University of Florida — The magnetocaloric effect, in which sweeping a magnetic field results in a temperature variation, is a powerful tool for detecting phase transitions in magnetic samples. The effect is particularly useful near the zero-temperature limit where a transition line becomes horizontal in the field-temperature phase diagram, a temperature region in which specific heat fails to exhibit sharp anomaly at the transition. At temperatures below 200 mK, however, eddy current heating produces a temperature background that becomes relative in magnitude to the temperature change of genuine features, seriously limiting sensitivity. This causes numerous problems in trying to extracting clear data. We describe a new calorimeter design which overcomes this problem in experiments using a dilution refrigerator in magnetic fields up to 20 T.

[1]Funded by The University Scholars Program at The University of Florida.

12:03PM B40.00005 Driven Intrinsic Localized Modes in a Coupled Pendulum Array. , RITOBAN BASU THAKUR, Dickinson College, LARS ENGLISH, ALBERT SIEVERS, Cornell University, DICKINSON COLLEGE, PHYSICS TEAM — Intrinsic localized modes (ILMs), also called discrete breathers, are directly generated via modulational instability in an array of coupled pendulums. These ILMs can be stabilized over a range of driver frequencies and amplitudes. They are characterized by a π-phase difference between their center and wings. At higher driver frequencies, these ILMs are observed to disintegrate via a pulsating instability, and the mechanism of this breather instability is investigated.

12:15PM B40.00006 Quartz tuning fork as a viscometer for Helium liquids[1] , J. JHAVERI, M. GONZALEZ, P. BHUPATHI, Y. LEE, Department of Physics, University of Florida, Gainesville, FL 32611-8440 — Oscillating beams serve as simple systems for measuring effects of energy dissipation as a result of interaction with their environment. Especially in miniature mechanical oscillators, the enhanced surface-to-volume ratio signifies the importance of damping caused by drag force. We have investigated the mechanical response of commercial miniature quartz tuning forks with a natural resonant frequency of 32.768 kHz. The changes in resonance frequency and damping have been measured at various Helium and Nitrogen gas pressures and various temperatures. Our results will be compared with theoretical predictions in order to extend its application to the sub-millikelvin temperature range as an effective thermometer in superfluid ^{3}He.

[1]This work is supported by NSF grant no. DMR-0239483 and University Scholars Fellowship at University of Florida (J.J).

12:27PM B40.00007 Demonstrating the Principle of an rf Paul Ion Trap , ANDREW JOHNSON, JAMES RABCHUK, Western Illinois University — An rf ion trap uses a time-varying electric field to trap charged ions. This is useful in applications related to quantum computing and mass spectroscopy. There are several mechanical devices described in the literature which have attempted to provide illustrative demonstrations of the principle of rf ion traps, including a mechanically-rotating "saddle trap" and the vertically-driven, inverted pendulum[1,2]. Neither demonstration, however, successfully demonstrates BOTH the sinusoidal variation in the electric potential of the rf trap AND the parametric stability of the ions in the trap described by Mathieu's equation. We have modified a design of a one-dimensional ponderomotive trap[3] so that it satisfies both criteria for demonstrating the principle of an rf Paul trap. Our studies indicate that trapping stability is highly sensitive to fluxuations in the driving frequency. Results from the demonstration apparatus constructed by the authors will be presented. [1] Rueckner, W., et al., "Rotating saddle Paul trap," Am. J. Phys., 63 (2), February 1995. [2] Friedman, M.H., et al., "The inverted pendulum: A mechanical analogue of a quadrupole mass filter," Am. J. Phys., 50 (10), October 1982. [3] Johnson, A.K. and Rabchuk, J.A., "A One-Dimensional Ponderomotive Trap," ISAAPT 2007 spring meeting, WIU, March 30, 2007.

