Friday, October 23, 2009 12:30PM - 2:00PM –
Session A1 Opening/Plenary Session I Green Center Metals Hall

12:30PM A1.00001 Welcome Remarks BILL FAIRBANK, Colorado State University —

12:38PM A1.00002 Mines, Physics and the Energy Dilemma , JOHN POATE, Vice-President for Research and Technology Transfer, Colorado School of Mines — .

12:48PM A1.00003 Environmental Impacts of a Shrinking Arctic Sea Ice Cover , MARK C. SERREZE[1], University of Colorado at Boulder — Arctic sea ice extent at the end of the summer melt season has declined sharply over the period of satellite observations and is projected to disappear entirely as concentrations of atmospheric greenhouse gases continue to rise. The extreme seasonal ice extent minima of September 2007 and 2008 serve as exclamation points on the downward trend and have fueled concern that rapid transition to a seasonally ice-free state may be imminent. While the factors forcing this trend have and will continue to be widely studied, less attention has been paid to the environmental impacts of current and future sea ice loss. Ice loss is already promoting increased wave action and coastal erosion and is resulting in strong rises in atmospheric temperature during autumn, not just at and near the surface, but extending through a considerable depth of the atmosphere. Through atmospheric transports, this strong warming, known as Arctic amplification, is starting to extend well beyond areas of ice loss, and will eventually influence Arctic land areas, glaciers, ice caps and the Greenland ice sheet. Though altering horizontal temperature gradients, continued loss of the ice cover is in turn likely to impact on patterns of atmospheric circulation and precipitation not just within the Arctic, but into middle latitudes. This talk addresses these and other emerging environmental impacts of Arctic sea ice loss.

[1]Director, National Snow and Ice Data Center, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder. CO.

1:24PM A1.00004 Quantum-Mechanical Combinatorial Design of Solids with Target Properties[1] , ALEX ZUNGER, National Renewable Energy Laboratory — One of the most striking aspects of solid-state physics is the diversity of structural forms in which crystals appear in Nature. The already rich repertoire of such (equilibrium) forms has recently been significantly enriched by the advent of artificial growth techniques (MBE, STM- atom positioning, etc) that can create desired structural forms, such as superlattices and geometric atomic clusters even in defiance of the rules of equilibrium thermodynamics. As is well known, different atomic configurations generally lead to different physical properties even at fixed chemical composition. While the most widely-known illustration of such "form controls function" rule is the dramatically different color, conductivity and hardness of the allotropical forms of pure carbon, the physics of semiconductor superstructures and nanostructures is full of striking examples of how optical, magnetic and transport properties depend sensitively on atomic configuration (e.g, compare the properties of random to ordered alloys). Yet, the history of material research generally proceeded via accidental discoveries of materials configuration with interesting physical property (semiconductivity, ferromagnetism; superconductivity etc). Given the ability of growing many different atomic configurations, and given the often sensitive dependence of physical properties on atomic configuration, makes one wonder: can one first articulate the desired target physical property, then search (within a class) for the configuration that has this property? This talk describes the recent steps made by solid-state theory and computational physics to address this "Inverse Design" problem. I will show how Genetic Algorithms, in combination with efficient ("Order N") solutions to the Pseudopotential Schrödinger equation allow us to investigate astronomical spaces of atomic configurations in search of the structure with a target physical problem. Only a small fraction of all ($\sim 10^{14}$ in our case) configurations need to be examined. Examples will include Band-Gap design in superlattices; architecture of impurity-clusters with desired optical properties, and Inverse Design of the Curie temperature in dilute magnetic systems.

[1]This work was performed in collaboration with A. Franceschetti, P. Piquini, S. Duidy.

Friday, October 23, 2009 2:10PM - 3:10PM –
Session B1 Astroparticle Symposium I: VHE Gamma Rays 1 Green Center 210N

2:10PM B1.00001 VERITAS observation of the E>200GeV gamma ray sky , STEPHAN LEBOHEC, University of Utah, VERITAS COLLABORATION — VERITAS is an array of four 12-m diameter imaging atmospheric Cherekov telescopes located in southern Arizona. The array has been in full operation since Fall 2007 and is sensitive to very high energy gamma-rays above 100 GeV. VERITAS has been used to detect new sources of TeV emission, such as the blazars 1ES 0806+524, RGB J0710+591 and W Comae and to study many other source classes including supernova remnants, gamma-ray binaries and radio galaxies. We will present a review of recent VERITAS results.

2:34PM B1.00002 Observations of SNR Cassiopeia A with VERITAS , BRAD SMITH, DONGQING HUANG, ALEXANDER KONOPELKO, Pittsburg State University — We report on observations of very high-energy gamma rays from the shell-type supernova remnant Cassiopeia A with the VERITAS stereoscopic array of four imaging atmospheric Cerenkov telescopes in Arizona. The total exposure time for these observations accounts for 21 hrs. The gamma-ray source associated with the SNR Cassiopeia A was decisively resolved above 200 GeV with a high statistical significance. The estimated integral flux for this gamma-ray source is about 5% of the Crab-Nebula flux. The photon spectrum is compatible with a power law. Along with a detailed description of the analysis results we present a short discussion of the physical mechanisms that may be responsible for the observed gamma-ray emission.

2:46PM B1.00003 Search for VHE gamma-ray emission from SNR Gamma Cygni using VERITAS , MATTHEW SHAW, University of Utah, VERITAS COLLABORATION — The nearby (d$\sim$1.8 kpc) F8 star Gamma Cygni is located in a shell-type Supernova remnant associated with the bright EGRET unidentified source 3EG J2020+4017. In 2009, we observed Gamma Cygni at TeV (10^{12} eV) energies using VERITAS, an Imaging Atmospheric Cherenkov Telescope observatory located in southern Arizona. From observations made between May 24th and June 24th 2009, we selected 730 minutes of useable data for analysis. The data was analyzed using the standard GRISU package, with modifications to account for the optically bright star Gamma Cygni (V=+2.23). At the meeting I will present some initial results of this analysis.

2:58PM B1.00004 Search for VHE gamma rays from ULIR Galaxy NGC 6240, ZEPHNE LARSEN, Brigham Young University, Department of Physics and Astronomy, Provo, Utah, VERITAS COLLABORATION — NGC 6240 is an ultra luminous IR galaxy resulting from the merger of two smaller galaxies. Its extraordinary IR luminosity may be due to the presence of intense star forming regions and/or supermassive black holes. It was observed in the spring of 2009 for 1360 minutes using the VERITAS Very High Energy (VHE) gamma-ray telescope array in southern Arizona. The data have been analyzed with the GrISU analysis package, using standard cuts and the ring background estimation method. We find no significant excess of TeV gamma rays arriving from the direction of NGC 6240, allowing us to set an upper limit on the VHE gamma-ray emission from this source: Flux $<$ 1.37% Crab (E $>$ 300 GeV).

Friday, October 23, 2009 2:10PM - 3:10PM – Session B2 Symposium on Soft Matter: Biophysics I Green Center 210S

2:10PM B2.00001 Single Molecule Force Spectroscopy using Optical Traps and AFMs, TOM PERKINS, University of Colorado/JILA — Force spectroscopy is an important single-molecule technique to study the energetics and dynamics of biological systems. Both optical traps and atomic force microscopes (AFMs) can measure the dynamics of individual molecules. My talk will focus on two intellectually distinct ways to improve these experiments: passive force clamps and an optically stabilized AFM. To increase measurement precision, feedback is used to maintain a constant force on a molecule - often called a force clamp. Precise yet rapid active feedback is limited by Brownian motion. This limited bandwidth leads to significant fluctuations in force that are particularly pronounced for the rapid, large changes in extension seen in nucleic acid structures (e.g. DNA hairpins, ribozymes, riboswitches). Here, we show that the dynamics determined in active force clamps are five-to-seven fold different than in a passive force clamp, which has a ($\sim$30-fold faster control of force. Thus, the dynamics of biological molecules can be significantly altered by the mechanism of force feedback. In AFM-based force spectroscopy experiments, force versus extension curves are generated by retracting the tip using a PZT stage while measuring force via cantilever deflection. Extension is not stable over the long times due to drift in the AFM assembly ($\sim$10 nm/min). We developed an ultrastable AFM by measuring and thereby stabilizing the tip in 3D using a laser scattered off the apex of a commercial AFM tip, not its back side. A second laser detected and thereby stabilized the sample. We next demonstrated simultaneous and independent measurement of extension and force. Preliminary studies of bacteriorhodopsin, a model membrane protein, highlight this instruments unique force- and position-clamp modes.

2:34PM B2.00002 Induction of Electrode-Cellular Interfaces with $\sim$ 0.05 μm^2 Contact Areas[1], BRET FLANDERS, PREM THAPA, Kansas State University — Individual cells of the slime mold *Dictyostelium discoideum* attach themselves to negatively biased nanoelectrodes that are separated by 30 μm from grounded electrodes. There is a -43 mV voltage-threshold for cell-to-electrode attachment, with negligible probability across the 0 to -38 mV range but probability that approaches 0.7 across the -46 to -100 mV range. A cell initiates contact by extending a pseudopod to the electrode and maintains contact until the voltage is turned off. Scanning electron micrographs of these interfaces show the contact areas to be of the order of 0.05 μm^2. Insight into this straight-forward, reproducible process may lead to new electrode-cellular attachment strategies that complement established approaches, such as blind sampling and patch clamp.

[1]Supported in part by NSF PHY-646966.

2:46PM B2.00003 Probing Kv2.1 Channel Dynamics Using Single Molecule Tracking, AUBREY WEIGEL, Colorado State University - School of Biomedical Engineering, MICHAEL TAMKUN, Colorado State University - Department of Biomedical Sciences, DIEGO KRAPF, Colorado State University - Department of Electrical and Computer Engineering — Kv2.1 potassium channels localize into micron-sized clusters in live neurons. This exceptional characteristic is essential for cellular function. Nevertheless, the physical mechanism behind Kv2.1 cluster formation and maintenance is largely unknown. We are investigating the dynamics of clustered Kv2.1 channels using total internal reflection fluorescence microscopy to track single molecules with nanometer accuracy in real time. Human embryonic kidney (HEK) cells are employed as a model system. HEK cells are induced to express biotinylated Kv2.1 channels fused to green fluorescent protein (GFP). Single channels are detected with streptavidin-conjugated red quantum dots (QD). GFP fluorescence provides characteristics of clusters as an ensemble while the red QDs enable tracking of individual channels. We study the dynamics of single channels inside the clusters and at the cluster interface in terms of their mean square displacement (MSD) and cumulative distribution function. Our results show a bimodal distribution of channels (clustered and non-clustered) and indicate that both Kv2.1 populations experience anomalous subdiffusion independent of cluster perimeter.

2:58PM B2.00004 Force-activated reactivity switch in a bimolecular chemical reaction at the single molecule level, ROBERT SZOSZKIEWICZ, Kansas State University, SERGI GARCIA-MANYES, JIAN LIANG, TZU-LING KUO, JULIO M. FERNANDEZ, Columbia University, NY — Mechanical force is a distinct and usually less explored way to activate chemical reaction because it can deform the reacting molecules along a well-defined direction of the reaction coordinate. However, the effect of mechanical force on the free- energy surface that governs a chemical reaction is still largely unknown. The combination of protein engineering with single-molecule force-clamp spectroscopy allows us to study the influence of mechanical force on the rate at which a protein disulfide bond is reduced by some reducing agents in a bimolecular substitution reaction (so-called SN2). We found that cleavage of a protein disulfide bond by hydroxide anions exhibits an abrupt reactivity "switch" at 500 pN, after which the accelerating effect of force on the rate of an SN2 chemical reaction greatly diminishes. We propose that an abrupt force- induced conformational change of the protein disulfide bond shifts its ground state, drastically changing its reactivity in SN2 chemical reactions. Our experiments directly demonstrate the action of a force-activated switch in the chemical reactivity of a single molecule. References: S. Garcia-Manyes, J. Liang, R. Szoszkiewicz, T-L. Kuo and J. M. Fernandez, Nature Chemistry, 1, 236-242, 2009.

Friday, October 23, 2009 2:10PM - 3:10PM – Session B3 Symposium on Advanced Optical Measurements I: Attosecond Physics Green Center Metals Hall

2:10PM B3.00001 Real-time observation of attosecond and femtosecond quantum dynamics using ultrafast lasers , ARVINDER SANDHU, University of Arizona — Recent innovations in ultrafast laser technology have led to generation of intense near-infrared (NIR) laser pulses in the few-cycle regime, which implies light pulses as short as 5-10 fs. These pulses offer an exciting opportunity to perform real-time measurements of the fast quantum dynamics occurring in gaseous and condensed phase matter. Experiments using such techniques can time-resolve the electronic, nuclear and correlated motions inside atoms, molecules and solids. In particular, the interaction of intense ultrafast laser pulses with noble gases can be used to generate coherent extreme ultraviolet (XUV) pulses with temporal duration as short as 100 attoseconds. As a comparison, the Bohr timescale of electron in a Hydrogen atom is $\sim$ 150 attoseconds. Thus, a pump-probe scheme consisting of attosecond XUV pulses and intense femtosecond NIR laser pulses has opened up the doors for excitation and control of extremely fast electronic processes. I will describe some of our work which uses these techniques to probe inner-shell ionized and highly-excited electron dynamics in atoms and molecules.

2:34PM B3.00002 High repetition rate HHG for VUV frequency combs , DYLAN YOST, JILA University of Colorado Boulder, JUN YE, JILA University of Colorado Boulder, NIST — By coupling a low-phase-noise, short-pulse laser to a femtosecond enhancement cavity, it is possible to obtain a large enhancement of the pulse energy and subsequently drive the high harmonic process at very high repetition rates ($\sim$100 MHz repetition rates). The generated radiation has could potentially be used for a multitude of experiments requiring VUV radiation with exceptional temporal coherence. An open question is whether a high level of phase coherence can be maintained through the HHG process. In response, we have recently conducted experimental studies of the quantum paths which contribute to a given below-threshold harmonic order. In addition to answering fundamental questions pertaining to the high harmonic process, these studies will allow one to understand amplitude to phase noise conversion in HHG more precisely. Finally, to show that temporal coherence can be maintained in practice, we utilize a self-homodyne measurement and find that the coherence time is greater than $\sim$10 ns by measuring the pulse-to-pulse coherence within the harmonic pulse train.

2:46PM B3.00003 Characterization and Application of Attosecond Pulse Trains , NIRANJAN SHIVARAM, LEI XU, ADAM ROBERTS, ARVINDER SANDHU — Femtosecond high intensity ($>10^{14}$ Wcm^{-2}) laser pulses can be focused onto a suitable gas to produce extreme ultraviolet (XUV) emission by the process high harmonic generation (HHG). In this process, the driving laser field pulls the electron out from an atom and when the laser electric field changes direction, the electron can be driven back to recollide with the parent ion core resulting in XUV emission. Since the recollision occurs once every half laser cycle, the emission consists of bursts which are a few hundred attoseconds in duration and separated by $\sim$1fs. In this talk I will provide a brief overview of attosecond pulse train generation and characterization. I will describe a two-pulse (one high harmonic pulse and one fundamental pulse) pump-probe measurement technique to extract information (particularly the phase) about the high harmonic pulse. A velocity map imaging detector is employed to image the photo-electrons produced in this process. This setup can also be used to study electron dynamics in atoms and molecules on a sub-femtosecond time scale. I will describe our work in progress using He and Ar atoms and our future plans.

2:58PM B3.00004 High-Frequency Surface Acoustic Wave Propagation in Nanostructures Characterized by Coherent Extreme Ultraviolet Beams , MARK SIEMENS, QING LI, Department of Physics and JILA, University of Colorado, Boulder CO, KEITH NELSON, Department of Chemistry, Massachusetts Institute of Technology, Cabridge MA, RONGGUI YANG, Department of Mechanical Engineering, University of Colorado, Boulder CO, ERIK ANDERSON, Center for X-ray Optics and Lawrence Berkeley Laboratories, Berkeley CA, MARGARET MURNANE, HENRY KAPTEYN, Department of Physics and JILA, University of Colorado, Boulder CO — We study ultrahigh frequency surface acoustic wave propagation in nickel-on-sapphire nanostructures. We make use of high-order harmonic generation to obtain ultrafast, coherent, beams in the extreme ultraviolet (EUV) region of the spectrum. The short wavelengths $\sim$30 nm allow us to measure propagation dynamics of surface acoustic waves to frequencies of nearly 50 GHz, corresponding to wavelengths as short as 125 nm. We repeat the measurement on a sequence of nanostructured samples to quantify dispersion of surface acoustic waves in a nanostructure series for the first time [1]. These measurements are critical for accurate characterization of interfaces beneath very thin films using this technique. [1] M. E. Siemens, et al. Applied Physics Letters, 94(9):093103, 2009.

Friday, October 23, 2009 2:10PM - 3:10PM – Session B4 Magnetic Materials Parker Student Center Ballroom E

2:10PM B4.00001 Ultrafast Magnetization Dynamics Probed at Elemental M-edges of Ni and Fe Using Tabletop High-Order Harmonic EUV Light , CHAN LA-O-VORAKIAT, STEFAN MATHIAS, Deparment of Physics and JILA, University of Colorado at Boulder, PATRIK GRYCHTOL, ROMAN ADAM, Institute of Solid State Research, IFF-9, Research Center Jülich, MARK SIEMENS, Deparment of Physics and JILA, University of Colorado at Boulder, JUSTIN SHAW, HANS NEMBACH, Electromagnetics Division, National Institute of Standards and Technology, CLAUS SCHNEIDER, Institute of Solid State Research, IFF-9, Research Center Jülich, MARTIN AESCHLIMANN, University of Kaiserslautern and Research Center OPTIMAS, THOMAS SILVA, Electromagnetics Division, National Institute of Standards and Technology, MARGARET MURNANE, HENRY KAPTEYN, Deparment of Physics and JILA, University of Colorado at Boulder — We show for the first time that EUV light generated from the high-harmonic generation process can be used to observe element-selective femtosecond-to-attosecond magnetization dynamics of magnetic materials. Using the transverse magneto-optic Kerr effect, we measured an asymmetry of reflectivity in a Permalloy film of up to 6% around the M absorption edges of Fe (54eV) and Ni (67eV). Furthermore, we observed an ultrafast demagnetization of the permalloy film within 250 fs after hearting up by a femtosecond pulse.

2:22PM B4.00002 A High Bandwidth Optically Pumped Atomic Magnetometer , RICARDO JIMENEZ-MARTINEZ, University of Colorado Boulder and NIST, Time and Frequency Division, CLARK W. GRIFFITH, SVENJA KNAPPE, JOHN KITCHING, NIST, Time and Frequency Division — The measurement of magnetic fields has proved to be relevant in many realms of basic and applied science. Among the different techniques to measure magnetic fields, that of optically pumped atomic magnetometers has experienced considerable attention recently. This interest stems from the development of atomic magnetometers that achieve sensitivities in the sub-femto Tesla range, and the development of techniques that enable highly miniaturized, compact, with low-power consumption magnetometers. The sensitivity and bandwidth of atomic magnetometers is set by their spin coherence time, which in most magnetometers is limited by atomic collisions. Better sensitivities are achieved by suppressing the spin decoherence introduced by atomic collisions, but at a cost of lower bandwidth. For certain applications, a magnetometer with a high bandwidth is useful. Here we present a technique to achieve high bandwidth while preserving high sensitivity. We support the technique with table-top measurements showing that a bandwidth of 10 KHz and sensitivity of 10 pT$_{rms}$/(Hz)$^{1/2}$ can be achieved in a compact device. We also highlight the current development of a miniature atomic magnetometer based on this technique.

2:34PM B4.00003 Effects of Seed Layers on Ferromagnetic Resonance Linewidths of $Fe_{65}Co_{35}$ Thin Films , LEI LU, KE SUN, MINGZHONG WU, JARED YOUNG, CHRISTOPH MATHIEU, MATTHEW HADLEY, COLORADO STATE UNIVERSITY TEAM, UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA COLLABORATION, SEAGATE TECHNOLOGY COLLABORATION — Because of their high saturation magnetization and low coercivity, FeCo thin films have promising applications in both magnetic recording heads and sensors. In light of the applications in recording heads, there is a critical need for the understanding of high-frequency magnetic losses in FeCo thin films. This need is critical because the losses in these films can substantially affect the dynamics of magnetization reversal. This presentation reports for the first time the effect of seed layers on the ferromagnetic resonance (FMR) linewidth of $Fe_{65}Co_{35}$ thin films. Six 100 nm-thick films were prepared under the exact same conditions but on different types of seed layers. The FMR measurements were conducted over 8.5-17.5 GHz. The measurements show that the type of seed layer strongly affects both the level and frequency dependence of the FMR linewidth of the films. The results demonstrate the feasibility of the tuning of microwave losses in FeCo films through the use of different seed layers.

2:46PM B4.00004 Growth of High-Quality Yttrium Iron Garnet Thin Films on Metallic Thin Layers , YIYAN SUN, YOUNG-YEAL SONG, MINGZHONG WU, DEPARTMENT OF PHYSICS, COLORADO STATE UNIVERSITY TEAM — Yttrium iron garnet (YIG) is one type of ferrite materials that has the lowest loss at microwave frequencies. One typically grows YIG on gadolinium gallium garnet (GGG) substrates, and this is typical mainly because of the perfect matching between the YIG and GGG lattice constants. For applications in monolithic devices, however, one needs to grow YIG films on metallic conductors or electrodes. This presentation reports the deposition of YIG thin films on metallic thin layers and the optimization of the deposition procedures. The metallic and YIG films were deposited by pulsed laser deposition and magnetron sputtering techniques and were characterized by scanning electron microscopy, x-ray diffraction, and ferromagnetic resonance measurements. The work shows rather clearly the critical roles of the selection of metallic materials, the thickness of the metallic layers, the deposition temperature, and the use of buffer layers on the deposition of high-quality YIG films.

2:58PM B4.00005 Vortex phase diagram for films of type-I Ginzburg-Landau superconductors , MARK SWEENEY, MARTIN GELFAND, Colorado State University — It has been known since the work of Tinkham, Maki, and Pearl in the early 1960's that a thin film of type-I material in a perpendicular field supports a triangular vortex lattice below the upper critical field H_{c2}. What happens as film thickness is increased? This was addressed in the vicinity of H_{c2} using linearized Ginzburg-Landau theory, first by Lasher and more completely by Callaway. The vortex phase diagram is remarkably rich. We have made progress on this question within the full G-L theory, following an approach widely applied by Brandt (iteratively solving the G-L equations in a space of trial functions). We find that Brandt's proposed form for the magnetic field in thin-film geometry leads to some unphysical results and have devised an alternative. Our calculations precisely locate phase boundaries between triangular, square, and rectangular vortex arrays as a function of film thickness and magnetic field. They are consistent with a simple picture of vortices which repel near the film surfaces but attract away from them.

Friday, October 23, 2009 2:10PM - 2:58PM –
Session B5 Thermal Phenomena Hill Hall 300

2:10PM B5.00001 Computational Modeling of Radiative Cooling Coupled with Thermoconductivity Using Maple Software: Challenges and Results , ALEXANDER PANIN, Utah Valley University — Maple is a versatile software package which can go as far as solving partial differential equations (PDEs). Many astrophysical problems (as well as many engineering situations) require coupling of thermoconductivity equation with radiative cooling/heating. Using Maple software for such problems results in serious challenge due to the fact that it requires non-linear boundary condition (black body radiation). Turns out that Maple cannot solve linear PDE with non linear boundary condition. However, Maple can solve some non-linear PDEs with non-linear boundary conditions (!). So if to slightly modify thermoconductivity equation by adding some non-linear terms, then Maple accepts non-linear boundary conditions for it too. Decreasing non-linear terms to insignificant values (for the particular problem in hand) allows accurate modeling of radiative cooling/hating, and thus adapting Maple for wide class of problems. As a few examples, we model radiative cooling of a chunk of molten silicate debris in vacuum (as a result of asteroid collision), the dynamics of radiative cooling and heating of lunar soil during lunar nights and days, daily and yearly variations of Earth soil temperature, radiative cooling of a planet, and cooling of a neutron star. The model we used and the computational results are discussed in the presentation.

2:22PM B5.00002 Optimum Cavity Radius Within a Bottle-Shaped Thermoacoustic Engine[1] , JUSTIN BRIDGE, BONNIE ANDERSEN, Utah Valley University — Heat energy can be used to generate acoustic energy due to thermoacoustic interactions. These engines can be used to create sound waves without any moving parts, like pistons, and could be used in space to convert solar energy into electricity. This research focused on the optimization of the geometry of bottle-shaped resonators used for thermoacoustic prime movers. These resonators have the advantage of non-harmonic overtones compared with half-wave resonators. The resonators for this research were constructed of concentric cylinders consisting of a neck piece and a cavity. The dimensions were approximately 5 cm with an ID of 2 cm for the neck and 10 cm long with IDs varying from about 2 cm to 12 cm for the cavity, producing operating frequencies ranging from approximately 1.2 to 1.5 kHz, following a theoretical model. Twelve different cavity radii were tested. The optimal cavity radius of 2.06 cm had an onset time that was 27 s faster and an onset temperature difference that was lower by 12°C than the smallest cavity (a half-wave resonator). Future research will explore the quality factor and optimum stack to surface area ratio of the engines.

[1]Supported by UVU.

2:34PM B5.00003 Optimum Stack Position Within a Bottle-shaped Thermoacoustic Engine[1] , ELWIN BASSETT, BONNIE ANDERSEN, UVU — Thermoacoustics involves turning heat energy into acoustic energy, or using sound to pump heat. A thermoacoustic engine with a transducer could be used, for example, to convert solar energy incident on a satellite into sound and then into electricity. This research focused on the optimization of stack placement within a bottle-shaped 1.4 kHz engine to achieve maximum acoustic pressure. The prime mover consisted of two connected cylinders: the bottle neck, 5 cm long and 1 cm in radius, and a cavity, 10 cm long and 2 cm in radius, with the stack located within the middle of the neck. Sound intensity is a function of both pressure and velocity; therefore, maximum intensity should be found in between their nodes. However, a phase shift is introduced for the velocity due to the thermoacoustic effect and the optimum position will not be exactly between the nodes. Therefore, 9 different stack positions within the neck were tested to determine the optimum location. The optimum was found to be 39% away from the closed end of the neck, which improved acoustic pressure by 50%. Further testing is planned, to verify the results and test different configurations.

[1]UVU

2:46PM B5.00004 Nonlinear Model of Onset of Thermoacoustic Engines , DANIEL JAMES, BONNIE ANDERSON, Utah Valley University — Thermoacoustic engines are devices that use heat to produce acoustic oscillations. Heat is applied to a heat exchanger within a resonator until an adequate temperature gradient is reached, at which point self-sustained oscillations occur. The buildup of oscillations for devices operating at a few kilohertz only last for a few seconds, but can be indicative of the performance of the device. This research uses a Van der Pol model for the self-sustained oscillations for engines operating near 1.5 kHz. Two parameters emerge from the model based on energy supplied to the system and losses of the system. LabVIEW is used to record data from different thermoacoustic engines, and fit the onset profile to a profile generated from the Van der Pol equation. A best fit of the model to the data yields quantitative comparisons of the gain and loss parameters between the engines.

Friday, October 23, 2009 3:40PM - 4:52PM – Session C1 Astroparticle Symposium II: UHE Cosmic Rays: Spectrum and Composition Green Center 210N

3:40PM C1.00001 The HiRes Stereo Measurement of the UHECR Spectrum , DOUGLAS BERGMAN, University of Utah, HIRES COLLABORATION — The High Resolution Fly's Eye (HiRes) Experiment has measured the ultra-high energy cosmic ray (UHECR) energy spectrum using a stereo technique combining the observations of its two sites to provide very accurate determination of extensive air shower geometry. The spectrum will be shown, along with previous measurements in monocular mode, fits to all the spectra to show the energy of the observed GZK suppression and a discussion of systematic errors.

3:52PM C1.00002 Measurement of the Cosmic Ray Energy Spectrum with the Pierre Auger Observatory , LAWRENCE WIENCKE, Colorado School of Mines — The Pierre Auger Observatory has measured the cosmic ray energy spectrum above $10^18eVusingseveraltechniques.Thespectrumcanbedescribedbyabrokenpower-lawofindex3.3belowtheanklewhichismeasuredatlg(Eankle/eV) = 18.6.Abovetheanklethespectrumisdescribedbyapower-law/E-2.6andafluxsuppressionwithlg(E1/2/eV) = 19.6Thistalkwillsummarizethemethodsandresults.$

4:04PM C1.00003 Cosmic Ray Composition Studies with the High Resolution Fly's Eye , JOHN BELZ, University of Utah, HIGH RESOLUTION FLY'S EYE COLLABORATION — The depth of shower maximum or X_{max} of extensive airshowers is a sensitive probe of the chemical composition of ultra-high energy cosmic rays. Both the evolution of mean X_{max} with energy and the width of the X_{max} distribution can provide clues as to the species of the particles initiating the airshowers. Here, we report the results of composition studies using X_{max} with data collected in stereoscopic mode by the High-Resolution Fly's Eye observatory. The HiRes data are best explained by a predominantly protonic composition above 1.6 EeV.

4:16PM C1.00004 Measurement of the Average Depth of Shower Maximum and its Fluctuations with the Pierre Auger Observatory , MEGAN LONGO, Colorado State University — We present a measurement of the rate of change of the depth of shower maximum with energy using data from the Pierre Auger Observatory. We introduce an event selection that assures an unbiased and high quality data sample. The analysis of these results will lead to further understanding of the hadronic interaction models and the mass composition of cosmic rays at ultra high energies.

4:28PM C1.00005 Programs that Think. Programs that Love. Programs that Identify the Composition of Ultra High Energy Cosmic Rays. , MICHAEL GUSSERT, Colorado State University: Fort Collins, THE PIERRE AUGER OBSERVATORY COLLABORATION — The use of evolutionary neural network techniques to identify the composition of ultra high energy cosmic rays is being explored. The air shower parameters measured by the Pierre Auger Observatory cannot easily identify the composition of the shower primary. However, Artificial Neural Networks (ANNs) can be evolved to learn the dependence of these parameters on the primary composition. Once completed, such a network would then be able to estimate the composition of the primary for a given air shower. A modified version of the Symbiotic, Adaptive, Neuro-Evolution (SANE) algorithm is being studied to allow neurons within the network to specialize in a specific aspect of the dependence.

4:40PM C1.00006 Preliminary results from a new Auger fluorescence detector drum calibration light source , ALEXEI DOROFEEV, JEFFREY BRACK, ROBERT COPE, BEN GOOKIN, JOHN HARTON, JAN KEMPINGER, YEVGENIY PETROV, Colorado State University, AUGER COLLABORATION — A new revision of electronics for Auger Observatory fluorescence detector drum calibration is in final completion stage now. The drum light source design is based on a new 365nm high power LED produced by Nichia. In this report we will present preliminary results on a spectrum of the drum light source and the influence of ambient temperature, pulse rate and pulse current amplitude on the drum spectrum.

Friday, October 23, 2009 3:40PM - 4:52PM – Session C2 Symposium on Soft Matter: Biophysics II Green Center 210S

3:40PM C2.00001 Vibrating virus capsids and interactions with short light pulses – picking up good vibrations , OTTO SANKEY, DARYN BENSON, Arizona State University — Viruses are the simplest "life" form. They reproduce by borrowing the machinery of their host cell. Viruses consist of an outer coat (capsid) that protects its genomic material inside. They are pathogenic to plants, bacteria, animals, and of course humans. Experimental studies at ASU by Tsen et al. have discovered that ultra-short laser pulses are capable of "inactivating" viruses. One potential mechanism is the coupling of light to the soft dynamical modes of the capsid. We describe theoretical modeling of this effect.

3:52PM C2.00002 Broadband Liquid Dielectric Spectrometer , SATYAN CHANDRA, JESUS ARELLANO, BRIAN MAZZEO, Brigham Young University — A dielectric spectrometer was built to measure the dielectric relaxation of proteins in solution. The dielectric cell consisted of two parallel stainless-steel electrodes (separation of 8.5 mm) embedded in PTFE. To provide temperature stability, thermally regulated water flowed through both electrodes. The cell was connected to a 4294A Precision Impedance Analyzer, providing impedance measurements from 40Hz to 110 MHz. Due to electrode polarization and high frequency parasitics, useful measurements were obtained for frequencies ranging from 10 kHz to 10 MHz. Calibration was performed using air, iso-propanol and deionized water. Experiments were also conducted on buffers and salt solutions. The dielectric relaxation of the protein beta-lactoglobulin was measured at mg/ml concentrations.

4:04PM C2.00003 Image Processing Diagnostics: Emphysema , ALEX MCKENZIE[1], Metropolitan State College of Denver — Currently the computerized tomography (CT) scan can detect emphysema sooner than traditional x-rays, but other tests are required to measure more accurately the amount of affected lung. CT scan images show clearly if a patient has emphysema, but is unable by visual scan alone, to quantify the degree of the disease, as it appears merely as subtle, barely distinct, dark spots on the lung. Our goal is to create a software plug-in to interface with existing open source medical imaging software, to automate the process of accurately diagnosing and determining emphysema severity levels in patients. This will be accomplished by performing a number of statistical calculations using data taken from CT scan images of several patients representing a wide range of severity of the disease. These analyses include an examination of the deviation from a normal distribution curve to determine skewness, a commonly used statistical parameter. Our preliminary results show that this method of assessment appears to be more accurate and robust than currently utilized methods which involve looking at percentages of radiodensities in air passages of the lung.

[1]Student talk sponsored by R. Krantz

4:16PM C2.00004 Three-Pulse Photon Echo Peak Shift (3PEPS) as a probe of conformational distribution in heme protein folding , ZHAOCHUAN SHEN, University of Colorado at Boulder, EMILY GIBSON, University of Colorado at Denver, RALPH JIMENEZ, University of Colorado at Boulder — Line broadening of electronic spectra of cofactor consists of two contributions: homogeneous broadening and inhomogeneous broadening. Inhomogeneous broadening reflects conformational diversity of the cofactor and its surrounding environment and is a key to quantifying the disorder of soft condensed matter system. To clarify the relation between contributions to the lineshapes and protein conformation, we investigated the equilibrium unfolding sample of Zn-cytochrome c (Zn-cyt c) in guanidine hydrochloride (GuHCl). Soret band UV-vis spectra were first measured as a function of GuHCl, and fitted with both two- and three- state models of protein folding. Then, we measured 3PEPS signal of the folded, midpoint and unfolded samples. By tuning the laser wavelength over Soret band on midpoint sample and comparing experimental asymptotic peak shift with simulated from two- and three-state models, we attributed folding of Zn-cyt c to a two-state model. This is a novel approach in understanding protein folding and should be applicable to investigate of other proteins.

4:28PM C2.00005 Thrombin flux and wall shear rate regulate fibrin fiber deposition state during polymerization under flow , DAMIAN ILLING, KEITH NEEVES, Chemical Engineering, Colorado School of Mines — Thrombin is released as a soluble enzyme from the platelet surface to trigger fibrin polymerization during thrombosis under flow conditions. While isotropic fibrin polymerization under static conditions involves protofibril extension and lateral aggregation leading to a gel, factors regulating fiber diameter and orientation are poorly quantified under hemodynamic flow due to the difficulty of setting thrombin fluxes. A membrane microfluidic device allowed combined control of both thrombin wall flux (10^{-13} to 10^{-11} nmol/μ m^2 s) and the wall shear rate (10 to 100 s^{-1}) of a flowing fibrinogen solution. At the thrombin flux of 10^{-12} nmol/μ m^2 s, both fibrin deposition and fiber thickness decreased as the wall shear rate increased from 10 to 100 s^{-1}. Direct measurement and transport-reaction simulations at 12 different thrombin flux-wall shear rate conditions demonstrated that two dimensionless numbers, the Peclet number (Pe) and the Damkohler number (Da),defined a phase diagram to predict fibrin morphology. For Da$<$10,we only observed thin films at all Pe. For 10$<$Da$<$100, we observed either mats of surface fibers or gels depending on the Pe. For Da$>$900 and Pe$<$100, we observed three-dimensional gels. These results indicate that increase wall shear rate first quenches lateral aggregation and then protofibril extension.

4:40PM C2.00006 Characterization of Manufactured Binding Sites in BPTI Using Laser Polarized ^{129}Xe[1] , ZAYD MA, GEOFF SCHRANK, BRIAN SAAM, Department of Physics University of Utah, DAVID GOLDENBERG, Deparment of Biology University of Utah — We measure the NMR chemical shift of laser polarized ^{129}Xe in wild type, Y35G, Y23A, and F45S BPTI (Bovine Pancreatic Trypsin Inhibitor) solutions of varying concentration. Our technique uses ^{129}Xe in unprecedented low concentrations as a biosensor. The results provide structural information concerning the aforementioned proteins [2,3]. We use a flow-through polarizer that outputs ^{129}Xe hyperpolarized to ∼10%. Hyperpolarized gas coupled with a high resolution NMR spectrometer, enables us to measure sub-ppm chemical shifts at very low Xe and protein concentrations. In accordance with the fast exchange regime, we observe a single resonance that is chemically shifted as a function of protein concentration. Consistent with a rigid lattice and a manufactured binding site, Y23A and F45S demonstrate strong binding relative to wild type and Y35G. Wild type is believed not to have a specific binding site. Other experiments on Y35G have demonstrated a hydrophobic cavity and extensive solution-phase motion [1]. Weak binding supports the notion that a small fraction of solution-phase Y35G is in a conformation such that the cavity is accessible to Xe. [1] S. A. Beeser, *J. Mol. Biol.*, **269**, 154-164v [2] W. M. Hanson *et al.*, *J. Mol. Biol.* 2007, **366**, 230-243 [3] A. T. Danishefsky *et al.*, *Protein Sci.* 1993, **2**, 577-587

[1]Work Supported by NSF grant # PHY-0855482 and UURF.

Friday, October 23, 2009 3:40PM - 4:52PM –
Session C3 Symposium on Advanced Optical Measurements II: Ultrafast Techniques
Green Center Metals Hall

3:40PM C3.00001 Optical 2D Fourier-transform spectra of GaAs quantum wells ,

ALAN BRISTOW, DENIS KARAISKAJ, XINGCAN DAI, STEVEN CUNDIFF, JILA, University of Colorado and NIST, LIJUN YANG, SHAUL MUKAMEL, University of California, Irvine, RICHARD MIRIN, National Institute of Standards and Technology — Optical 2D Fourier-transform spectra are presented for QWs at low temperature. Many-body effects are observed in the exciton lineshapes, and suppressed for certain polarization configuration [1]. Biexcitons are completely resolved and are formed from excitons on the same localization site. The 2D spectra simultaneously reveal homogeneous and inhomogeneous linewidths for all spectra features. Also observed are pure many-body interaction features in the form of 2-quantum transitions, which are spectrally separated from the biexciton contributions [2].

[1] A. D. Bristow, D. Karaiskaj, X. Dai, R. P. Mirin, S. T. Cundiff, Phys. Rev. B **79**, 161305(R) (2009).
[2] D. Karaiskaj, A. D. Bristow, L. Yang, X. Dai, R. P. Mirin, S. Mukamel, S. T. Cundiff, arXiv:0906.4068v1 [cond-mat.mes-hall] (2009).

3:52PM C3.00002 Coherent excitonic resonances of natural quantum dots studied with optical 2D Fourier transform spectroscopy[1] ,

GALAN MOODY, ALAN BRISTOW, MARK SIEMENS, XINGCAN DAI, JILA, National Institute of Standards and Technology, and University of Colorado, DENIS KARAISKAJ, JILA, National Institute of Standards and Technology, University of Colorado, and University of South Florida, STEVEN CUNDIFF, JILA, National Institute of Standards and Technology, and University of Colorado — Optical 2D Fourier transform spectroscopy [1] is used to study the coherent nonlinear response from interfacial (or "natural") GaAs quantum dots [2], found within the monolayer fluctuations of a quantum well. The low temperature (~6K) spectra show excitonic resonances from both the quantum dots and the quantum well, the former having a larger inhomogeneous distribution and narrower homogeneous linewidth. Variation of the population time delay (of the excitation sequence) and lattice temperature reveals a coupling associated with the phonon mediated, incoherent relaxation from the quantum well states to the lower energy quantum dots. [1] S. T. Cundiff, T. Zhang, A. D. Bristow, D. Karaiskaj, X. Dai, Acc. Chem. Res. **42**, 1423 (2009). [2] D. Gammon, E.S. Snow, B.V. Shanabrook, D.S. Katzer, and D. Park, PRL **76**, 3005 (1996).