12:39PM B40.00008 Experimental characterization of piezoelectric THUNDER actuator shape , PAUL HARRIS — A new type of piezoelectric composite actuator called THUNDER, which was originally developed by NASA, has potential applications in micro robotics, aeronautics, acoustics and hydraulics. The manufacturing process produces internal stresses with accompanying structural deformation. It is the aim of this research to characterize these deformations. Detailed measurements were taken by a motion control LabView data acquisition system and measured with a laser micrometer on several different types of actuators. Several functional forms were used in an attempt to fit the data. The data was best fit by a circular segment function. We also used a transcendental equation to be able to compare to other single point published values. We found the range of dome heights to be between 10.15 mm and 1.45 mm. For one particular model, the manufacturing difference was found to be 16% with an experimental error of 0.5%. The robust experimental data is vital to the development of our finite elements models. Preliminary experimental results of voltage induced deformations will be presented.

12:51PM B40.00009 A Relativistic Understanding of Rotating Reference Frames , KACEY MEAKER, TOM MICHALIK, Randolph College (founded as Randolph-Macon Woman's College) — The purpose of this research is to obtain a greater understanding of relativistic acceleration and rotation. Particles in a rod experiencing constant acceleration have hyperbolic worldlines. A simple global rigid rotating frame cannot be physically realized, because the force needed to maintain an object in circular motion approaches infinity. This understanding will be discussed in this presentation.

Monday, March 10, 2008 2:30PM - 5:30PM –

Session D40 SPS DBP: SPS Undergraduate Research and Outreach II Morial Convention Center 232

2:30PM D40.00001 Oxide Reliability of SiC MOSFETs[1] , ENRIQUE CARRION, Student, MOSHE GURFINKEL, JOHN SUEHLE — SiC is one of the materials that presents the most promise for harsh environment electronics. Its ability to operate under high temperature and high power, as well as under radiation, made it the material of choice for this study. SiC MOSFETs constitute an important step towards the development of the next generation of resistant electronics. The eventual industrial manufacturing of this type of field effect transistor depends on the effectiveness to improve its performance. Currently, a sudden current degradation, and an unsatisfactory low mobility are observed during the operation of these devices. In this work, we studied both of these drawbacks as a function of temperature. The devices used were SiC nMOSFETs with a SiO_2 oxide. Two types of measurements (ultra fast and conventional) were performed during this experience in order to observe 8 decades of current degradation. From our experience, it was observed that as the temperature was lowered the threshold voltage (V_{TH}) increased, while the mobility and the drain current (I_D) decreased.

[1]National Institute of Standards and Technology

2:42PM D40.00002 X-ray degradation studies of Nafion in a PEM fuel cell , REBECCA JENKINS, JUAN FRAGOSO — The overall goal of this research is to test for degradation of the Polymer Electrolyte Membrane (PEM) fuel cells due to exposure to ionizing radiation. We have successfully developed a Membrane Electrode Assembly (MEA) that can be fully disassembled down to the bare Proton Exchange Membrane (PEM) and reassembled repeatedly. This is crucial for testing the degradation effects on the individual components of the MEA. It was also important to establish baseline repeatability of the polarization curves of the MEAs. Therefore, we systematically varied different parameters to test their effect as well as to establish consistent experimental procedures. Hydration of the fuel cell has been found to be crucial for repeatable results. These polarization curves showed voltages that ranged from 0.4V to 1.0V and current densities up to 11mA/cm2. The Nafion can then be exposed to an x-ray source and the respective polarization data can be studied. A working fuel cell has also been built that fits into the microwave cavity of an electron paramagnetic resonance spectrometer. This allows for study of in situ behavior of free radicals formed in a normal operational fuel cell as well as fuel cells with x-ray exposed membranes.

2:54PM D40.00003 Polymer Nanocomposite Gyroids[1] , CHRIS KNOROWSKI, Virginia Tech, JOSHUA ANDERSON, ALEX TRAVESSET, Iowa State University and Ames Laboratory — Self-assembled polymer phases are increasingly being used in the development of nanocomposite materials. The polymer matrix provides a template for nanoparticles added to the system, transferring the structure of the polymer to the nanoparticles. We perform Molecular Dynamics simulations of these polymer nanocomposite materials and characterize their phase diagrams. Two striking results are found. First, a specific interaction of the polymer and the nanoparticles is required for a successful templating. Second, the presence of nanoparticles can change the pure polymer phase entirely. For instance, a small nanoparticle concentration turns a polymer system from a hexagonal phase into a gyroid phase, both for the polymers and the nanoparticles. In fact, the gyroid is the most prevalent phase over a wide range of interaction strengths and polymer composition.