[1]This work was supported by the U.S. Department of Energy and the National Science Foundation.

4:04PM C3.00003 Spatio-Temporal Dynamics of Cross Polarized Wave Generation[1]

, DANIEL ADAMS, JEFF SQUIER, CHARLES DURFEE, Colorado School of Mines — We use time-domain Spatially and Spectrally Resolved Interferometry (SSRI) to investigate cross-polarized wave (XPW) generation in barium fluoride. We find that the XPW pulse is $\sqrt{3}$ smaller than the input in the spatiotemporal domain regardless of the input chirp. Additionally, we calculate a temporally dependent focal length resulting from the nonlinear interaction, and discuss its implications.

[1]AFOSR under contract FA9550-07-10026.

4:16PM C3.00004 Complete vector characterization of tightly focused electric fields via nonlinear scattering by nanospheres ,

DAVID KUPKA, RANDY BARTELS, Colorado State University — We introduce an algorithm for characterizing a 3D focal field valid under tight focusing conditions utilizing far field third harmonic (TH) collection. This allows reconstruction of the focal field from a charge-coupled device (CCD) image. A nano-particle, acting as a point source probe in a focal volume, generates a localized TH signal carrying mixed vector polarization information in the far field. When scanned throughout the volume, a series of intensity patterns captured in the far field are mapped to these localized point sources. The spatial mapping resolution is limited by the size and position control of the probe. We present simulation results of the far field CCD images produced for a variety of common incident field polarizations under both low numerical aperture (NA) and high NA conditions. Each image, analyzed by integration over selected regions, provides initial estimates for parameters describing the focal vector field. A Nelder-Mead simplex algorithm allows complete reconstruction of the vector point spread function from the captured far-field intensity, yielding both longitudinal and transverse field components in the focal volume.

4:28PM C3.00005 Novel technique for uniform-field transverse electroreflectance using a mode-locked laser and oscillating field ,

HAIPENG ZHANG, JARED WAHLSTRAND, STEVEN CUNDIFF, JILA, National Institute of Standards and Technology, and University of Colorado, Boulder — Electroreflectance is a widely-used characterization technique for semiconductor materials [1]. A modulated electric field produces a resonant differential reflectance spectrum at band structure critical points. Typical experiments are performed using a longitudinal geometry, due to the ease of generating large electric fields by doping. Transverse geometries, in which the electric field is perpendicular to the light wavevector, yield additional information about the symmetry of critical points. We have developed a way to apply a uniform electric field in a transverse electrode structure by using a radio frequency bias and a sample structure with an insulating layer between electrodes and the sample. The rapidly oscillating bias, synchronized to the laser repetition rate, prevents space charge from building up, and the insulating layer prevents highly nonuniform trap-enhanced fields. This technique could also be used in ultrafast experiments that require a large, uniform, effectively static field. Results are presented for GaAs using a Ti:sapphire laser.

[1] F. Pollak and H. Shen, Mater. Sci. Eng. R **10**, 275-374 (1993).

4:40PM C3.00006 Quasi-ballistic thermal transport from a nanoscale hotspot oberserved using ultrafast coherent extreme ultraviolet beams ,

QING LI, MARK SIEMENS, JILA, University of Colorado at Boulder, RONGGUI YANG, Department of Mechanical Engineering, University of Colorado at Boulder, KEITH NELSON, Department of Chemistry, MIT, ERIK ANDERSON, Lawrence Berkeley Labs and Center for X-Ray Optics, MARGARET MURNANE, HENRY KAPTEYN, JILA, University of Colorado at Boulder — We study thermal transport from a nanoscale hotspot into a bulk material using ultrafast, coherent, extreme ultraviolet beams. When the size of the hotspot is smaller than the mean free path of the energy-carrying phonons in the substrate, we measure a decrease in energy transport compared with the diffusive Fourier law prediction. This is the first observation and quantitative measurement of quasi-ballistic thermal transport from a nanoscale heat source. Our results show that the Fourier law can be corrected to describe energy dissipation from nanostructures into the bulk by introducing a size-dependent ballistic thermal resistance. This finding could have significant impact on the thermal management and reliability of emerging nanoscale devices, and nano-enabled energy systems.

Friday, October 23, 2009 3:40PM - 4:52PM –
Session C4 Spintronics and Quantum Computing Green Center 211

3:40PM C4.00001 Observing coherent spin motion with electrical currents , CHRISTOPH BOEHME, University of Utah — The spin degree of freedom of electrons and nuclei is important for many materials properties of condensed matter. Spins have also been proposed as information carriers for quantum information and spin-electronic applications. The investigation of spin states for materials research and technological applications therefore requires very sensitive spin measurement (readout) techniques. Our research is aimed at the investigation of such spin readout mechanisms for electron and nuclear spins in semiconductor materials. The focus of this work is on spin-selection rules which allow control of electronic transitions such as charge carrier recombination, transport, trapping or scattering. I will present two spin-dependent mechanisms which allow the extremely sensitive observation of coherent spin nutation of electron spins in crystalline silicon and a conducting pi-conjugated polymer, respectively. It will be shown that using these mechanisms, it is possible to observe spin effects such as spin-Rabi nutation, spin-echo, spin inversion recovery and spin polarization by technologically simple transient current measurements.

4:04PM C4.00002 Spin incoherence of donor electrons near c-Si(111)/SiO2 interface defects , SEOYOUNG PAIK, SANG -YUN LEE, WILLIAM J. BAKER[1], DANE R. MCCAMEY, CHRISTOPH BOEHME, Department of Physics and Astronomy, University of Utah, DEPARTMENT OF PHYSICS AND ASTRONOMY, UNIVERSITY OF UTAH TEAM — Electron and nuclear spins of phosphorous (^{31}P) donors in crystalline silicon have been investigated extensively in recent years as they both have extremely long quantum mechanical coherence times which makes them extremely interesting candidates for quantum information and spin-electronics applications [1]. Existing silicon quantum computer concepts [2] propose to use ^{31}P qubits close to the silicon surface. We present here a study of how microscopic defects at the oxide layer of the silicon surface influence the spin coherence times (T_1 and T_2 times) of the ^{31}P qubits. Using pulsed electrically detected magnetic resonance spectroscopy [3], we show that due to the interaction of the ^{31}P qubits with the interface states, the previously known, extremely long bulk coherence times are drastically shortened [4].

[1] J. J. L.Morton, et al., Nature **455**, 1085 (2008).
[2] B. E. Kane, Nature 393, 133 (1998).
[3] A. R. Stegner, et al., *Nature Physics* 2, 835 (2006).
[4] S.-Y. Paik, et al., arXiv:cond-mat/0905.0416 (2009).

[1]graduate student

4:16PM C4.00003 Enhanced estimation of quantum evolution parameters with entangled states , DAVID COLLINS, MIKE FREY — Quantum estimation considers the issue of estimating parameters associated with the description of a quantum state or of the evolution of a quantum state when only a finite number of copies of the quantum system are available. The accuracy of any estimation scheme is limited by both standard statistical sampling issues as well as the inherent statistical nature of measurement outcomes for quantum systems. We consider rotations of a spin-1/2 particle about a fixed axis and which are parametrized by a rotation angle, which is to be estimated. We use the quantum Fisher information to establish optimal bounds on the variance in any estimator of this parameter in scenarios involving one use of the rotation upon each of a collection of spin-1/2 particles. We show that optimal estimation occurs when all spin-1/2 particles are entangled and present exact analytical results for the bound that is generated and the required input state. We show that this offers a significant advantage over the use of unentangled states.

4:28PM C4.00004 Fidelity of Arbitrary Single-Qubit Gates , NATHAN STEIGER, Brigham Young University, PETER PEMBERTON-ROSS, Cambridge University — Recent work suggests that conservation laws limit the inherent accuracy of gate operations in quantum computing. One way to quantify these limitations is through a gate operation's fidelity. We extend and clarify previous work by Karasawa et al. (J. Phys. A **42**, 225303, (2009)) for an arbitrary single-qubit gate operation by incorporating the Schrödinger form of the uncertainty relation and arrive at a Bloch sphere representation of the gate fidelity. We find that these modifications are non-trivial and could have important ramifications for quantum computing.

4:40PM C4.00005 Consensus and Frustration in the Heisenberg Model , WESLEY KRUEGER, MANUEL BERRONDO, Brigham Young University — In the creation of a model for flocking behavior, we have developed a set of two rules, termed consensus and frustration, which consist of a topologically unique non-symmetric alignment tendency among individual particles, coupled with an antagonistic, generally external influence opposing full particle alignment. These rules act to produce a spectacular range of deterministic, complex motion. Placing the particles in a lattice structure and allowing the velocity to go to zero produces a modified Heisenberg spin model. We discuss the development and exploration of such a model; in particular the compatibility of common numerical integration methods with our consensus and frustration rules and quantification of the results using thermodynamic techniques.

Friday, October 23, 2009 3:40PM - 4:52PM –
Session C5 Planetary Science Green Center 215

3:40PM C5.00001 An Investigation of Polar Mesospheric Clouds Using Satellite and Groud-based Measurements , JAIMY TOMLINSON, MICHAEL TAYLOR, Utah State University, MATTHEW DELAND, Science Systems and Applications Inc., Maryland, MARK ZALCIK, CENTER FOR ATMOSPHERIC AND SPACE SCIENCE TEAM — Noctilucent clouds (NLCs) occur in the very cold summer mesosphere at high latitudes. They stand out brightly against a dark twilight sky because they are high enough that the sun still illuminates them when it is 5 to 16 degrees below the horizon. These clouds are also known as polar mesospheric clouds (PMCs) when observed from space. Satellite data have shown an increase in brightness and occurrence frequency over the past 30 years, possibly associated with climate change. In this presentation, I will discuss our work in mapping and correlating satellite data from OMI and SBUV orbiting instruments with ground-based Canadian-American and European NLC observing networks, and our efforts to find patterns and trends in the data. I will show animations that demonstrate the evolution of the clouds through the northern hemisphere 2007 and 2008 seasons. We have identified several days during the 2007 and 2008 seasons with OMI detections coinciding in time and space with visual ground-based observations.

3:52PM C5.00002 Comparison of Sprite-Halo Characteristics Imaged Over the USA and South America

, LANCE PETERSEN, MIKE TAYLOR, DOMINIQUE PAUTET, Utah State University, MATTHEW BAILEY, Trinity College, STEVEN CUMMER, Duke University, CENTER FOR ATMOSPHERIC AND SPACE SCIENCES TEAM, DUKE UNIVERSITY TEAM — Sprites and Halos are prominent members of an extraordinary family of Transient Luminous Events (TLEs) that have been discovered over the past 20 years. Halos are short-lived (few millisecond) diffuse optical emissions that appear as horizontal bright disks suspended above distant thunderstorms. They frequently precede the formation of a vertically structured sprite. Reports of halos are relatively few and indicate a limited height range centered at approximately 80 km with optical diameters up to about 100 km. Unlike sprite events, which occur almost exclusively in association with large positive cloud-to-ground lightning discharges, halos have recently been observed from satellites in association with both positive and negative discharges. This presentation compares the optical and electrical properties of a large number of halos and sprite-halos imaged over the U.S. Great Plains and over Northern Argentina in South America. Our goal is to improve current knowledge of their characteristics and variability.

4:04PM C5.00003 Exoplanet's Atmospheres Characteristics vs. Exoplanet's Orbital Elements[1]

, KARAN MOLAVERDIKHANI — 400 years after Galileo Galilei was detected Jovian system, we know about 400 exoplanets in other stellar systems. But we identify just about their major properties like some of orbital elements, planet's radii or density. Also, there are many scientists who interested in searching for life or habitability on these planets. They are working in different ways such as planetary formation, planetary orbital stability or immigration, HabStars, composition of atmospheres, most probable zone in sky for exoplanets detection, etc. In this research we distinct and defined some main characteristics of terrestrial planet's atmospheres with surveying on solar system's planets and matching with current theorems on atmosphere formation. On the other hand, we were modeled Mars, Venus, Titan, single Hadley Earth and virtual Venus with different tilt angel (applying Global Circulation Modeling) to finding a critical limit on Polar Vortex formation in our last research. With extension this method on hypothetical terrestrial planets in constraint mass between 0.7 to 2.5 Earth's mass on Green Belt and applying host stars from 0.5 to 1.5 Sun's mass, we found some limitations on planet's atmosphere formation and estimation values of atmosphere's main characteristics.

[1]We gratefully acknowledge professor Lee for his helpful guidance and NStED collaboration.

4:16PM C5.00004 Methane Imaging Search for Planetary Mass Objects in Rho Ophiuchi[1]

, SHERENE HIGLEY, KARL E. HAISCH JR., Utah Valley University, MARY BARSONY, San Francisco State University, CHRIS TINNEY, University of New South Wales — T dwarfs are the coolest and least massive compact astrophysical objects that we can directly observe outside our Solar System. They share many properties with the expanding population of known exoplanets (almost all of which are inaccessible to direct observation themselves). An understanding of T dwarf atmospheres, therefore, is critical to our developing understanding of exoplanets. Moreover, T dwarf surveys in young star clusters can provide important answers to questions such as "Is there a minimum mass for star formation?" and "How important is dynamical evolution for cluster mass functions?" In recent years, methane imaging has emerged as a powerful tool for identifying T dwarf candidates in very young clusters, where T dwarfs are at their brightest and have not yet been subject to possible dynamical ejection from their clusters. We have recently conducted a methane imaging survey of the Rho Ophiuchi cluster for T dwarfs using the IRIS2 near-infrared imaging spectrograph on the Anglo-Australian Telescope. The Rho Ophiuchi cluster is the closest (d $\sim$ 120 parsecs) star-forming region to Earth that has a compact core harboring several hundred young ($\sim$ 1 Myr) stellar objects. In this talk, we present the results of our imaging survey.

[1]Scholarly and Creative Activities Council

4:28PM C5.00005 Can a Planetary System Survive a Host Star Supernova Explosion?

, ALEXANDER PANIN, JUSTIN GIOVANNONI, Utah Valley University — The recent search for extrasolar planets has brought a surprising discovery – almost any star seems to have a planetary system around it. We know that massive stars end their lives in a violent supernova explosion, during which extremely large amount of energy (3x10 46J) is released by the star in a very short time. Can a planetary system survive such a violent event? Can a planet survive? Can planetary biosphere survive? In the current presentation we analyze, based on known physics, the effect of a supernova explosion on a planet orbiting such a star in its habitable zone. Our calculations show that even a small Earth-like planet is not destroyed mechanically nor thermally in such an explosion (and larger planets are even more stable). Nor is a planet kicked out of its orbit due to the momentum of exploding star shell or of due to star's radiation pressure. In some cases even a portion of a planetary biosphere (deep in planet's crust) can survive. However, if a star loses too much mass, a planet would leave. Also, if star's collapse is asymmetric then the star itself can leave the planetary system. The sequence of events during supernova explosion and how they influence such a planet is discussed in the presentation.

4:40PM C5.00006 The Elasticity of (Fe,Ni) Alloys

, OWEN BOBERG, New Mexico, BORIS KIEFER — The Earth's core is the most remote part of the interior of our planet. Astronomical and cosmochemical evidence suggest that the composition of the core is dominated by an iron-rich (Fe_{1-x},Ni_x) alloy that likely contains at least one light element. At ambient conditions Fe adopts a bcc structure and undergoes a phase transition to hcp at high pressure (P $>\sim$13 GPa). However, the stable phase in the presence of nickel and/or light element(s) at inner core pressures (P$\sim$3.7 million atmospheres) is much less certain. Using *state-of-the-art* density-functional-theory calculations we determined the effects of Ni concentration on the elasticity and stability of FeNi alloys. We find that hcp derived FeNi alloys are stable at 0K, at least for 3.1 at%, 6.2 at%, and 12.5 at% nickel content, which encompasses the expected nickel content in the Earth's core ($\sim$5-10 at%). Furthermore we find that the bcc structure is least stable. This is in contrast to recent work that finds that bcc derived FeNi is stable. We will discuss possible reasons for this difference and its implications for core chemistry and structure.

Friday, October 23, 2009 3:40PM - 4:52PM –

Session C6 BEC and Atom Interferometry gre 249

3:40PM C6.00001 Spatial Dependence of Entropy in Trapped Ultracold Bose Gases[1]

, LINCOLN D. CARR, Colorado School of Mines, MARKUS K. OBERTHALER, Kirchhoff Institute for Physics, University of Heidelberg — We find a new physical regime in the trapped Bose-Hubbard Hamiltonian using time-evolving block decimation. Between Mott-insulating and superfluid phases, the latter induced by trap compression, a spatially self-organized state appears in which non-local entropy signals entanglement between spatially distant superfluid shells. We suggest a linear rather than harmonic potential as an ideal way to observe such a self-organized system. We also explore both quantum information and thermal entropies in the superfluid regime, finding that while the former follows the density closely the latter can be strongly manipulated with the mean field.

[1]Supported by the National Science Foundation, by the Graduate School of Fundamental Physics at the University of Heidelberg, by the Aspen Center for Physics, and by the ExtreMe Matter Institute EMMI in the framework of the Helmholtz Alliance.

3:52PM C6.00002 Nonlinear Scattering of BECs on a Finite Barrier[1]

, RACHEL R. MILLER, LINCOLN D. CARR, Colorado School of Mines — We consider the scattering of a Bose-Einstein condensate (BEC) on a finite barrier. The nonlinear Schrödinger equation (NLS) models the mean field of a BEC. The nonlinearity gives rise to several interesting physical and mathematical features which are not present in the linear problem. We present density and transmission plots for several physical cases, along with a discussion of these novel features. We also use the theory to model recent experiments.

[1]We gratefully acknowledge the support of the National Science Foundation.

4:04PM C6.00003 p-Wave Resonant Bose Gas: A Finite-Momentum Spinor Superfluid[1]

, SUNGSOO CHOI, LEO RADZIHOVSKY, University of Colorado at Boulder — We study a degenerate gas of two-species bosonic atoms interacting through a p-wave Feshbach resonance (as realized in, e.g., a ^{85}Rb-^{87}Rb mixture). We show that this model exhibits a finite-momentum atomic-molecular superfluid (AMSF), sandwiched by a molecular p-wave (orbital spinor) superfluid and by an s-wave atomic superfluid at large negative and positive detunings, respectively. The magnetic field can be used to tune the modulation wave vector of the AMSF state, as well as to drive quantum phase transitions in this rich system.

[1]NSF No. DMR-0321848

4:16PM C6.00004 Calculation of Feshbach Resonances with Rb-85 Atoms Using Realistic Potentials to Constrain Separable Potentials[1]

, WALTER UNGLAUB, J.A. MCNEIL[2], Colorado School of Mines — The phenomenology of Feshbach resonances in cold quantum gases has been studied with Rb-85 atoms in the presence of an external magnetic field. For a pair of such atoms interacting with a particular magnetic field value, various separable potential models have been utilized to calculate the singlet and triplet scattering lengths and corresponding strength parameters from fitted dipole form factors. Such calculations are extended to incorporate more realistic potential models in order to constrain separable potentials applicable to the 3-body interaction. Unitary pole expansion approximations are explored in the attempt to extract the particular atomic states contributing to the Feshbach resonance from spectral decompositions of such realistic potentials. A full 2-body calculation of Rb-85 atoms is to be presented in position- space, from which 3-body calculations in momentum-space can be done in order to study the phenomenon of 3-body recombination and breakup processes in cold quantum gases.

[1]Colorado School of Mines

[2]Research Advisor

4:28PM C6.00005 A Slow Ion Strontium Interferometer

, CHRISTOPHER ERICKSON, DALLIN DURFEE, BYU — I will discuss an interferometer centered around a laser-cooled source of $^{87}Sr^+$ ions, which will be split and recombined using stimulated Raman transitions. This will take place inside a conducting cylinder allowing the interferometer to measure electric and magnetic fields with unprecedented precision. Practical applications for the device include the precision measurement of the evolution of fields near solids to reveal their electronic structure. It will also be used for fundamental tests of the basic laws of electromagnetism and the search for a non-zero photon rest mass. The device should detect possible photon rest mass more than 100 times smaller than previous laboratory experiments. Both the details of the device and the theory connecting deviations from Coulomb's inverse-square law to a theory of massive photons will be discussed.

4:40PM C6.00006 Optical Feshbach Resonances in Alkaline Earth Atoms

, T.L. NICHOLSON, JILA and University of Colorado, S. BLATT, G.K. CAMPBELL, B.J. BLOOM, J.W. THOMSEN, J. YE, University of Colorado — Recent proposals have shown that a quantum degenerate gas of alkaline earth atoms can be used for a number of novel quantum computing and quantum simulation experiments. Strontium is a good candidate for such experiments because it can be controlled with high precision, as demonstrated in recent atomic clock experiments. Unfortunately, the small scattering length of strontium is not amenable to evaporative cooling techniques that are used to reach quantum degeneracy. Furthermore, increasing the scattering length of alkaline earths with a magnetic Feshbach resonance is not possible due to their spinless electronic ground state configuration. However, recent theoretical and experimental work suggests the possibility of changing scattering lengths in alkaline earths with laser light. Using this optical Feshbach resonance near strontium's narrow $^1S_0 \rightarrow ^3P_1$ intercombination transition might allow its scattering length to be controlled without significant atom loss. We report our recent progress in demonstrating an optical Feshbach resonance in strontium 88.

Friday, October 23, 2009 3:40PM - 4:52PM –
Session C7 Symposium on Renewable Energy – PV Green Center 263

3:40PM C7.00001 Single Molecule Lifetime Studies of Small Clusters of Semiconductor Nanocrystals , DOUGLAS SHEPHERD, Physics Department, Colorado State University, KEVIN WHITCOMB, Chemistry Department, Colorado State University, PETER GOODWIN, Center for Integrated Nanotechnology, Los Alamos National Laboratory, MARTIN GELFAND, Physics Department, Colorado State University, ALAN VAN ORDEN, Chemistry Department, Colorado State University — Enhanced fluorescence intermittency has been reported in single molecule fluorescence experiments on small clusters of semiconductor nanocrystals[1], and single Mn^{2+} doped semiconductor nanocrystals[2]. This behavior is attributed to electronic coupling between nanocrystals in the clusters. We report here on further studies of small clusters of semiconductor nanocrystals utilizing single molecule time-correlated single photon counting, which provides insight into the nature of the coupling. According to this analysis, clusters typically blink on a microsecond to millisecond time scale; whereas, isolated nanocrystals blink on much longer millisecond to second time scale. 1. Yu, M. and A. Van Orden, *Enhanced Fluorescence Intermittency of CdSe-ZnS Quantum-Dot Clusters.* Physical Review Letters, 2006. **97**(23): p. 237402-4 2. Yanpeng Zhang, C.G., Javed Muhammad, David Battaglia, Xiaogang Peng and Min Xiao, *Enhanced Fluorescence Intermittency in Mn-Doped Single ZnSe Quantum Dots.* Journal of Physical Chemistry C, 2008. **112**(51): p. 20200-20205

3:52PM C7.00002 Surface Modification of Zinc Oxide Nanorods , DARICK BAKER, Colorado School of Mines, CHRISTIAN WEIGAND, Norwegian University of Science and Technology, JAMIE ADAMSON, Colorado School of Mines, CARY ALLEN, University of Arizona, MATT BERGREN, Colorado School of Mines, DANA OLSON, NREL, CECILE LADAM, SINTEF, DAVID GINLEY, NREL, REUBEN COLLINS, THOMAS FURTAK, Colorado School of Mines — Zinc oxide (ZnO) nanorod arrays have a number of advantages over both planar ZnO/P3HT and ZnO/P3HT:PCBM blend solar cell devices. In this study, molecular surface modifications of the ZnO have been explored as a strategy for improving both charge transfer and polymer morphology at the ZnO surface. Surface molecular layers were formed on planar ZnO and ZnO nanorod arrays using octadecyltriethoxysilane, phenyltriethoxysilane, octadecanethiol, and thiophenol. FTIR, SEM, UV-Vis, XPS and contact angle data were used to characterize the resulting layers. The effects of these surface treatments on solar cells are reported. Molecular layers with different attachments to the ZnO but the same terminal group showed different behavior, confirming that both the terminal and attachment group play important roles in interface structure, energetics, and charge transfer. This research is aimed at improving organic solar cell performance, yet is applicable to a broad range of hybrid organic/inorganic systems. Support from NSF Awards DMR-0606054 and DMR-0820518 is gratefully acknowledged.

4:04PM C7.00003 Studying the Nanostructure of Hydrogenated Nanocrystalline Silicon Thin Films , K.G. KIRILUK, D.L. WILLIAMSON, P.C. TAYLOR, Colorado School of Mines, B. YAN, J. YANG, S. GUHA, United Solar Ovonic, LLC — Hydrogenated nanocrystalline silicon (nc-Si:H) is increasingly being used as the bottom layer in multi-junction solar cells. In order to better understand its growth and unique optoelectronic properties, we have used x-ray diffraction (XRD) and small angle x-ray scattering (SAXS) experiments to study its nanostruture. The XRD patterns indicate approximately 20 nm crystallites that are preferentially oriented in the (220) direction. The SAXS intensities indicate that these crystallites are elongated in the growth direction with a width of approximately three to four times less than the length. Combined, these results show ellipsoidal grains oriented in the growth direction. Transmission electron microscopy (TEM) images corroborate these results. The work performed at the Colorado School of Mines is partially supported by NSF under grant number DMR-0702351, by the NSF MRSEC program under grant number DMR-08-20518, and by DOE under subcontract number DE-FC36-07G017053. The work done at United Solar Ovonic is also partially supported by DOE under subcontract number DE-FC36-07G017053.

4:16PM C7.00004 Growth of Tin Seeded Silicon Nanowires (SiNWs) Using Plasma Enhanced Chemical Vapor Deposition[1] , SOMILKUMAR RATHI, JOSEPH BEACH, JEREMY FIELDS, BHAVIN JARIWALA, SUMIT AGARWAL, REUBEN COLLINS, Colorado School of Mines , PAULS STRADINS, National Renewable Energy Laboratory — Silicon nanowires (SiNWs) have attracted much attention among the photovoltaic community. With high surface to volume ratios, these nanowires are ideal candidates for nano-structured solar devices. Considerable effort has been put towards the growth and characterization of these nanowires. However, growing high quality SiNWs for PV applications is still considered to be a challenge. The role of different metal seeds during vapor-liquid-soild (VLS) growth and the electronic properties of these wires is also investigated. The present study extends the available literature on the use of Sn as a metal catalyst for VLS growth of SiNWs

[1]Support of the NSF Renewable Energy Materials Research Science and Engineering Center and Center for Revolutionary Photoconversion is gratefully acknowledged.

4:28PM C7.00005 Electron Reflector to Enhance Photovoltaic Efficiency: Application to Thin-Film CdTe , KUO-JUI HSIAO, Colorado State University — Numerically, electron reflector, which is a strategy to enhance the efficiency of photovoltaic devices, is applied to thin-film CdTe record-cell baseline model (efficiency = 16.5%). Simulation shows that to have the optimal effect from electron reflector, thinning cells to few microns is required. Moreover, thin cells (absorber layer below two microns) will have additional benefit from the optical reflection from the back surface. Theoretically, more than 19.5% efficiency is achievable with 0.2-eV electron reflector, 1-micron absorber layer, 10^{14} cm^{-3} hole density, and 1-ns lifetime. Moreover, 20% efficiency is possible with the consideration of 100% optical reflection. Realistic case should have the performance in the case between 20 and 100% optical reflection. This work gives thin-film CdTe cell an approach to 3% increase in efficiency.

4:40PM C7.00006 Interference Lithography for Vertical Photovoltaics , AMY BALLS, LEI PEI, JOSHUA KVAVLE, ANDREW SIELER, STEPHEN SCHULTZ, MATTHEW LINFORD, RICHARD VANFLEET, ROBERT DAVIS, Brigham Young University — We are exploring low cost approaches for fabricating three dimensional nanoscale structures. These vertical structures could significantly improve the efficiency of devices made from low cost photovoltaic materials. The nanoscale vertical structure provides a way to increase optical absorption in thin photovoltaic films without increasing the electronic carrier separation distance. The target structure is a high temperature transparent template with a dense array of holes on a 400 - 600 nm pitch fabricated by a combination of interference lithography and nanoembossing. First a master was fabricated using ultraviolet light interference lithography and the pattern was transferred into a silicon wafer master by silicon reactive ion etching. Embossing studies were performed with the master on several high temperature polymers.

Friday, October 23, 2009 3:40PM - 4:52PM –

Session C8 Symposium on Physics Education I: PER and Educational Transformations

Green Center 265

3:40PM C8.00001 What does it mean to learn physics? , VALERIE OTERO, University of Colorado at Boulder — Learning physics involves much more than developing a "conceptual understanding" of a phenomenon. Part of learning physics involves learning how to reason with evidence, learning how to engage in mechanistic reasoning, and learning how to generate and use models. These important scientific practices are rarely explicitly addressed in physics courses. I will present physics education research that focuses on how these practices unfold for students as they attempt to develop a model of magnetism on the basis of their observations. I will also present data that suggests that students increase their interest in physics and develop positive attitudes about physics as a result of participating in the practice of model building in the physics class. I conclude by discussing how learning physics has as much to do with learning a specialized "Discourse" as it does with learning the canonical knowledge of the discipline.

4:04PM C8.00002 Sustaining Educational Transformation in a Physics Department (part 1 of 2)[1] , NOAH FINKELSTEIN, STEVEN POLLOCK, Department of Physics, University of Colorado — The CU Boulder Physics Department has been engaged in the systematic transformation and study of many of its physics courses for the last five years. We report on two interrelated research threads: 1) sustaining and 2) scaling of educational innovations. In this first, of two talks, we examine the sustainability of two of the most widespread PER-based innovations, Peer Instruction and the University of Washington's Tutorials in Introductory Physics, at our institution. We demonstrate measures of improved student conceptual mastery, and that these achievements can be reliably maintained as the introductory sequence is taught by a variety of faculty. Applying a contextual constructivist framework, we document key factors that might account for the success and variation in student performance.

[1]With support from NSF CCLI and REESE awards.

4:16PM C8.00003 Scaling Educational Transformation in a Physics Department (part 2 of 2)[1] , STEVEN POLLOCK, NOAH FINKELSTEIN, PAUL BEALE, STEPHANIE CHASTEEN, MICHAEL DUBSON, STEVEN GOLDHABER, KATHERINE PERKINS, CHANDRA TURPEN, University of Colorado, Boulder — We report on two interrelated research threads, sustaining and scaling of educational innovations. In this second of two talks, we examine the scaling of educational innovations into the upper division. We have begun course transformation of Quantum Mechanics and E&M, which employ the practices and findings from educational research at the lower division. Related, we examine the spread of clicker-based approaches into the upper division and graduate level courses. We have studied faculty choices about how they come to adopt these reforms, and what choices they make as they adopt new materials and pedagogical approaches. We identify critical components of success: resources (whether undergraduate learning assistants or post-doctoral science teaching fellows), faculty buy-in and inclusion (from the earliest stages), and institutional support.

[1]Work supported by the Science Education Initiative at Colorado and NSF CCLI.

4:28PM C8.00004 Enriched Curriculum for Energy Education , RUWANG SUNG, University of Northern Colorado — Introducing fundamental science concepts and real world issues in energy, renewable energy, energy conservation and the environment to college students has become increasingly important and urgent in higher education. Efforts to effectively incorporate energy materials have led to improvements in the instructional methodology of the general education course "Energy and the Environment." A new approach will be reported, including: 1) adding hands-on projects related to daily life experience; 2) infusing updated information on renewable energy applications into course projects through collaborations; 3) introducing energy and environmental concepts to art majors to stimulate creative art work; 4) broadening student understanding of related issues from a global perspective through a successful study-abroad initiative; and 5) using an online course platform *EnhanceEdu* to manage multilevel interactions with students.

4:40PM C8.00005 Using a Non-Equivalent Groups Quasi Experimental Design to Reduce Internal Validity Threats to Claims Made by Math and Science K-12 Teacher Recruitment Programs , LAURA MOIN, University of Colorado at Boulder — The American Recovery and Reinvestment Act national policy established in 2009 calls for "meaningful data" that demonstrate educational improvements, including the recruitment of high-quality teachers. The scant data available and the low credibility of many K-12 math/science teacher recruitment program evaluations remain the major barriers for the identification of effective recruitment strategies. Our study presents a methodology to better evaluate the impact of recruitment programs on increasing participants' interest in teaching careers. The research capitalizes on the use of several control groups and presents a non-equivalent groups quasi-experimental evaluation design that produces program effect claims with higher internal validity than claims generated by current program evaluations. With this method that compares responses to a teaching career interest question from undergraduates all along a continuum from just attending an information session to participating (or not) in the recruitment program, we were able to compare the effect of the program in increasing participants' interest in teaching careers versus the evolution of the same interest but in the absence of the program. We were also able to make suggestions for program improvement and further research. While our findings may not apply to other K-12 math/science teacher recruitment programs, we believe that our evaluation methodology does and will contribute to conduct stronger program evaluations. In so doing, our evaluation procedure may inform recruitment program designers and policy makers.

5:00PM - 5:00PM –
Session D1 Poster Session (5:00-6:30 PM) Green Center Lobby

D1.00001 Temperature Dependence of the Electrostatic Breakdown of Polymeric Insulators[1] , CHARLES SIM, J.R. DENNISON, Utah State University — The temperature dependence of the electrostatic discharge of polymeric insulators has been measured by applying a high voltage across the polymer to induce an electrical breakdown. The breakdown electric field was determined by a rapid rise in I-V curves that were measured in a custom, high vacuum chamber over a temperature range of ∼150 K to ∼320 K. Our results showed the electrostatic discharge of the polymer Low Density Polyethylene (LDPE) to be 318±60 (±18%) MV/m with no significant variation over the full temperature range. The results are compared with thermodynamic models of the electric field aging process and limited prior measurements. The motivation for this research was the concern of spacecraft charging and the potential damage from electrostatic breakdown of polymers to be used on the James Webb Space Telescope, which will operate at temperatures down to 30 K.

[1]USU URCO Fellowship

D1.00002 Charge Dynamics in Disordered Insulating Materials[1]

ALEC SIM, J.R. DENNISON, Utah State University — Modeling and understanding electron transport in disordered insulating materials is fundamentally based on a detailed knowledge of the distribution and occupation of the density of states of nearly free and trapped charged carriers. The conductivity of the material is a key transport parameter in determining charge mobility, how rapidly charge imbalances will accumulate or dissipate, and what equilibrium potential will be established under given experimental conditions. We motivate a discussion of conductivity mechanisms with simple physical concepts that lead to a wide variety of observed physical phenomena. In particular, we extend the standard band model for extended state conduction to include the effects of localized trap states within the band. We discuss trap controlled transport and its relation to the mobility and density of conduction electrons. We consider the following commonly observed conduction mechanisms; thermally activated and variable range hopping conductivity, radiation induced conductivity and luminescence.

[1]NASA RMSGC Fellowship

D1.00003 Reduction and Characterization of Error in Low Current Measurements

JUSTIN DEKANY, J.R. DENNISON, ALEC SIM, Utah State University — An apparatus has been developed to measure electron transport at a level low enough that radiation induced conductivity associated with the cosmic background radiation is of concern. To accurately measure such low currents, typically A, it is critical to eliminate noise in key components of the hardware setup. Improvements include highly filtered signals, ground isolation and stability, extensive shielding, vibration isolation, and signal averaging. Careful tracking of the error associated with each component in the system and examination of the limitations of each constituent part, allows for precise monitoring of error propagation as improvements are made to the system. Successful implementation of these techniques has pushed the lower current limit of a 25 year old Keithley 616 low level electrometer to these extreme limits. These methods have been employed to measure the conductivity of high resistivity polymers, commonly used in the construction of spacecraft.

D1.00004 The Effects of Surface Contamination and Roughening on Diffuse Optical Reflection and Photoyields of Spacecraft Materials[1]

AMBERLY EVANS, J.R. DENNISON, Utah State University — Modification of a material's surface affects the optical properties (reflection, transmission and absorption) and charge accumulation of that material. This project has been designed to study the properties of Kapton HN and gold and the affects that surface modification (roughening and contamination) have on them. Samples of each material were roughened with varying sizes of roughening compounds or contaminated with diffusion pump oil. Reflectivity and transmission measurements were compared for all samples. It is evident that modifying the surface changes the reflectance, implying a change in absorbance. Absorbed photons can contribute to charge accumulation in materials through photoemission, whereas reflected and transmitted photons do not. However, reflection and transmission are readily measured and can be related to absorbance. In the harsh space environment, materials are going to be damaged and contaminated, affecting the optical properties of the material and, in turn, charge accumulation. Understanding absorbance and charge accumulation is important in spacecraft construction because charging can inflict serious damage on spacecraft.

[1]USU Ecceles Fellowship

D1.00005 Carbon Nanotube templated structures

RICKY WYMAN, ROBERT DAVIS, RICHARD VANFLEET, JUN SONG — Carbon nano tubes are of great interest to science due to their strong mechanical and exotic electrical properties. Nano tubes have potential application in transistors, micro electrical mechanical devices (MEMS), and structural materials. We have been using nanotube forests as a template to fabricate larger scale structures. The nanotube template is infiltrated with another material (like silicon or carbon). This infiltration can be thin to stabilize the forest and make a porous structure or thick to make a solid structure. Different methods employed at Brigham Young University of patterning, growing, and infiltrating nano tubes are presented on a poster along with applications.

D1.00006 Ultrafast Laser-induced Structural and Electron Dynamics in Graphite

ZHIBIN LIN, REMRSEC and Dept. of Physics, Colorado School of Mines, ROLAND ALLEN, Dept. of Physics, Texas A&M Univ. — Ultrafast structural and electron dynamics in graphite under femtosecond (fs) laser irradiation are investigated in density-functional-based simulations. We show from our simulations that it is possible to separate a graphene mono-layer from graphite surface at moderate laser excitation where no melting occurs. Strong vibrational excitation of graphene layers is found to cause this monolayer separation. At higher laser excitation, covalent bonds between carbon atoms are significantly weakened by the presence of a large number of excited electrons leading to an ultrafast melting within a few tens of fs following the laser irradiation. In addition, we have observed a potentially useful phenomenon from our dynamic simulations: the excited electrons automatically equilibrate to a Fermi-Dirac distribution within 100 fs, solely because of their coupling to the ionic motion, even though the resulting electronic temperature is one to two orders of magnitude higher than the kinetic temperature defined by the ionic motion. Microscopic simulations like these can then provide the separate electronic and kinetic ionic temperatures, chemical potentials, pressures, and non-hydrostatic stresses as input for studies on larger length and time scales.

D1.00007 Synchrotron Studies on Copper-Phthalocyanine

ROBERT CALL, Utah State University, TREVOR WILLEY, Lawrence Livermore National Laboratory — Studies were carried out using synchrotron radiation to investigate the properties of Copper-Phthalocyanine (CuPc) on different substrates. CuPc's have a wide variety of applications from dye to chemical sensors. This study was done at Lawrence Livermore National Laboratory in conjunction with UC San Diego to investigate properties of CuPc's for application in sensors. Near edge x-ray fine structure spectroscopy (NEXAFS) was used to determine orientations of CuPc molecules on two different substrates (gold and sapphire). Orientations were found to be drastically different on the two substrates. On gold, CuPc molecules were found to be nearly prostrate and on sapphire they were found to be almost normal to the surface.