[1]This work is supported by DOE contract no. DE-AC02-07CH11358 and NSF grant DMR-0426597

3:06PM D40.00004 Sol-gel synthesis and characterization of terbium doped tin-oxide[1] , REBECCA SOBEL, CHRISTIE LAROCHELLE, Franklin and Marshall College — Rare earth doped tin oxide nanocrystals emit visible light when excited in the ultra-violet. Using a sol-gel process, we embedded Tb^{3+} doped SnO_2 nanocrystals in silica glass and characterized the samples using x-ray diffraction, photoexcitation and emission spectroscopy, and transmission electron microscopy. We synthesized four sets of samples, SnO_2-$99SiO_2$, $3SnO_2$-$97SiO_2$, $5SnO_2$-$95SiO_2$, $7SnO_2$-$93SiO_2$ with constant weight ratios of Tb^{3+} to measure the effects of varying the molar concentrations of Tin-Oxide on the photoluminescence properties of the nanocrystals.

[1]Franklin and Marshall College

3:18PM D40.00005 Generation of 279nm Light for Single Photon Ionization of Laser Cooled Rubidium , LUCAS WILLIS, MICHAEL LIM, Rowan University — The ionization of rubidium for the formation of ultracold plasma is often done by a two photon process; a 479nm photon ionizes the rubidium from an excited state pumped by the 780nm trapping beams. We detail the generation and characterization of this 297nm light from a Nd:YAG pumped dye laser and a tracking doubling crystal. Supported by Rowan University College of Liberal Arts and Sciences, Research Corporation grant CC6180 and NSF grant PHY-0613659.

3:30PM D40.00006 Bio-Photonic Detection of Various Cellular Cultures , PATRICK HANN, MARIA GARZON, ERIK PFEIFFER, SAMUEL LOFLAND, ERNST KNOESEL, Rowan University — Since it is non-invasive, there has been increased research in the field of bio-optics. Many biological systems display an unusual phenomenon, delayed luminescence, produced by what is known as bio-photons. We present an apparatus and procedure for the detection of these ultra-weak photonic emissions using a single photon detection device. The results of bread yeast, saccramyces, and algae will be presented and compared to other reports in the literature

3:42PM D40.00007 Epitaxial Thin Film Growth of CMR Manganites on Silicon: The Effect of Thermal Stress , SANJAY ADHIKARI, BAO HA, GRACE YONG, DAVID SCHAEFER, RAJESWARI KOLAGANI, Towson University — Our research addresses some of the challenges associated with growing epitaxial thin films of the CMR manganite material, $Nd_{1-x}Sr_xMnO_3$ (NSMO) on Silicon for application as a bolometric x-ray sensor. Due to the chemical incompatibility between NSMO and Silicon, the formation of amorphous SiO_2 and crystal lattice mismatch issues, 'buffer layers' and 'template layers' of other suitable materials need to be interposed between NSMO and the Silicon substrate. Even with such schemes in place, there exists a mismatch between the thermal expansion coefficients of Silicon (α_{Si}=2.618×$10^{-6}K^{-1}$ at 300K) and NSMO (α_{NSMO} ∼3×$10^{-5}K^{-1}$). This large mismatch induces thermal stresses that deteriorate the film properties. Our research investigates how the thermal stress evolves as a function of the thickness of the multi-layers, and how the process parameters such as the film growth kinetics and thermal kinetics can be optimized to minimize the stress. We are using the Pulsed Laser Deposition technique for thin film growth and characterizing the properties of the sensor layer using X-ray diffraction, electrical resistance measurements, optical microscopy and atomic force microscopy. Acknowledgement: We acknowledge support for this research from Lawrence Livermore National Laboratory.