D1.00008 Quasiparticle Spectrum of 2-d Dirac Vortices in Optical Lattices[1]

LAITH HADDAD, Colorado School of Mines — Bose-Einstein condensates in a honeycomb optical lattice are described by a nonlinear Dirac equaton (NLDE) in the long wavelength, mean field limit [1]. The upper and lower two-spinor equations decouple and superficially resemble the equations of previously studied NLDE's such as the Soler model for extended fermions. Although much work has been done on NLDE's, the bulk of the literature deals with models with Poincare invariant nonlinearites. In contrast our equations break Poincare symmetry providing an opportunity to study phenomenological models in cosmology and particle physics where this symmetry is not manifest. We obtain and classify localized solutions to our equations for both repulsive and attractive contact interactions. We also derive analogs of the Bogoliubov-de Gennes equations for the lattice and use these to study the stability and low energy spectrum of our solutions showing the existence of stable exotic structures such as vortices with fractional statistics.

[1] L. H. Haddad and L. D. Carr, "The Nonlinear Dirac Equation in Bose-Einstein Condensates: Foundation and Symmetries," Physica D: Nonlinear Phenomena, v. 238, p. 1413 (2009). http://arxiv.org/pdf/0803.3039v1

[1]Laith H. Haddad, CSM Department of Physics. Advisor: Lincoln D. Carr

D1.00009 Controlled Ag Nanopattern Formation through UV Wavelength Dependent Photochemical Interactions on PPLN[1]

, YANG SUN, ROBERT NEMANICH, Department of Physcis, Arizona State University — This study establishes that ferroelectric nanolithography is dependent on the excitation wavelength and that the process can be controlled through optimization of the wavelength dependent photochemical surface interactions. Periodically poled lithium niobate (PPLN) is used as a template for "nanolithography" of metallic nanoparticles and nanowires through a photochemical process. Prior research has established that above band gap UV emission is necessary to initiate the deposition process. Depending on the nature of the surface screening, the deposition will occur predominantly on the positive domains (internal screening) or at the domain boundaries (external screening). This research employs PPLN, which exhibits external screening, and it is shown that the location and rate of Ag nanostructure deposition is dependent on the wavelength of the UV excitation. The selective deposition is explained by a combined theory of band-bending, the mechanism of polarization surface charge screening, and the absorption depth of the UV light. As an application example, the Ag nanopatterns are employed for spatially specific surface enhanced Raman spectroscopy (SERS).

[1]NSF Grant DMR -0805353

D1.00010 Anomalous non-magnetic high field loss peak for a high Q copper TE011 microwave cavity

, LIAM KILCOMMONS, Colorado State University, FALKO KUESTER, CARL PATTON, Colorado State University — Recent off resonance magnetic loss measurements with high quality factor (Q) TE011 cavities have revealed the presence of a small anomalous loss peak at high field overlying the usual magnetic response. Precision measurements of the cavity Q vs. field by the ABA metrological substitution method for a special 99.99% pure OFHC (oxygen free high conductivity) copper cavity have now confirmed the presence of a broad and weak yet distinct magnetic field dependent empty cavity loss peak centered at about 8.8 kOe in applied field with a width of about 1 kOe. This loss peak has been confirmed to come from the copper response and not from any type of magnetic impurities or waveguide effects. Possible origins of this response are under investigation.

D1.00011 Large N model of bose gases

, KE KE, LEO RADZIHOVSKY, University of Colorado at Boulder — We construct the large N model of bose gases. Using an artificial parameter 1/N to do the perturbative analysis to study two models: $U(N)$ bose gases and $U(1) \times O(N)$ bose gases. We find that for the U(N) model we get the same Bogoliubov spectrum and LHY thermal dynamical relations with ordinary bose gases. For the $U(1) \times O(N)$ model, however, we calculate dispersion relation, chemical potential and free energy when N goes to infinity and find that every quantities depends on the ration of two scattering length and $\sqrt{(na^3)}$.

D1.00012 Thickness Dependency of Ferromagnetic Domains in CoPt Multilayers

, ANDREW WESTOVER, NATHAN GAY, KARINE CHESNEL, OLAV HELLWIG, BRIGHAM YOUNG UNIVERSITY, PROVO TEAM, HITACHI GLOBAL STORAGE COLLABORATION — Ferromagnetic materials have been providing and still provide large potential technological interests, especially in the data storage industry. We use Atomic and Magnetic Force Microscopy (AFM/ MFM) to study the influence of the film thickness on domain morphology in Co/Pt multilayers. While AFM is sensitive to the topography of the film, MFM allows the imaging of magnetic domains through an interaction between a sharp magnetic probe and the stray fields emanating from the sample in the perpendicular direction. Through this technique we have obtained AFM and MFM images of Co/Pt multilayers ranging from 4A to 60A and have found that as the thickness of the Co/Pt multilayers influences the morphology (periodicity, orientation, and correlation length etc.) of the magnetic domains.

D1.00013 Atomic Force Microscopy Imaging Techniques for Piezoelectric Materials

, JEREMY KUNZ, COLIN INGLEFIELD, Physics Department, Weber State University — Using an Atomic Force Microscope (AFM) and a Lock-in Detector we investigated the effectiveness of two different methods of local piezoelectricity within a standard commercial piezoelectric material, Pb(Ti, Zr)O_3 (PIC 151). In the first method, sometimes known as piezo-mode AFM, we applied an AC voltage to the sample locally through the tip of the AFM; we were able to image the local piezoelectric response while taking a topographical image. For the second set of measurements, we used a sample of the PIC 151 material with a uniform silver electrode over the entire surface. The voltage was applied to the entire sample through the electrodes and the AFM cantilever measured local response. Images based on the two techniques will be compared along with the methods themselves.

D1.00014 Monte Carlo modeling of the spatially dispersive carrier transport in P3HT and P3HT:PCBM blends

, XIN JIANG — The presence of traps, arising from morphohological or chemical defects, can be critical to the performance of organic semiconductor devices. Traps can reduce the charge carrier mobility, disturb the internal electrical field, drive recombination, and reduce the overall device efficiency as well as operational stability. In this work, we investigate the role of traps in determining charge transport properties of organic semiconductors and blends such as P3HT and P3HT:PCBM through Monte-Carlo (MC) simulations in conjunction with time-of-flight (TOF) mobility measurements. We employ a Marcus theory description of individual hopping events based on the molecular reorganization energy (lambda) for the MC simulations. Trap states are modeled as diffuse bands that reside at some energy away from the main transport band. This model is used to simulate TOF transients, and the results are compared to experimental data. As is expected from the Marcus theory equation, the mobility is seen to be maximum for an optimal value of lambda. This optimal value is strongly field dependent, but is found to be independent of the trap density. In comparing MC simulations with TOF data, it is found that inclusion of traps results in a much better fit to the data and provides for a mechanism to simulate dispersive transport with a long tail resulting from trapping and detrapping of carriers before they exit the device. We present results for a range of trap densities and statistical distributions and discuss the implications on the operation of bulk heterojunction organic photovoltaic devices.

D1.00015 Ab Initio Study of Carboxylated Graphene[1]

, NABIL AL-AQTASH, IGOR VASILIEV, New Mexico State UniVersity — We investigate chemical functionalization of graphene by carboxyl (COOH) groups using first principles computational methods. The binding energies and equilibrium geometries of COOH groups covalently attached to graphene clusters with no surface defects, Stone-Wales defects, and vacancies are examined in the framework of density functional theory combined with the generalized gradient approximation. We find that the attachment of COOH groups induces substantial structural changes in graphene. Our calculations show that the binding of the COOH group to graphene is significantly stronger in the presence of surface defects. This result suggest an important role of point surface defects in the carboxylation of graphene.

[1]Supported by NSF DMR-0505270 and DOE DE-FG36-08GO88008.

D1.00016 Positive, Neutral, and Negative Mass-Charges in General Relativity

, DMITRI RABOUNSKI, FLORENTIN SMARANDACHE, University of New Mexico — As shown, any four-dimensional proper vector has two observable projections onto time line, attributed to our world and the mirror world (for a mass-bearing particle, the projections posses are attributed to positive and negative mass-charges). As predicted, there should be a class of neutrally mass-charged particles that inhabit neither our world nor the mirror world. Inside the space-time area (membrane) the space rotates at the light speed, and all particles move at as well the light speed. So, the predicted particles of the neutrally mass-charged class should seem as light-like vortices.

D1.00017 Less Mundane Explanation of Pioneer Anomaly from Q-Relativity

, FLORENTIN SMARANDACHE, University of New Mexico - Gallup, VIC CHRISTIANTO, Sciprint.org — There have been various explanations of Pioneer blueshift anomaly in the past few years; nonetheless no explanation has been offered from the viewpoint of Q-relativity physics. In the present paper it is argued that Pioneer anomalous blueshift may be caused by Pioneer spacecraft experiencing angular shift induced by similar Qrelativity effect which may also affect Jupiter satellites. By taking into consideration "aether drift" effect, the proposed method as described herein could explain Pioneer blueshift anomaly within _0.26% error range, which speaks for itself. Another new proposition of redshift quantization is also proposed from gravitational Bohr-radius which is consistent with Bohr-Sommerfeld quantization. Further observation is of course recommended in order to refute or verify this proposition.

D1.00018 Development of a Pressure Switched Microfluidic Cell Sorter

, BARIS OZBAY, ALEX JONES, EMILY GIBSON, Department of Physics, University of Colorado Denver — Lab on a chip technology allows for the replacement of traditional cell sorters with microfluidic devices which can be produced less expensively and are more compact. Additionally, the compact nature of microfluidic cell sorters may lead to the realization of their application in point-of-care medical devices. Though techniques have been demonstrated previously for sorting in microfluidic devices with optical or electro-osmotic switching, both of these techniques are expensive and more difficult to implement than pressure switching. This microfluidic cell sorter design also allows for easy integration with optical spectroscopy for identification of cell type. Our current microfluidic device was fabricated with polydimethylsiloxane (PDMS), a polymer that houses the channels, which is then chemically bonded to a glass slide. The flow of fluid through the device is controlled by pressure controllers, and the switching of the cells is accomplished with the use of a high performance pressure controller interfaced with a computer. The cells are fed through the channels with the use of hydrodynamic focusing techniques. Once the experimental setup is fully functional the objective will be to determine switching rates, explore techniques to optimize these rates, and experiment with sorting of other biomolecules including DNA.

D1.00019 Vector Inverses and Other Powerful Applications of Geometric Algebra

, TIM WENDLER, MANUEL BERRONDO, Brigham Young University — Geometric algebra has an elegance and simplicity that motivates reforming traditional analytic representations in physics. I exploit the ease of the vector inverse with a sphere-to-plane mapping application on the method of images in electrostatics. I also briefly explore rotors, Green functions, and more, to illustrate the power of geometric algebra in the physics curriculum.

D1.00020 A fully connected qubit network model for quantum information processing applications[1]

, MARK COFFEY, Colorado School of Mines — We describe a fully connected qubit (spin-1/2) network model for quantum information processing applications. This scalable network in the case of spin 1/2 has recently been realized in the laboratory, using Josephson phase qubits, and other solid- state implementations are likely. We have very recently collaborated in the development of a rigorous protocol for producing the important maximally entangled generalized GHZ states for this implementation [1]. (GHZ states generalize the well known Bell states for two qubits.) As an additional application of the spin network model, we mention how it could be used to perform factoring or other tasks of interest to computational number theory. Joint work with Andrei Galiautdinov and Ron Deiotte.

[1] A. Galiautdinov, M. W. Coffey, and R. Deiotte, arXiv:0907.2225v1 (2009).

[1]Work partially supported by Northrop Grumman.

D1.00021 Loss Induced via $5P_{3/2}$ to $5D_{5/2}$ Resonant Light in an ^{85}Rb MOT[1]

, TRUMAN WILSON, JACOB ROBERTS, Colorado State University — As part of our investigations of possible routes to photoionization in a Rb MOT, we observed relatively large density-dependent loss rates induced by light at 776 nm. This light corresponds to the $5P_{3/2}$ to $5D_{5/2}$ transition in Rb. This poster presents our characterization of these losses.

[1]We would like to acknowledge the support of the Monfort Foundation.

D1.00022 Self-trapped dynamics in a 2D optical lattice

, SHUMING LI, JILA & Department of Physics, University of Colorado, Boulder, RAFAEL HIPOLITO, Department of Physics, Boston University, JEAN-FELIX RIOU, DAVID WEISS, Physics Department, The Pennsylvania State University, University Park, ANATOLI POLKOVNIKOV, Department of Physics, Boston University, ANA REY, JILA & Department of Physics, University of Colorado, Boulder — We use a mean field model to study the expansion of an array of one dimensional vertical tubes of cold bosonic atoms confined in a two dimensional optical lattice after the crossed dipole trap used for the initial loading is suddenly turned off. In our model the pure mean field dynamics predicts macroscopic self trapping manifested in the accumulation of atoms at the edge of the cloud and the formation of a hole at the center. When quantum fluctuations are accounted for, the localization of the wave packet is enhanced, the formation of the hole is suppressed, and the predictions of the model are in better agreement with the experimental measurements.

D1.00023 Spectroscopy of High-L Rydberg States of Nickel

, KRISTEN VOIGT, STEPHEN LUNDEEN, JULIE KEELE, SHANNON WOODS, Colorado State University — In this study, the fine structure of high-L Rydberg states of nickel is measured. In these high-L Rydberg states, a highly excited "spectator electron" reveals, by the details of its binding energy, certain properties of the Ni+ ion which it "orbits". These special states are created and measured by a technique called RESIS: Resonant Excitation Stark Ionization Spectroscopy. This method involves creating a fast beam of Ni+ ions which travel through a Rb 9F Rydberg target where many of them capture a single electron to form Rydberg states of neutral nickel with population concentrated near n=9. Any unneutralized Ni+ ions are blocked by a high electric potential. The fast Ni Rydberg atoms then pass through a Doppler-tuned CO2 laser which may excite them from n=9 to n=19 or 20, and any atoms so excited are ionized by a strong electric field and collected and counted. As the CO2 laser is tuned across the excitation resonance, the complex fine structure of n=9 L > 5 levels is fully resolved, and analysis of the fine structure pattern determines properties of the Ni+ ion such as its quadrupole moment and polarizabilitiy. Currently, the data of the study is being analyzed to give unprecedented results for these properties of Ni+.

D1.00024 Resolution Enhancement Through Focal Field Polarization Control in Third Harmonic Generation Microscopy , OMID MASIHZADEH, PHILIP SCHLUP, RANDY BARTELS, Colorado State University — In optical microscopy, the polarization state of the focal field strongly influences formed images due to its impact on effective focal spot size, and interactions with the sample. We demonstrate control over focal field spatial polarization state improves spatial resolution in laser-scanning third harmonic generation (THG) microscopy. The focal field is manipulated by imaging a spatial light modulator to the focal plane of a moderate numerical aperture microscope. The resolution enhancement arises as THG is quenched for circularly-polarized fundamental field in isotropic media. A transverse spatial resolution of up to 2 times is demonstrated. Moreover, a non-iterative algorithms is developed for characterization of the polarization state at the focus under moderate focusing. In this regime, the recorded THG signal is dominated by the incident paraxial polarization component, the spatial polarization state is determined non-iteratively via three linear-polarization projection THG images. A nano-particle, localizes THG scattering to a small focal volume. Scanning this nano-probe through the focal volume allows for complete reconstruction of the vector point spread function, yielding transverse field components from the focal volume.

D1.00025 Metastable states and macroscopic quantum tunneling in a cold atom Josephson ring , DMITRY SOLENOV, DMITRY MOZYRSKY, Theoretical Division (T-4), Los Alamos National Laboratory — We study macroscopic properties of a system of weakly interacting neutral bosons confined in a ring-shaped potential with a Josephson junction. We derive an effective low energy action for this system and evaluate its properties. In particular we find that the system possesses a set of metastable current-carrying states and evaluate the rates of transitions between these states due to macroscopic quantum tunneling. Finally we discuss signatures of different metastable states in the time-of-flight images and argue that the effect is observable within currently available experimental technique.

D1.00026 Microscopy of extreme ultraviolet lithography masks with 13.2 nm table-top laser illumination , S. CARBAJO, F. BRIZUELA, Y. WANG, C.A. BREWER, F. PEDACI, W. CHAO, E.H. ANDERSON, Y. LIU, K.A. GOLDBERG, P. NAULLEAU, P. WACHULAK, M.C. MARCONI, D.T. ATTWOOD, J.J. ROCCA, C.S. MENONI, COLORADO STATE UNIVERSITY TEAM, LAWRENCE BERKELEY NATIONAL LABORATORY TEAM — We report the demonstration of a reflection microscope that operates at 13.2 nm wavelength with a spatial resolution of 55+/-3 nm. The microscope uses illumination from a tabletop extreme ultraviolet laser to acquire aerial images of photolithography masks with a 20 s exposure time. The sample used for the initial demonstration of this EUV microscope consisted of Ni grating and elbow patterns printed onto a Mo/Si multilayer coated 2.5×2.5 cm square Si wafer. Patterns with half-pitch sizes ranging from 80 nm to 500 nm were successfully printed onto the Mo/Si coated sample. The modulation transfer function of the optical system was characterized and these results constitute a first step toward the realization of table-top actinic microscopes for EUVL mask inspection.

D1.00027 Matter-Wave Interferometery at BYU , CHRISTOPHER ERICKSON, JAMES ARCHIBALD, BYU, DANIEL MERRILL, Purdue University, AARON BENNETT, DALLIN DURFEE, BYU — We report on the progress of two matter-wave interferometers at BYU. The first device is a thermal-beam Ramsey-Bordé calcium interferometer. The second device is an ion interferometer based on a laser-cooled $^{87}Sr^{+}$ beam which will be split and recombined using stimulated Raman transitions. Design considerations, instrumentation development, and possible applications of the devices will be discussed.

D1.00028 Intra-Annual Comparison of Mesospheric Gravity Waves Over Halley and Rothera Stations, Antarctica , JONATHAN PUGMIRE, MICHAEL TAYLOR, KIM NIELSEN, ALLEN WALL, JONATHAN THOMPSON, DOMINIQUE PAUTET, Utah State University, Center for Atmospheric and Space Sciences, UTAH STATE UNIVERSITY TEAM, BRITISH ANTARCTIC SURVEY TEAM — We present an intra-annual study of short-period, mesospheric gravity wave events observed over Antarctica in the near infrared OH emission. The measurements were made using an all-sky airglow imager operated at either Halley Station on the Brunt Ice Shelf, or Rothera Station, situated on the Antarctic Peninsula. A total of six austral winter seasons have been analyzed (2000-2006). This study comprises the first detailed winter seasonal investigation of short-period mesospheric gravity waves at high-Antarctic latitudes. Distributions of their observed wave parameters were found to be similar to previous findings using imaging instrumentation at other latitudes in the Northern and Southern Hemispheres. However, the observed wave headings exhibited strong, but dissimilar anisotropy at both sites that was also found to be repetitive from year to year, establishing a persistent recurrent pattern. In this poster we present example wave data and seasonal summaries of their properties at both observing sites focusing on wave anisotropy and the strong year to year consistency.

D1.00029 A Quantitative Analysis of the Clustering around Intermediate-Mass Pre-Main Sequence Stars[1] , WILL FLANAGAN, University of Colorado, NICOLE VAN DER BLIEK, JAYADEV RAJAGOPAL, Cerro Tololo Interamerican Observatory — The study of intermediate-mass pre-main sequence stars (Herbig Ae/Be stars) o?ers the possibility a more complete picture of star formation theory by bridging the gap between high and low mass star formation regimes. The clustering around Herbig Ae/Be stars has been studied by other groups, most notably Testi et al. (1999). We present preliminary results from a survey of Herbig Ae/Be stars using the Two Micron All-Sky Survey Point Source Catalog (2MASS PSC). From our results, we present implications for comparing results to and improving the analysis of the Testi et al. survey, the utility of the 2MASS catalog for such a survey, and implications for our own survey. In particular, we discuss the possibility and limitations of studying clustering as a function of mass, as well as characterizing the cluster companions of our Herbig stars with JHK colors.

[1]This project was supported in part by the NSF REU program.

D1.00030 Study of Galaxy NGC 3885 Centered at 100 micro meter Far Infrared Cavity[1] , BARUN GUPTA, University of Utah — A cavity in the 100 μm infrared sky is investigated and it's shaping mechanism is studied. Interestingly, a galaxy NGC 3885 is found to be located at the center of the cavity. In this work we have calculated the amount of the displaced mass emitted from the cavity. In addition, we estimated the energy required to displace the calculated mass from the cavity. For this, we used Groningen server in order to get high resolution 500 x 500 pixel image of the region of interest. The software ALADIN2.0 is used for the data processing and MATLAB6.2 is used for the calculation. The nature of the discrete sources and the multiwave-length images are studied in the field of interest. The displaced mass is found to lie in the range 8.60x10^{-6} M (solar mass) to 1.73x10^{-6} M (solar mass) for the distance 20±20% pc and the temperature 20±20% K. Active galactic nuclei of the galaxy NGC 3885 powers the surroundings by emitting a jet having energy in the range 10^{32}-10^{34} Joule/s. In our case, we estimated $\sim$ 1.1x10^{31} Joule/s to 7.5x10^{32} Joule/s energy, which is essential to create the cavity. Thus, there is a very good compatibility between these estimates. We conclude that the shaping mechanism of this cavity is due to the extragalactic jets emitted from the super massive black hole of the galaxy NGC 3885.

[1]University of Utah

D1.00031 Characterization of Enzyme Structure-Function Relationship of Adenylosuccinate Lyase , STEPHEN RAY, University of Denver (DU), DAVID PATTERSON, Eleanor Roosevelt Institute (ERI), KINGSHUK GHOSH, DU, TERRY WILKINSON, ERI, SEAN SHAHEEN, DU — Adenylosuccinate lyase (ADSL) is an enzyme involved in de novo purine biosynthesis required for several important biological functions. Occasionally disturbances within the enzyme occur, causing a disorder known as ADSL deficiency. It is likely these mutations affect the formation of the tetramer structure by protein misfolding or aggregation. We are beginning to study fundamental properties of the enzyme structure-function relationship of Wild-Type ADSL compared to mutants associated with ADSL Deficiency with two major studies: i) Stability and formation of multimeric complexes in a heterogeneous pool of other structures, ii) Enzymatic activity and reaction kinetics studies by measuring reaction rates of the conversion of substrate into products and enzyme substrate complex formation equilibrium. Our group has successfully expressed Wild-Type (WT) and the mutants R426H and A291V in a protein expression vector and have measured their respective enzyme activity after purification. Modelling approaches for molecular interactions of monomer subunits show the trimer structure could be problematic. We have also carried out our preliminary analysis of the structure-function relationship using microscopic model for the A291V mutant compared to the WT protein.

D1.00032 Field Friendly Tuberculosis Biosensor , N. PROPER, M.S. SCHERMAN, K.L. JEVSEVAR, J. STONE, M.R. MCNEIL, D. KRAPF, Colorado State University, KRAPF LABS COLLABORATION — Tuberculosis (TB) is a fading threat in the United States, but in the developing world it is still a major health-care concern. Given the rising number of cases and lack of resources, there is a desperate need for an affordable, portable detection system. We are working towards the development of a field-friendly immunological biosensor that utilizes florescence microscopy to undertake this task. We observe fluorescently labeled antibodies/antigens as they bind to a glass slide treated with polyethylene glycol (PEG) in order to inhibit non-specific adsorption. Antibodies against the antigens of interest are bound to the PEGylated glass slides via biotin-streptavidin interactions. Then, fluorescently labeled antibodies are mixed with different concentrations of TB antigens and this solution is incubated on the treated glass slides for 30 minutes. The slides are thoroughly rinsed with water following the incubation period. The antigens are then detected by fluorescence using a low-cost biosensor. Our system includes a "supermarket-scanner" HeNe laser, home-built electronics, off-the-shelf optics and a Si photodiode. Work is underway to incorporate a flow-cell into the system, in a small portable box.

D1.00033 UV Photo-enhanced Adsorption of DNA on Mica[1] , SARAH RUPPRECHT, YANG SUN, ROBERT NEMANICH, Department of Physics, Arizona State University, NSL TEAM — Studies of DNA adsorption on mica have contributed to the further understanding of signal detection and immobilization for biosensors. Over the past two decades DNA adsorption has been investigated to further understand how immobilization occurs. The experiment presented here explores the effects of UV light exposure on double-strand lambda DNA immobilization on mica. In this research atomic force microscopy (in non-contact mode) was employed to image mica surfaces after exposure of the surface to a buffered solution containing DNA. The mica surfaces were immersed in the liquid for 5 min with and without UV exposure from a Hg arc lamp. The surfaces were rinsed and then imaged in the AFM, and individual DNA strands were clearly evident. The sample incubated with UV light showed a significantly enhanced adsorption. The results are discussed in terms of the photo excited carriers in the mica and charge transfer processes and their affect on the adhesion process. Further experiments are planned to observe the effects of UV exposure to adsorption of DNA on polarity patterned surfaces of ferroelectric materials.

[1]NSF Grant DMR -0805353

D1.00034 Fluorescence correlation spectroscopy to measure the metabolism of high-density lipoprotein , RUSSELL DEITRICK, EMILY GIBSON, University of Colorado Denver, Dept of Physics, HAMID RAZZAGHI, University of Colorado Denver, Dept of Cardiology — High-density lipoprotein (HDL), referred to as the "good cholesterol", carries free cholesterol to the liver to be filtered from the bloodstream and is important to our understanding of atherosclerosis. HDL is metabolized in part by the enzyme Endothelial Lipase (EL). With this project we will use fluorescence correlation spectroscopy (FCS) to study the metabolism of HDL by EL comparing wild type with different genetic mutations. FCS is an advanced microscopy technique in which we record fluctuations in the fluorescence of dye-labeled molecules (in this case, HDL labeled with Nile Red) as they freely diffuse through a small focal volume. This data can be analyzed mathematically using the cross-correlation function, from which we can ultimately ascertain much information. In our case, we are interested in the diffusion coefficient which, via the Stokes-Einstein relation for a sphere, we can determine the size of HDL as it undergoes the process of metabolism. Preliminary results seem to indicate that the metabolic process occurs very quickly, that the final size of HDL depends primarily on the concentration of EL, and that the wild and mutant variants of EL have a similar effectiveness. In following experiments, we hope to investigate these relationships further.

D1.00035 Solvation and Deprotonation Dynamics in Reverse Micelles via Broadband Femtoseond Transient Absorption (BFTA) Spectroscopy , RICHARD COLE, Department of Chemistry, Colorado State University — Broadband femtosecond transient absorption (BFTA) spectroscopy is a useful tool in characterizing femtosecond and picosecond physical and chemical dynamics such as solvation, electron transfer, and deprotonation dynamics. This presentation will focus on our most recent results, which utilize BFTA spectroscopy in the ultraviolet-visible (UV-vis) spectral range to probe deprotonation and solvation dynamics in the nanoscopic confinement of reverse micelles. In these studies, pyranine, a 'photo-acid', probes both solvation and deprotonation dynamics in reverse micelles formed from cationic (cetyl trimethylammonium bromide, CTAB), anionic (sodium dioctyl sulfosuccinate, AOT), and neutral (polyoxyethylene nonylphenylether, Igepal) surfactants. Dynamic behavior will be discussed in terms of the degree of nanoscopic confinement (micellar size) and the impact of varying interfacial environments.

D1.00036 Reactive Inorganic Membranes for CO_2/N_2 separations: Ab-initio Density Functional Theory Calculations[1] , M. OSTWAL, J.D. WAY, M. LUSK, Colorado School of Mines — The selectivity (CO_2/N_2) of mesoporous silica membranes can be enhanced by surface modification using APTS (3-aminopropyl-triethoxy silane). The hypothesized transport mechanism in such materialsis the reaction of CO_2 with surface amine groups to form a carbamate species and subsequent surface "hopping" of CO_2. DFT calculations were performed in order to elucidate the mechanism of CO_2 transport in APTS modified membranes, to compute the CO_2 diffusivity through the membrane, and to calculate its binding energy on an amine strand. The computed binding energy for docking one CO_2 molecule to an amine was calculated to be 15.5 kcal/mol (0.67 eV). The activation/barrier energy for a CO_2 molecule to hop from one amine strand (in form of carbamate) to another computed using Transition State Theory (TST) was 7.2 kcal/mol (0.31 eV) and compares well with our experimental data ($\sim$ 8kcal/mol; 0.35 eV). In the configuration studied, CO_2 hops from one strand to another in a zigzag fashion due to thermal motion of the strands; a strand with the CO_2 molecule undulates and eventually moves so that the CO_2 can be attracted by an adjacent strand. The CO_2 diffusivity calculated using the computed activation energy ranged from 1.1 X 10^{-11}m^2/sec (@ 25 C) to 5.7 X 10^{-10}m^2/sec (@100 C).

[1]We gratefully acknowledge the financial support from Department of Energy Office of Science, Basic Energy Sciences, Chemical Sciences, Geosciences and Biosciences division under Grant DE-FG03-93ER14363.

D1.00037 Strain and edge passivation induced band gap modulation and effective mass tuning in Armchair Graphene Nanoribbons , SELINA VELASQUEZ, PAUL LOGAN, XIHONG PENG, Arizona State University — We carried out a theoretical study of the effects of strains and molecular/chemical edge passivation on electronic properties in armchair graphene nano-ribbons (AGNR), using first principles calculations. The electronic properties we studied include band gaps and effective masses of the electron and hole. We found strain and edge passivation could significantly modify the gap and effective masses of AGNR. Three different patterns of strain-gap response, i.e., linear, concave and convex curves, are identified for different width of AGNR. Such kinds of modulations of electronic properties in AGNR are important for its applications in future electronics technology.

D1.00038 Quantum Confinement in Strained Si/Ge Core-Shell Nanowires , PAUL LOGAN, XIHONG PENG, Arizona State University — First principle calculations based on density-functional theory were performed to study quantum confinement on the electronic properties of strained Si/Ge core-shell nanowires along the [110] direction with the diameter up to 5 nm. Particularly the band gap and the effective masses of the electron and hole were investigated. As shown in the calculations, the Si/Ge core-shell [110] nanowires possess a direct band gap, in contrast to the nature of an indirect band gap in bulk Si and Ge. The band gap of the core-shell wires is decreased compared with the pure Si or Ge nanowires with the same size. This reduced gap is ascribed to the intrinsic strain in the core-shell wires, which partially counters the quantum confinement effect. Moreover, the effects of unaxial strain on the effective mass and hole will be discussed.

D1.00039 Nanoparticle Interactions with Low-Frequency Electromagnetic Fields for Ablation Therapy , SCOTT JENSEN, TIMOTHY DOYLE — The *in vivo* ablation of malignant tumors can be significantly enhanced with nanoparticles (NPs) that absorb energy from electromagnetic (EM) waves and subsequently heat targeted regions in the body. Low-frequency EM fields can penetrate much deeper than near-infrared and visible light. Ohmic heating has primarily been the sole mechanism considered for the coupling of the EM fields to the NPs, but few quantitative analyses have been published to predict NP heating rates. To address this issue, this study identified and modeled four excitation mechanisms for the remote heating of NPs by low-frequency EM waves. These mechanisms included (1) ohmic heating of conductive NPs, (2) translational vibrations of charged NPs, (3) rotational vibrations of piezoelectric NPs, and (4) acoustic wave generation by piezoelectric NPs. Preliminary results showed that for a constant NP volume, the heating rate is independent of NP size for ohmic heating. Additionally, ohmic heating produced the lowest heating rates of the four mechanisms. These results point to possible new NP technologies to optimize heating rates and tumor ablation in patients.

D1.00040 Ge and Ge-rich Group IV Alloys on Si for Photonic Device Applications , JAY MATHEWS, JOSE MENENDEZ, VIJAY D'COSTA, Department of Physics, Arizona State University, Tempe, AZ, 85287-1504, USA, SHUI-QING YU, Department of Electrical Engineering, University of Arkansas, Fayetteville, AR 72701, USA, RADEK ROUCKA, JUNQI XIE, YANYAN FANG, JOHN KOUVETAKIS, Department of Chemistry and Biochemistry, Arizona State University, Tempe, AZ, 85287- 1604, USA — The application of silicon photonic technologies to optical telecommunications requires the development of near-infrared detectors monolithically integrated to the Si platform. Recently, new low-temperature CVD techniques have been developed for growth of high-quality epitaxial films of Ge, $Ge_{1-y}Sn_y$, and $Si_xGe_{1-x-y}Sn_y$ directly on Si. In this poster, we present details on the growth of these films, optimization of processes for the fabrication of photonic devices, and results from some prototype p-i-n heterostructure devices.

D1.00041 Mechanical Strength of Composite Nanowires , HOWARD HORTON, BRET HESS, Brigham Young University — Motivated by the recent creation of carbon nanotubes coated in silicon, we investigate the mechanical properties of carbon nanotubes embedded in silicon nanowires using empirical force models and molecular dynamics. We predict the Young's modulus and shear modulus for these composite nanowires. We also discuss the mechanical strength and ability to withstand severe deformation.

D1.00042 Explicit Cross-Property connection between overall electric conductivity and fluid permeability of a porous conductor , MANJITA SHRESTHA, New Mexico State University, IGOR SEVOSTIANOV — Here we try to address the problem of cross-property connection between electrical conductivity and fluid permeability of a porous material with conducting solid phase. Variational inequality connecting the said two properties is obtained. Development of explicit closed-form connection is complicated by the fact that the two properties are governed by different microstructural parameters. This complication can be over-passed if certain information on phase distribution is available. As an illustration, material with randomly distributed interconnected phases is discussed in details. The cross-property connection for this case is obtained in closed explicit form.

D1.00043 Hydrogen Storage in Clathrate Hydrates , JOANNA HAAG, TAKESHI SUGAHARA, PINNELLI S.R. PRASAD, ASHLEIGH WARNTJES, E. DENDY SLOAN, AMADEU SUM, CAROLYN KOH — Clathrate hydrates have been investigated as a possible storage medium. There are several advantages of using clathrate hydrates as a hydrogen storage material. Firstly, an advantage is that the system is composed of water. There are no harmful byproducts when the hydrogen is released. In addition, the hydrogen can be released by simply de-pressurizing the system (by turning a valve). Therefore, no chemical reaction is required. However, the disadvantage is that the stability condition for pure hydrogen hydrates is at severe conditions, such as high pressures. In order to alleviate the severe conditions, promoter molecules, for example, tetrahydrofuran are used to shift the phase equilibrium boundary to lower pressures and higher temperature conditions. Other molecules can be used as well. However, the addition of a promoter molecule reduces the possible storage capacity for hydrogen In this work, new synthesis methods have been studied to increase the hydrogen storage capacity of a hydrogen hydrate system, while stabilizing the system at pressure conditions. The results indicate that using these new methods, the hydrogen and promoter molecules can both occupy the large cage within a certain composition range, which results in a storage amount of 3.4 wt.%.

D1.00044 Metal Oxide Surface Modification for Organic Photovoltaics , K. XERXES STEIRER, Colorado School of Mines, DAVID S. GINLEY, REUBEN T. COLLINS — Organic photovoltaics devices may pose one of the least expensive routes toward conversion of solar power. Two significant obstacles are low intrinsic material stabilities as well as poor interfacial charge transfer kinetics between the transparent conducting oxide and organic semiconductor. Presented is a series of investigations for several surface preparations on a popular metal-oxide (indium tin oxide) using cyclic voltammetry, four-point probe, work function, and contact angle measurement techniques. Surface treatments are correlated with device results in a prototypical organic photovoltaic architecture with an eye toward enhanced charge transfer and material stability at the metal-oxide/organic interface. Included is an overview of main organic photovoltaic operation and degradation mechanisms in the context of surface modification studies.

D1.00045 Reduction of Zinc Oxide Thin Films to Form Zinc Metallic Seeds for Silicon Nanowire Growth[1]

, LOUIS GERSTENBERGER, Colorado School of Mines Undergraduate, S. RATHI TEAM, A. YOCCOM TEAM, J. BEACH TEAM, R. COLLINS TEAM — A method for reduction of poly-crystalline zinc oxide films to generate uniform pure zinc particles for VLS (vapor-liquid-solid) growth of silicon nanowires is presented. A uniform zinc oxide film is sputtered onto a glass substrate and then treated in a plasma reducing environment at 419 °C to produce pure zinc metal particles on the films surface. These particles may act as the liquid metal catalyst required for VLS growth of oriented silicon nanowires.

[1]REMRSEC students and faculty who guided this work. This work is supported by National Science Foundation Renewable Energy Materials Science and Engineering Center Grant No. DMR-0820518.

D1.00046 Use of planar organic-inorganic heterojunction architectures for understanding charge separation in hybrid solar cells

, JAMIE ADAMSON, Colorado School of Mines, Golden, CO, DANA OLSON, MATTHEW WHITE, JOSEPH BERRY, National Renewable Energy Laboratory, Golden, CO, REUBEN COLLINS, Colorado School of Mines, Golden, CO, DAVID GINLEY, National Renewable Energy Laboratory, Golden, CO — Organic photovoltaic cells are valued in part for their compatibility with highly scalable fabrication techniques and low-cost materials. These excitonic solar cells are engineered to create large interfacial surface area between the donor and acceptor phases to maximize the region where photoexcited excitons can be dissociated into free carriers. ZnO, in particular, is attractive for these bulk heterojunction (BHJ) devices because of the many nanostructures that can be easily fabricated from its chemical precursors. It is unclear whether poor cell performance is due to unoptimized BHJ morphology or other effects. In this study, hybrid photovoltaic devices with p-type poly(3-hexylthiophene) and n-type ZnO are made with planar geometries to enable interpretation of device performance without morphological complications of a BHJ.

D1.00047 Charge generation/dissociation mechanisms at the interface oxide/polymer hybrid heterojunctions studied by microwave conductivity measurements

, ALEXANDRE NARDES, University of Denver, MATTHEW WHITE, DANA OLSON, JOSEPH BERRY, NIKOS KOPIDAKIS, NREL, SEAN SHAHEEN, University of Denver, DAVID GINLEY, NREL — Pulse laser deposition (PLD) has been used to obtain thin films of ZnO and a-TiO_x to be employed as acceptor materials in hybrid oxide/polymer organic photovoltaic (h-OPV). Films with varying electrical and morphological properties can be obtained, offering a great advantage on optimizing materials and interfaces for h-OPV. P3HT is spin coated on top of the oxides to serve as donor material. A detailed insight of the charge generation mechanism at the interface oxide/polymer is provided by Time-Resolved Microwave Conductivity (TRMC) measurements and correlated to device performance. Single, bi- and tri-layers of these materials have been studied. By varying the carrier concentration of the oxide acceptor layer in the h-OPV devices, one can control the electric field at the planar donor-acceptor interface thereby enhancing charge separation at the interface. The effects of the interfacial electric field are reflected by an increase in the TRMC signal and consistent with the short-circuit current and fill factor improvements observed in devices. Moreover, we found that an interfacial layer of a-TiO_x between the ZnO and the P3HT reduces recombination with corresponding benefits to device performance.

D1.00048 Growth and Characterization of Digitally Alloyed Zinc Oxide Based TCOs

, AJAYA SIGDEL, SEAN SHAHEEN, University of Denver, JOHN PERKINS, DAVID GINLEY, JOSEPH BERRY, National Renewable Energy Laboratory, DU-NREL COLLABORATION — Transparent conducting oxides (TCOs) based on substitutionally doped zinc oxide and novel amorphous oxides offer the potential of high performance and low cost for organic solid-state lighting and organic photovoltaic (OPV) applications. We present studies on digitally alloyed amorphous indium zinc oxide (InZnO) with crystalline gallium doped zinc oxide (GaZnO) and zinc tin oxide (ZnSnO3). The films were grown using pulse laser deposition system with varying oxygen pressure. Alternating layers of two constituent materials are deposited with periodicity of around 5 nm. We find that the composite material has similar conductivity as the constituent species grown at similar conditions but the surface roughness and the work function are determined solely by the terminating layer. We observe that both IZO and GZO terminated stacks result in conductivity of 1.5E3 S/cm, but the surface roughness varies from 0.3 nm to 0.7 nm respectively. We also explore other possible combination of zinc based oxide materials in order to optimize the optical and the electrical properties of TCO for possible application in opto-electronic devices.