3:54PM D40.00008 Synthesis and Characterization of CrAlC Thin Films , JUAN ROCHE, JEFFREY HETTINGER, SAMUEL LOFLAND , Rowan University, TED SCABAROZI, Drexel University — We have synthesized and characterized Cr2AlC thin films grown on substrates Al2O3, MgO and seed layers of VC, and TiC at room temperature up to 850°C. Texture films were successfully grown above 550°C while Raman spectroscopy shows vibrations down to 500°C. Films below 500°C down to room temperature show texturing upon annealing at 750°C. The films were prepared using RF magnetron sputtering from elemental targets. Electrical transport shows metallic behavior of the films down to 10 K. EDS was used to verify chemistry from which the MA ratios were found that a slight deviation still allowed formation of the MAX phase. X-ray diffraction shows that when the chemistry is off it results in secondary phases of Cr26C6 and Cr2Al. Atomic Force Microscopy (AFM) shows smoother films at lower temperatures and rough at higher temperatures with a surface roughness $>$ 20 nm. Friction test results will be presented.

4:06PM D40.00009 Spatially resolved quasiparticle tunneling spectra in the vortex state of optimally hole-doped $YBa_2Cu_3O_x$ (Y-123) , M.S. GRINOLDS, A.D. BEYER, M.L. TEAGUE, N.-C. YEH, Phys. Dept., Caltech, Pasadena, CA — We report cryogenic scanning tunneling spectroscopic (STS) studies of superconducting single crystalline Y-123 (T_c = 93 K) as a function of magnetic field. We study and model the influence of competing orders (COs), which coexist with superconductivity (SC), on the quasiparticle (QP) excitation spectra. The spatial dependence of the QP tunneling spectra is probed via STS to quantify the presence and spatial extent of SC and CO. Zero-field spatial maps of the QP spectra (100×100 nm^2) in Y-123 exhibit long-range spatial homogeneity of SC (Δ_{SC}= 23±1 meV) associated with the spectral coherence peaks and the presence of CO (V_{CO}= 33±2 meV) that gives rise to the spectral satellite features at $\Delta_{eff} = [(\Delta_{SC})^2+(V_{CO})^2]^{1/2}$. Conductance maps of the Y-123 in finite fields demonstrate spatially varying spectra consistent with the periodicity a_0 of the vortex lattice, with pseudogap (PG) like features at ∼V_{CO} inside the vortex core and SC gap features remaining at ∼ Δ_{SC} outside the vortex core. Moreover, conductance histograms of the vortex state reveal that the ratio of the areas associated with Δ_{SC} and V_{CO} is comparable to $(a_0/\xi_{ab})^2$, (ξ_{ab}: in-plane SC coherence length). These results therefore suggest the important role of COs in the cuprate QP excitations. This work is supported by NSF Grant DMR-0405088.

4:18PM D40.00010 High Frequency Electrical Properties of Carbon Nanotubes[1] , DOBROMIR KAMBUROV, BETH PARKS, Colgate University, ZHAOHUI ZHONG, PAUL MCEUEN, Cornell University — We report on measurements of the high frequency electrical properties of single-walled carbon nanotubes. These measurements are accomplished by incorporating a single nanotube into a microwave stripline and using optical pulses from a femtosecond laser to create short electrical pulses on the stripline. By varying the time delay between the pulses, it is possible to determine the frequency dependence of the response of the nanotube.

[1]This work was supported by the NSF through the Center for Nanoscale Systems. Sample fabrication was performed at the Cornell Nanoscale Science and Technology Facility, a National Nanotechnology Infrastructure Network node, funded by NSF.

4:30PM D40.00011 Current State of Research of Alternate Fuel Sources for Passenger Vehicles[1] , LEE MASSEY, University of Wisconsin at River Falls — The purpose of this project is to report on the current state of research in the field of alternate fuel sources for passenger vehicles. Because the number of alternate fuel options is very large, this study focuses on selected bio-fuels and briefly describes a couple of the most popular non-bio and non-renewable alternatives. The fuel and energy sources studied are compared using well-to-wheel and well-to-tank net energy balances. Data also includes relative production capabilities by volume in terms of current fossil fuels. Qualitative data includes production methods and transportability.