D1.00049 Solution-processed Gallium Zinc Oxide for Inverted Organic Photovoltaics

, ALISHA HUMPHRIES, University of Denver, DANA OLSON, JOSEPH BERRY, DAVID GINLEY, National Renewable Energy Laboratory, SEAN SHAHEEN, University of Denver, NREL COLLABORATION — Organic photovoltaics (OPV) is an emerging technology with the promise of inexpensive and scalable solar power harvesting. Inverted devices typically exhibit somewhat lower efficiencies than standard OPVs, therefore this study focused on improving performances of inverted devices through gallium doping of the electron-transport layer, zinc oxide (ZnO). Introducing an n-type dopant into ZnO films is expected to increase the carrier concentration and band-bending in devices for improved charge collection. In this study, gallium zinc oxide (GZO) was fabricated through 0-20 wt. % doping levels. Carrier concentrations were successfully increased as shown by conductivity measurements made on GZO films. X-ray diffraction shows GZO is converted to a crystalline oxide at higher temperatures. Crystalline GZO films show promise for improving power conversion efficiencies of OPV devices, however high temperatures are necessary and may introduce the need for an alternative transparent conducting oxide underlying the electron transport layer.

D1.00050 Nickel Oxide as an Inorganic Hole Transport Layer in Organic Photovoltaics

, BRIAN BAILEY, University of Denver, N. EDWIN WIDJONARKO, University of Colorado, Boulder, JOSEPH J. BERRY, National Renewable Energy Laboratory, SEAN E. SHAHEEN, University of Denver, DAVID S. GINLEY, DANA C. OLSON, National Renewable Energy Laboratory — This work explores the use of nickel oxide as a hole transport layer in organic photovoltaics (OPV). The purpose of the hole transport layer (HTL) is to provide an energetic barrier to electrons at the anode of the OPV device, while facilitating extraction of holes. At present, poly(3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS) is commonly used in this layer of the device, but it suffers from inherent problems in phase separation of the PEDOT and PSS components leading to non-uniform conductivity, incompatibility with various transparent conducting oxides due to its acidity, and high rate of water uptake that can accelerate degradation of interfaces and surrounding layers. Inorganic metal oxides such as nickel oxide present a potential solution to these problems. Using pulsed laser deposition (PLD) to deposit nickel oxide films, we show OPV device performance to be tunable by varying deposition parameters. Parameters explored include oxygen partial pressure during PLD, substrate temperature, film thickness, and post PLD surface treatments. These tune physical properties of the film such as work function and conductivity, which were measured directly, and in device performance.

D1.00051 Properties of CuO Deposited by Spray Pyrolysis for Photovoltaics, MATTHEW BELL, CARY TIPPETTS, ROBERT DAVIS, RICHARD VANFLEET, BYU — We are studying the possibility of CuO as the main absorption material for a photovoltaic cell. CuO has a reported band gap of 2.1 eV, which is optimal for photovoltaics. CuO is an inexpensive material and since it is an oxide, it is stable in an oxygen rich environment. However, CuO has poor mobility, making it difficult for electrons to be carried away. We are attempting to overcome this barrier by depositing the CuO on a three dimensional surface, making it thick enough vertically to absorb photons, but thin enough horizontally for the electrons to escape. Spray pyrolysis is a promising choice because of its affordability and reported reliablility. We are spraying Cu(NO3)2 dissolved in distilled water on a heated substrate. We are testing spray pyrolysis's ability to cover three dimensional figures, and testing the properties of the CuO deposited in this method.

D1.00052 Free-Standing Silicon Nanocrystals using Plasma Enhanced Chemical Vapor Deposition, B.N. JARIWALA, Colorado School of Mines, P. STRADINS, National Renewable Energy Lab, J.D. BEACH, R.T. COLLINS, J. FIELDS, S. RATHI, S. AGARWAL, Colorado School of Mines — Si nanocrystals (NCs) less than 5 nm in diameter exhibit a size-dependent tunable band gap, visible photoluminescence, and multiple exciton generation. These properties of Si NCs have led to an increased interest in their utilization in third-generation photovoltaic (PV) devices. In this presentation, we will discuss the synthesis of Si NCs from a SiH_4/Ar plasma. The particles are transported out of the plasma by gas flow, and are collected onto a grid. The structure and optical properties of the as-synthesized NCs have been characterized using transmission electron microscopy, infrared and Raman spectroscopy, and photoluminescence (PL) spectroscopy. The TEM measurements show that the NCs have a diameter over the range of 3 to 7 nm: the average size can be controlled by varying the residence time in the plasma volume. PL from $\sim$7 nm NCs has an emission peak centered at 850 nm, which blue shifts as the crystal size decreases due to oxidation. Our infrared measurements are consistent with the PL data and show that although the surface Si atoms of the as-synthesized NCs are H-terminated with mono-, di-, and tri-hydride species, these NCs oxidize over a few minutes. Support from NSF award number DMR-0820518 is gratefully acknowledged.

D1.00053 Octadecanethiol Island Formation on Single Crystal Zinc Oxide Surfaces, ANDREA YOCOM, Colorado School of Mines — Organic photovoltaic devices, comprised of zinc oxide (ZnO) nanorod electron acceptor arrays intercalated with organic polymers, could lead to low-cost renewable energy generation. Surface modifications of ZnO with octadecanethiol (ODT) monolayers can help to improve charge transfer in such devices. In the present work, single crystals of ZnO provided well-defined oxygen-terminated and zinc-terminated surfaces on which to learn fundamentally about the attachment and growth of ODT. Both bare zinc oxide and ODT-functionalized surfaces were characterized with atomic force microscopy, Fourier transform infrared spectroscopy, x-ray photoemission spectroscopy, and contact angle analysis. ODT seemed to form islands of multilayers on zinc-terminated surfaces, while it formed islands of monolayers on oxygen-terminated surfaces. While ODT was expected to preferentially bond along defects and terraces on oxygen-terminated surfaces, this was not observed. ODT was also expected to more effectively bond to the zinc-terminated surface, which was observed. Finally, surface preparation treatments designed to leave atomically-flat oxygen terminated surfaces were developed. This work was made possible by the National Science Foundation Division of Materials Research and the Renewable Energy Materials Research Science and Engineering Center at the Colorado School of Mines.

D1.00054 Factor Analysis and the Force Concept Inventory, MATTHEW SEMAK, COURTNEY WILLIS, RICHARD DIETZ, Physics, University of Northern Colorado — Four sections of introductory physics (n=244) at the University of Northern Colorado took the Force Concept Inventory (FCI) both before and after instruction in Newtonian mechanics. Factor analyses of the results reveal several interesting contrasts that may shed some light on the development of concept organization in the introductory physics course. Post-test FCI results indicate that at the end of the semester student responses have become more closely aligned with the particular Newtonian concept associated with each question by the authors of the FCI.

D1.00055 The Harmony of Physics, Mathematics, and Music: A discovery in mathematical music theory is found to apply in physics, RICHARD KRANTZ, Metropolitan State College of Denver, JACK DOUTHETT, Central New Mexico Community College (retired) — Although it is common practice to borrow tools from mathematics to apply to physics or music, it is unusual to use tools developed in music theory to mathematically describe physical phenomena. So called "Maximally Even Set" theory fits this unusual case. In this poster, we summarize, by example, the theory of Maximally Even (ME) sets and show how this formalism leads to the distribution of black and white keys on the piano keyboard. We then show how ME sets lead to a generalization of the well-known "Cycle-of-Fifths" in music theory. Subsequently, we describe ordering in one-dimensional spin-1/2 anti-ferromagnets using ME sets showing that this description leads to a fractal "Devil's Staircase" magnetic phase diagram. Finally, we examine an extension of ME sets, "Iterated Maximally Even" sets that describes chord structure in music.

D1.00056 Comparison of Van der Waals Potential calculations to experimental results[1], CATHY KLAUSS, VINCENT LONIJ, WILL HOLMGREN, ALEX CRONIN, University of Arizona — The strength of the Van der Waals atom-surface interaction (C3) depends not only on the polarizability of the atoms but also on the permittivity of the surface. We compare calculations of C3 based on different models for metal surfaces and insulators as well as different models for the atom. The electric dipole polarizabilities of alkali atoms are calculated using a Lorentz oscillator model as well as a model that includes core electrons and relativistic effects. To model metal and insulating surfaces we compare a Drude model to models that include the band gap or interband transitions in the material. We compare the results of our calculations with recent experimental results from atom interferometer and atom diffraction experiments.

[1]This work was supported by the NSF.

D1.00057 Towards Spin Squeezing via Collective Quantum Non-Demolition Measurements[1], ZILONG CHEN, JIAYAN (PHOENIX) DAI, JUSTIN G. BOHNET, JILA, University of Colorado at Boulder, JAMES K. THOMPSON, JILA, University of Colorado at Boulder, NIST — Current state-of-the-art microwave atomic clocks are limited by quantum projection noise associated with uncorrelated atoms. The current generation of neutral atom optical atomic clocks have already reached a frequency stability very close to the projection noise limit. By using entangled atoms, precision better than the projection noise limit can be obtained, so generating significant amounts of squeezing is of practical interest to the current generation of atomic clocks and precision measurement experiments. We will report experimental progress on generating spin squeezing via optical resonator-enhanced, collective Quantum Non-Demolition measurements on large ensembles of Rubidium 87 atoms.

[1]Funding: NIST and NSF Physics Frontier Center

D1.00058 Fluorescence OPA FROG of NIR Dyes

COLLEEN WOODWARD, NANCY LEVINGER, Colorado State University — In standard applications, optical parametric amplification (OPA) is accomplished using a white light continuum as the seed. This presentation will describe a design for an ultrafast fluorescence-OPA-FROG (Frequency Resolved Optical Gating) experiment and its utility for measuring fluorescence dynamics on an ultrashort timescale. This technique has several attractive features compared to current state-of-the-art fluorescence upconversion because it has the potential to amplify weak fluorescence, detection occurs at the wavelength of the fluorescence signal in the visible or near IR spectral region, and the phase-matching condition is $\vec{k}_{pump} = \vec{k}_{signal} + \vec{k}_{idler}$. We will demonstrate time gating and effective amplification of the fluorescence of common near infrared dyes, IR 125, IR 132, and IR 140 in DMSO.

D1.00059 Two Photon Resonant Ionization of ^{28}Si Isotopes: Experimental Methods[1]

JONATHAN KLUCK*, WILLIAM CZAJKOWSKI*, SIU AU LEE, WILLIAM FAIRBANK, KATHERINE ZAUNBRECHER, Colorado State University — As part of the W.M. Keck Project for research in quantum computing, it was necessary to identify optical frequencies required for resonant photo-ionization of ^{28}Si isotopes. This is necessary to aide in future precision on demand single atom deposition. A silicon atomic beam was excited by a 222nm CW deep ultraviolet laser at between 10 and 30mW from ground state to the $3s^2 3p^2\ 3p_2$ state. Simultaneously a tunable pulsed dye laser operating in the 484 to 490nm range with an average energy around 5mJ was used to photo-ionize the atoms to the $3s3p^3\ {}^3D_0^3$ state. A channeltron was used to measure the number of ions obtained. To determine the ideal resonance frequency for the pulsed laser, initially wide wavelength scans were conducted until peaks in ion count were identified. The resonance frequency was then further refined by conducting narrower width scans while collecting ion counts at various power levels. By this method we were able to obtain saturation curves and determine photo-ionization cross sections.

[1] Research supported by the W.M. Keck Foundation and the National Science Foundation. *Fellowships of the U.S. Military Academy, West Point, NY.

D1.00060 Simultaneous loading of ^{85}Rb and ^{87}Rb into a shallow FORT[1]

MATHEW HAMILTON, Colorado State University, ANTHONY GORGES, JACOB ROBERTS — We have studied the effects of simultaneous loading of ^{85}Rb and ^{87}Rb into a shallow Far Off Resonance Trap (FORT). To fully characterize the loading parameters both homonuclear (β') and heteronuclear (β) loss rates were measured. Once this characterization was completed, we could compare our measured FORT loading performance to a model of the FORT loading process. Measurements of the simultaneous load led to the observation of unexpected interferences. The presence of one isotope significantly reduced the maximum number of atoms loaded beyond the reduction expected from light assisted collisions. These observations are consistent with a disruption of laser cooling efficiency during loading due to long-ranged induced dipole-dipole inter-species collisions.

[1] work supported by AFOSR

D1.00061 Growth and characterization of transition metal oxide thin films by dual ion beam sputtering

ERIK KROUS, PETER LANGSTON, DINESH PATEL, FEDERICO FURCH, BRENDAN REAGAN, JORGE ROCCA, CARMEN MENONI, Colorado State University, ASHOT MARKOSYAN, ROGER ROUTE, MARTY FEJER, Stanford University, LUKE EMMERT, DUY NGUYEN, WOLFGANG RUDOLPH, University of New Mexico — The development of high power lasers operating in the near infrared heavily relies on the availability of robust optical coatings. We present results on the growth and characterization of transition metal oxide thin films by dual ion beam sputtering. Single layer films are grown under different conditions and characterized for their structural, chemical and optical properties using glancing angle x-ray diffraction, variable angle spectroscopic ellipsometry, x-ray photoelectron spectroscopy, photothermal commonpath interferometry, laser-induced damage threshold studies and atomic force microscopy. The laser damage threshold for single pulse (1-on-1) and multiple pulses (S-on-1) has also been measured. The results of these experiments have revealed the important role that native impurities and laser created excitonic effects have on the optical response of the single layer films. Results on interference coatings with superior performance will also be presented.

D1.00062 Soft X-Ray Diagnostic System for STOR-1M Tokamak[1]

JEREMY BISHOP, AJAY SINGH, ERIC HELD, WILLIAM EDWARDS, Physics Department, Utah State University, Logan, UT — In this paper we report design and construction of a soft x-ray (SXR) pinhole camera. A linear array of sixteen SXR detectors (AXUV-16) is used. The camera is housed in stainless steel housing with the amplifiers and other electronics inside the vacuum chamber. Thin foils of Aluminum are used as filters. The signals received give line-of-sight measurement of soft x-ray emission from the plasma volume. Some measurements on the tokamak STOR-1M (on loan from Plasma Physics Laboratory, University of Saskatchewan, Saskatoon, Canada) using this camera will be discussed. We will also report some initial measurements of normal ohmic discharges as well as discharges with turbulent heating. A method to estimate plasma temperature using ratios of intensities will be discussed.

[1] Financial support from USTAR and SDL Tomorrow Fellowship is acknowledged.

D1.00063 Novel Numerical Solution to the Plasma Kinetic Equation

JOSEPH SPENCER, ERIC HELD, JEONG-YOUNG JI, Utah State University, NIMROD TEAM — The finite element method (FEM) is a numerical approach to solving partial differential equations commonly used in engineering applications. In this work, we discuss the application of the FEM to velocity space to solve plasma kinetic equations. We have approached the investigation one step at a time. At first, we treat an initial value problem with the kinetic equation including the time derivative and Lorentz collision operator, a simplified form of the full, Coulomb collision operator. We show results that verify that the Lorentz operator causes generic distribution functions to evolve toward Maxwellian distributions. We also show that by refining the size of the grid and increasing the order of the 2-D polynomial basis, we obtain exponential convergence. Our next step was to look at the effects of including the speed drag and diffusion part of the Coulomb collision operator. We conclude by discussing the extension to the full Coulomb collision operator, the inclusion of external electric and magnetic fields, and the generalization to multiple spatial dimensions.

D1.00064 Laboratory plasma with cold electron temperature of the lower ionosphere, SHANNON DICKSON, SCOTT ROBERTSON, University of Colorado at Boulder — For the first time, plasma with cold electron temperatures less than 300K has been created continuously in the laboratory. The plasma is created in a cylindrical double-walled vacuum chamber in which the inner chamber (18cm in diameter and 30cm long) is wrapped in copper tubing through which vapor from liquid nitrogen flows, providing a cooling mechanism for the neutral gas. The inner chamber has two negatively-biased filaments for plasma generation and a platinum wire Langmuir probe for diagnostic measurements. Neutral gas pressures of 1.6mTorr and a total filament emission current of 2mA are used to obtain plasma densities near 4×10^8 cm^{-3}. When carbon monoxide is used as the working gas, decreasing the neutral gas temperature also decreases the cold electron temperatures, yielding cold electrons with 21meV (240K) when the neutral CO is at 150K. The same experiment conducted with H_2, He, or Ar results in a doubling of the cold electron temperatures, yielding 80meV (930K) when the neutral gas is at 150K. The lower electron temperature with CO is attributed to the asymmetric CO molecule having a nonzero electric dipole moment which increases the cross section for electron energy exchange. Nitric oxide, a dominant constituent of the ionosphere, has a similar dipole moment and collision cross section as carbon monoxide and is likely to be equally effective at cooling electrons.

Friday, October 23, 2009 6:30PM - 8:15PM –
Session E1 Reception and Banquet Friedhoff Hall

6:30PM E1.00001 Reception –

7:00PM E1.00002 Banquet –

8:00PM E1.00003 Advanced Physics Labs and Undergraduate Research: Helping Them Work Together[1], RICHARD W. PETERSON, Bethel University — The 2009 Advanced Lab Topical Conference in Ann Arbor affirmed the importance of advanced labs that teach crucial skills and methodologies by carefully conducting a time-honored experiment. Others however argued that such a constrained experiment can play a complementary role to more open-ended, project experiences. A genuine "experiment" where neither student or faculty member is exactly sure of the best approach or anticipated result can often trigger real excitement, creativity, and career direction for students while reinforcing the advanced lab and undergraduate research interface. Several examples are cited in areas of AMO physics, optics, fluids, and acoustics. Colleges and universities that have dual-degree engineering, engineering physics, or applied physics programs may especially profit from interdisciplinary projects that utilize optical, electromagnetic, and acoustical measurements in conjunction with computational physics and simulation.

[1]Work supported in part by the MN NASA Space Grant and the Carlsen- Lewis Endowment at Bethel University.

Friday, October 23, 2009 8:30PM - 9:30PM –
Session E2 Evening Plenary Session Green Center Metals Hall

8:30PM E2.00001 A Hubble Story, JOHN GRUNSFELD, NASA — This abstract is not available.

Saturday, October 24, 2009 8:00AM - 9:12AM –
Session F1 Astroparticle Symposium III: VHE Gamma Rays 2 Green Center 211

8:00AM F1.00001 The Milagro Gamma-Ray Telescope – A New Look at an Old Problem, GUS SINNIS, Los Alamos National Laboratory — The origin of the cosmic radiation has remained a mystery since its discovery nearly a century ago. While there are good theoretical reasons to believe that supernovae play an important role in the acceleration of cosmic rays, experimental evidence for the acceleration of nuclei at these sites has proven difficult to obtain. In this talk I will briefly review the history of cosmic rays and discuss some of the new instrumentation that has given us a fresh look at this age-old problem. In particular I will discuss results from the Milagro water Cherenkov telescope and our plans for a future telescope known as HAWC.

8:24AM F1.00002 Observations of gamma ray emission from Markarian 501 by the VERITAS Observatory, JOSHUA BINKS, University of Utah Department of Physics and Astronomy, Salt Lake City, Utah, VERITAS COLLABORATION — Markarian 501 is a blazar-type galaxy with an active galactic nucleus (AGN) at a red shift of 0.0337. In blazar type AGN, jets emerging from the vicinity of the core supermassive black hole are chance aligned with the observer. Markarian 501 was observed by the VERITAS TeV gamma ray telescope array between April and June 2009. A total of 1116 minutes of B grade (or better) weather data was selected for this analysis. In this data set Markarian 501 was detected at a significance level of 24.1 sigma, corresponding to a rate of 0.428 gamma-rays/minute. In this talk I will describe the results of this analysis and compare it to previous observations of VHE emission from Markarian 501.