[1]Research funded by APS Fellowship in the Forum on Physics and Society.

4:42PM D40.00012 Universal Properties of Population Dynamics with Fluctuating Resources , SAYAK MUKHERJEE, Virginia Tech, HANS-KARL JANSSEN, Heinrich-Heine-Universitat, Dusseldrof, BEATE SCHMITTMANN, Virginia Tech — Starting from the well-known field theory for directed percolation, we describe an evolving population, near extinction, in an environment with its own nontrivial spatio-temporal dynamics. Here, we consider the special case where the environment follows a simple relaxational (Model A) dynamics. Two new operators emerge, with upper critical dimension of four, which couple the two theories in a nontrivial way. While the Wilson-Fisher fixed point remains completely unaffected, a mismatch of time scales destabilizes the usual DP fixed point, suggesting a crossover to a first order transition from the active (surviving) to the inactive (extinct) state.

4:54PM D40.00013 First-principles density-functional theory investigation of FOX-7 , BRIAN VOHASKA, MICHAEL CONROY, IVAN OLEYNIK, University of South Florida, CARTER WHITE, Naval Research Laboratory — Due to the expense and difficulty of experimental investigation of the chemical and physical properties of energetic materials (EMs), computational methods provide a unique opportunity for accurate determination of the chemical and physical properties of EM molecular crystals based on underlying atomic structure. In this presentation, we discuss the results of first-principles density functional theory (DFT) calculations of hydrostatic and uniaxial compression of the important energetic material, FOX-7. The calculated equilibrium properties, such as lattice parameters, elastic constants, and the bulk modulus will be reported and compared with experiment, as well as the isothermal equation of state. Due to the anisotropic nature of energetic molecular crystals, physical properties such as cohesive energy, band gap, and stress-strain relationships are reported as functions of each uniaxial compression studied. In addition, the shear stress behavior upon uniaxial compression will be discussed, as well as its possible relation to anisotropic shock-sensitivity in FOX-7.

5:06PM D40.00014 Variational Wavefunction Monte Carlo method applied to electrons in a two dimensional square lattice with zero doping , SUNITA KANNAN, COURTNEY LANNERT, Wellesley College — We present the theoretical results from the Variational Wavefunction Monte Carlo method applied to electrons in cuprates, of a two dimensional square lattice with zero doping. Since the true Hamiltonian of the cuprates is not definitively known, much study has gone into identifying the best possible Hamiltonian. To do this, we vary the terms in the Extended Heisenberg Hamiltonian - the neighbor spin coupling term J, the spin next-neighbor term J' and the spin ring exchange term Jring, where each variation represents a different electronic interaction. We then use the variational approach to find the best groundstate wavefunction for each model Hamiltonian. Once we find the best groundstate wavefunction for each Hamiltonian, we can deduce the magnetization predicted by that model. Hence, by comparing our results for the magnetization to known experimental results, we can identify the most suitable model.

5:18PM D40.00015 Quantum Criticality and Neutron Scattering Solutions for a Spin-1/2 Ladder Model[1] , JUSTIN COHEN, JEREMIAH BARRY, MARK MEISEL, University of Florida — Exact solutions for a two dimensional, $S = 1/2$ quantum spin ladder model are obtained through mapping the Hamiltonian and correlation functions onto those of a one dimensional Ising chain model [1]. These solutions include a three dimensional ground state phase diagram, establishing states of ladder rung singlets, triplets, and alternating singlets and triplets in terms of interaction parameters and applied magnetic field. Evidence of quantum criticality is uncovered for select regions of the phase diagram through explorations into ladder site correlations and correlation lengths. Neutron scattering solutions for scattering intensities provide insight into the energy spectra associated with various rung spin configurations.
[1] J. H. Barry and M. W. Meisel, *Phys. Rev. B* **58**, 3129 (1998).

[1]This work was supported, in part, by the National Science Foundation via DMR-0701400 and grants for the NHMFL and UF Physics REU Summer 2007 Programs.