8:36AM F1.00003 Sensitivity Study of the Multi-Telescope Array for Ground-Based Gamma-Ray Astronomy, DONGQING HUANG, ALEXANDER KONOPELKO, Pittsburg State University — Recently, ground-based very high-energy (VHE) gamma-ray astronomy achieved a remarkable advancement in the development of the observational technique for the registration and study of gamma-ray emission above 100 GeV. Construction of multi-telescope arrays of currently used 12 m class telescopes combined with a few telescopes of much larger reflector size (20-25 m) can drastically improve the sensitivity of ground-based detectors to gamma rays of energy from 10 GeV to 100 GeV. Based on Monte Carlo simulations we have studied the response of such an array of imaging atmospheric Cherenkov telescopes. The sensitivity estimates will be presented at the meeting.

8:48AM F1.00004 Development of a wavelet based tool for variability statistical analysis , RYAN PRICE, University of Utah, VERITAS COLLABORATION — It can sometimes be problematic to distinguish between variations in data on a light curve due to interesting occurrences and statistical or background noise. By using a simple Haar wavelet transform on the data with error propagation through the coefficients calculation, it becomes possible to establish the confidence level with which variability at specific time scales is observed. Advantages and disadvantages of the Haar wavelets over other basis are discussed and example applications are presented.

9:00AM F1.00005 Geminga and the Diffuse Source Sensitivity of Imaging Air Cherenkov Telescopes , DANIEL KIEDA, West High School, Salt Lake City, Utah — Geminga, a supernova remnant, is a source of high energy (E > 1 GeV) gamma rays. The Milagro, Fermi, and EGRET observatories have detected high energy gamma rays from Geminga below 10 GeV and above 10 TeV energies. Imaging Atmospheric Cherenkov Telescopes (IACTs) such as VERITAS and MAGIC have been unable to detect this source between 100 GeV and 10 TeV energies. In this talk, I have analyzed the sensitivity of various IACT observatories as a function of the angular extent of observed sources. This analysis demonstrates that IACT sensitivity decreases with increasing source diameter. The large angular extent of Geminga (2.6 degrees, as determined by Milagro) is the likely reason why VERITAS and MAGIC have not yet detected this source.

Saturday, October 24, 2009 8:00AM - 9:00AM –
Session F2 Symposium on Soft Matter III Green Center 215

8:00AM F2.00001 Generalized Fibonacci Description of Fractal aggregates , CHRIS SORENSEN, WILLIAM HEINSON, AMIT CHAKRABARTI, Kansas State Univ. — We present a theory for calculating the fractal dimension of Diffusion Limited Cluster Aggregates (DLCA) based on cluster shape preservation. The shape is described by a d-dimensional Golden Mean, which is the ratio of consecutive d-dimensional Fibonacci numbers. For d =2 the canonical Fibonacci series is found with the Golden Mean value known since antiquity, phi = 1.618. . . to yield a fractal dimension of 1.44, in agreement with simulations and experiment. Generalizations to other dimensions are equally successful. Recent computer simulations also yield accurate values for the fractal aggregate prefactor, thus completing the theory.

8:12AM F2.00002 A Method to Calculate Protein Dipole Moments , BRETT MELLOR, BRIAN MAZZEO, Brigham Young University — The electric dipole moments of globular proteins, determined experimentally by dielectric relaxation spectroscopy, contribute to both protein function and structure. Numerical computations of dipole moments can be obtained from structures in the Protein Data Bank. However, previous computations in literature have agreed with experimental results for only a limited number of proteins. This paper presents a method to compute the pH-dependent dipole moment. The protein molecule is considered as an array of electrical point charges in aqueous solution. The dipole moment is calculated as the vector sum of two components: (1)the core dipole moment which emerges from the unequal sharing of electrons in covalent bonds; (2)the surface charge dipole moment resulting from pH-dependent side chain partial charges. pKa shifts for each side chain amino acid are determined by the H++ server employing the Poisson-Boltzmann equation. The net charge and dipole moment over a range of pH are calculated. The Oncley equation is used to predict the dielectric increment at arbitrary pH, temperature, and protein concentration.

8:24AM F2.00003 Liquid crystal cells with "dirty" substrates[1] , QUAN ZHANG, LEO RADZIHOVSKY, Department of Physics, University of Colorado, Boulder, CO 80309 — We explore liquid crystal order in a cell with a "dirty" substrate imposing a random surface pinning. Modeling such systems by a random-field xy-model with *surface* heterogeneity, we find that orientational order in the three-dimensional system is marginally unstable to such surface pinning. We compute the Larkin length scale, and the corresponding surface and bulk distortions. On longer scales we calculate correlation functions using the functional renormalization group and matching methods, finding a universal logarithmic and double-logarithmic roughness in two and three dimensions, respectively. For a finite thickness cell, we explore the interplay of homogeneous-heterogeneous substrate pair and detail crossovers as a function of disorder strength and cell thickness.

[1]NSF DMR-0321848, MRSEC DMR-0213918

8:36AM F2.00004 Molecular interactions of a photo-active monolayer , YU AN LO, THOMAS FURTAK, Colorado School of Mines, JOSEPH DAHDAH — Photo-active materials are widely applied in optical data storage,wave guides,refractive index manipulation, and photo-alignment of liquid crystals. Many of these materials involve an azobenzene unit, which undergoes trans-cis photoisomerization. In this work, a methyl red derivative (dMR) monolayer was studied to understand its high light sensitivity and power-law kinetics when responding to polarized light. We simulated a variety of monolayer molecular fields by dilute dMR solutions in different organic solvents. We studied the spectral and time-dependent characteristics of the absorbance in these environments and in monolayer films. The cis-trans thermal relaxation demonstrates an unexpectedly complex dependence on molecular environments that may be related to the monolayer behavior.

8:48AM F2.00005 Spin Coherence of Polarons in Organic Semiconductors , WILLIAM BAKER, DANE MCCAMEY, KIPP VAN SCHOOTEN, SANG-YUN LEE, SEO-YOUNG PAIK, JOHN LUPTON, CHRISTOPH BOEHME, University of Utah — Organic semiconductors such as MEH-PPV are carbon based conjugated polymers and, as a result of their low nuclei mass, charge carriers within these materials have very small spin-orbit coupling. With this absence of spin-orbit coupling, strong spin selection rules are imposed on their optical and electrical transitions. As these materials are being utilized for light harvesting and device applications, the nature of the spin-dependent transitions is of significant interest. In this talk I will discuss the details of a novel magnetic resonance technique that is sensitive to these spin-dependent transitions, namely pulsed electrically detected magnetic resonance. We show that, with the application of spin-resonant magnetic field pulses, the device current can be modulated by the spin-Rabi nutation of charge carrier pairs between triplet and singlet configurations in both solar cell and light emitting diodes. With this tool we can address questions regarding efficiency, spin coherence times, recombination and generation rates, all of which are paramount to understanding the overall effectiveness of these unique materials.

Saturday, October 24, 2009 8:00AM - 9:12AM –
Session F3 Symposium on Advanced Optical Measurements III: Microscopy Green Center 249

8:00AM F3.00001 Axial-scanning techniques for multiphoton imaging[1] , MICHAEL YOUNG, ERICH HOOVER, ERIC CHANDLER, JEFFREY FIELD, JEFF SQUIER, MOABC, CENTER FOR MICROINTEGRATED OPTICS FOR ADVANCED BIO-IMAGING AND CONTROL TEAM — We have developed a novel multiphoton imaging system that is capable of imaging multiple focal planes simultaneously. In this talk, we describe a new method that enables us to electronically control the offset of the focal planes by up to 80 micrometers with little or no degradation in focus (diffraction-limited sectioning is maintained as the focal planes are shifted). This method of shifting the focus will enable access to arbitrary focal planes, e.g., focal planes that are rotated with respect to one another. By exploiting this new capability, this microscope will greatly facilitate the study of biological systems.

[1]Supported by NIBIB under BRPEB003832.

8:12AM F3.00002 Using FPGAs for Simultaneous Photon Counting Imaging of Multiple Focal Planes[1] , ERICH HOOVER, ERIC CHANDLER, JEFF FIELD, KRAIG SHEETZ, RAMÓN CARRILES, JEFF SQUIER, MOABC, CENTER FOR MICROINTEGRATED OPTICS FOR ADVANCED BIO-IMAGING AND CONTROL TEAM — Photon counting detection has been shown to provide significant signal-to-noise improvements in multi-photon microscopy. However, due to the time scales involved, it is non-trivial to assemble the necessary electronics to process PMT analog voltage signals into an image. By instead building the necessary logic inside of a Field Programmable Gate Array, photon counting imaging becomes tractable. This method also easily permits extending beyond simple 2D imaging into de-multiplexing data obtained from multiple focal planes nearly simultaneously. Given sufficient hardware, such a system can also be used to stream image data back to a PC and record video from each focal plane. Since imaging with a multi-photon microscope typically involves signals with repetition rates in the hundreds of megahertz, such imaging will not succeed without attention to seemingly minor details in the circuit design. This talk will present our photon-counting circuit design within the context of our imaging system.

[1]Partially supported by the NIBIB under BRPEB003832.

8:24AM F3.00003 Coherence modulated third harmonic generation for interface vibrational spectroscopy , JESSE WILSON, DAVID KUPKA, OMID MASIHZADEH, RANDY BARTELS, Colorado State University — Though third harmonic generation (THG) by tightly focused beams at an interface is generated in bulk regions of the two surrounding materials, we demonstrate measurement of surface-specific vibrational information by coherence-modulated THG (CM-THG). In CM-THG, a tightly focused ultrafast pulse in the presence of an impulsively-prepared vibrational coherence will undergo modulation by the coherence during the THG process. Measuring the CM-THG signal as a function of scanning the interface allows separation of bulk and interface phonon oscillation contributions to the CM-THG signal. Three distinct processes occur leading to modulation of the detected third harmonic signal by the coherence: 1) The third harmonic generation itself is modulated by the coherence through a transient nonlinear susceptibility, i.e. coherent second hyper-Raman scattering (CSHRS); 2) the fundamental is modulated by transient linear susceptibility cascading to the third harmonic; and 3) the index of refraction at the boundary modulates the fundamental prior to third harmonic generation in air after the sample interface. To our knowledge, this is the first measurement of CSHRS. Though hyper-Raman selection rules have been proposed, no experimental verification has yet been performed.

8:36AM F3.00004 Detection at the single molecule level using an optical fiber[1] , THOMAS TOPEL, Northeast Christian Academy and Colorado State University, BRIAN MONG, WEI-TING CHEN, WILLIAM FAIRBANK, Colorado State University — We are developing a method for detecting single Ba+ ions in solid xenon on a fiber probe for the EXO double beta decay experiment. As a demonstration of potential capability, we have explored detection of Rhodamine 6G molecules and quantum dots in solution using the same optical setup. We report results on detection of $\sim$1 dye molecule on the average in the probe volume and attempts to do the same with quantum dots. Steps to fix single dye molecules or quantum dots in position and observe blinking from single molecules or dots will follow.

[1]This work was supported by NSF and DOE under grant numbers 0652347 and DE-FG02-03ER41255.

8:48AM F3.00005 State of the art in Van der Waals atom-surface potential measurements[1] , VINCENT LONIJ, CATHY KLAUSS, WILL HOLMGREN, ALEX CRONIN, University of Arizona — Van der Waals and Casimir-Polder potentials are the dominant interactions between charge-neutral objects at nano- to micrometer length scales. As such they have attracted considerable interest in the field of nanotechnology. Understanding of these potentials is important in searches for new forces such as deviations from Newtonian potentials at very short length scales and vacuum friction. We have recently made significant advances in precision measurements of the Van der Waals atom-surface potential strength (C3). Using either interferometer or diffraction experiments we are able to determine the interaction strength (C3) between an atom and a nano-grating with a precision of 6%. This is a factor of 5 improvement over previous diffraction experiments. We also report ratios of C3 for different atoms with a precision of better than 3%. At this level of precision we are sensitive to the contribution of core electrons in the atom as well as the geometry of the surface. We have already been able to set an upper limit on the magnitude of non-newtonian potentials for lithium that is competitive with previous limits.

[1]This work was supported by the NSF.

9:00AM F3.00006 An all electrical method for measuring ultra-small forces acting on nanowire oscillators , SCOTT HOCH, JOHN TEUFEL, JOSHUA MONTAGUE, CHARLES ROGERS, KRIS BERTNESS, KONRAD LEHNERT — As nano technology becomes more prevalent in today's world, it is increasingly more important to understand how nanodevices, including mechanical resonators, behave in a range of environments. The purpose of this experiment is to measure small forces exerted on nanowires. The measurement is made using capacitive coupling between a high-Q microwave resonator and the aforementioned nanowire. This technique was used to successfully measure forces smaller than 0.1mirco-Newton on aluminum cantilevers. The experiment is currently being performed to measure forces on the order of 1pico-Newton exerted on Gallium-Nitride nanowires. The apparatus should provide a general, all-electrical method of measuring the motion of nanowire oscillators.

Saturday, October 24, 2009 8:00AM - 9:12AM –
Session F4 Physics of Data Storage Green Center 263

8:00AM F4.00001 Commercial Holographic Data Storage , KEVIN CURTIS, InPhase Technologies — An overview of the laser, servo, recording, and media technologies for a 300GB holographic, archival data storage product is presented.

8:24AM F4.00002 Carbon Coated Tellurium Film for Optical Data Storage , JONATHAN ABBOTT, Brigham Young University, TRAVIS NIEDERHAUSER, ERIK BARD, MIKE MILLER, Millenniata, Inc., MARK WORTHINGTON, CD Associates, DOUG HANSEN, Millenniata, Inc., GUILIN JIANG, ROBERT DAVIS, RICHARD VANFLEET, MATTHEW LINFORD, Brigham Young University — A highly durable optical disk has been developed for data archiving. This optical disk uses tellurium as the write layer and carbon as a dielectric and oxidation prevention layer. The sandwich style CTeC film was deposited on polycarbonate and silicon substrates by plasma sputtering. These films were then characterized with SEM, TEM, EELS, ellipsometry, ToF-SIMS, etc, and were tested for writability and stability. Results show the films were uniform in physical structure, able to form pits, and promise longer lifetimes than currently available media. Data was written to a disk and successfully read back in a commercial DVD drive.

8:36AM F4.00003 From exchange coupling to magnetic memory: how domains remembers at nanoscale , KARINE CHESNEL, JOSEPH NELSON, BRIAN WILCKEN, BYU, STEVE KEVAN, U Oregon, MATTHEW CAREY, ERIC FULLERTON, Hitachi GST — Magnetic memory, the ability of a material to remember its magnetic domain configuration throughout magnetization, offers potential technological interest for the data storage industry. One way to quantify the magnetic memory is to use Coherent X-ray Resonant Magnetic Scattering (XRMS) tools, at synchrotron facilities. The light is tuned to resonant edges of magnetic element to optimize the magneto-optical contrast. When illuminated by coherent beam, the sample produces speckle patterns. Our approach is to cross-correlate patterns recorded at different field values throughout the magnetization cycle, and at different temperatures. We have studied the return point memory (RPM) that characterizes the memory after a full cycle, and developed a q-selective correlation analysis to study the spatial dependency of the memory. We will give here an overview of different type of memory behaviors, first showing disorder induced memory in thin CoPt films and influence of roughness, then demonstrating the ability to control the magnetic memory by inducing exchange bias [1]. We will see how the local exchange couplings pin the magnetic domain in the ferromagnetic layer and lead the large memory enhancement at different spatial scales.

[1] K.Chesnel et al, PRB **78**, 132409 (2008)

8:48AM F4.00004 Spatial Dependency of Magnetic Domain Memory in Exchange Bias Films , JOSEPH NELSON, BYU — The properties of magnetic materials have become increasingly important to many applications, including high-density magnetic memory storage. In recent years, thin films have been developed which exploit F/AF exchange bias, effectively "freezing" the microscopic magnetic domain patterns in a desired orientation [1]. We have quantified magnetic memory—the degree to which domain patterns resume their prior orientation after magnetic saturation—in these films using speckle analysis of X-Ray Resonant Magnetic Scattering (XRMS) data. The correlation between domain patterns is directly related to the correlation between their respective speckle patterns. We have measured the magnetic memory of these samples as a function of applied field, number of major field cycles, and spatial scale. We have observed very high correlations, exceeding 95% in many cases, even after repeated field cycles. We have also developed a q-vector selective analysis which reveals specific general features in the spatial dependencies of these correlations.

[1] K.Chesnel et al, PRB **78**, 132409 (2008)

9:00AM F4.00005 Vortex-in-nanodot potential energy , GARY WYSIN, Kansas State University — Vortex states in a thin circular magnetic nanodot are studied using auxilary constraining fields as a way to map out the potential energy space of the vortex, while avoiding a rigid vortex approximation. In the model, isotropic Heisenberg exchange competes with the demagnetization field caused both by surface and volume magnetization charge density. The system energy is minimized while applying a constraint on the vortex core position, using Lagrange's method of undetermined multipliers. The undetermined multiplier is seen to be the external field needed to hold the vortex core in place at any desired radial distance r from the dot center. This auxilary field is applied only in the core region of the vortex. For a uniform nanodot, the potential energy is found to be very close to parabolic with r, as in the rigid vortex approximation, while the constraining field increases linearly with r. Effects of nonmagnetic holes in the medium can also be estimated and compared with alternative descriptions. Especially, the local depth of the potential well produced by a hole can be found.

Saturday, October 24, 2009 8:00AM - 9:12AM –
Session F5 Astronomy and Astrophysics Green Center 265

8:00AM F5.00001 Development of a Stellar Intensity Interferometry System at StarBase Utah , DAVID KIEDA, STEPHAN LEBOHEC, PAUL NUNEZ, BENJAMIN ADAMS, RYAN PRICE, University of Utah Department of Physics and Astronomy, Salt Lake City, Utah — The Intensity Interferometry technique (II) has the potential to open up high-resolution stellar imaging into frequency bands which are traditionally inaccessible to classical Michelson Interferometry (such as UBV). The II technique requires use of very large area optical dishes (3-10 meter diameter or greater), distributed over baselines of tens to hundreds of meters, in order to reconstruct high resolution images of stellar disks. Next generation ground-based gamma-ray telescope arrays (such as CTA and AGIS) involve kilometer scale telescope arrays of up to one hundred large light collectors (8-20 m diameter), allowing development of a modern implementation of the Intensity Interferometry technique pioneered by the Narrabri Stellar Intensity Interferometer nearly fifty years ago. In this talk I will describe the science capabilities of the Stellar Intensity Interferometer technique, and describe the progress achieved in developing a modern Stellar Intensity Interferometry System with a pair of new 3 m diameter optical telescopes located at StarBase Utah.

8:12AM F5.00002 Status of the Frisco Peak Observatory , PAUL RICKETTS, WAYNE SPRINGER, KYLE DAWSON, DAVE KIEDA, PAOLO GONDOLO, ADAM BOLTON, University of Utah, Department of Physics and Astronomy, Salt Lake City, Utah — The University of Utah has constructed an astronomical observatory located at an elevation of approximately 9600 feet of Frisco Peak west of Milford, Utah. This site was chosen after performing a survey of potential observatory sites throughout Southern Utah. At the time of writing this abstract, the dome and control buildings have been completed. Installation of a 32" telescope manufactured by DFM Engineering is scheduled to start October 5, 2009. Commissioning of the telescope will take place this fall. A study of the photometric quality of the observatory site will be performed as well. A description of the observatory site survey and the construction and commissioning of the Frisco Peak Observatory will be presented.

8:24AM F5.00003 Global Magnetic Reversal in a Rapidly Rotating Sun , NICHOLAS J. NELSON, University of Colorado at Boulder, BENJAMIN P. BROWN, University of Wisconsin-Madison, JURI TOOMRE, University of Colorado at Boulder — Global MHD simulations of the solar convection zone and a tachocline of shear at its base have demonstrated that strong bands of toroidal magnetic field can be built in the tachocline through stretching and organizing of small-scale fields pumped downward from the convection zone. Recent 3D simulations of more rapidly rotating suns have revealed that global-scale wreathes of toroidal magnetic field can be achieved in the bulk of the convection zone itself, remarkably even without a tachocline present. Continuing this work, we have carried out new simulations at higher turbulence levels in a sun-like star rotating at three times the solar rate. We obtain toroidal magnetic wreathes which have large temporal variations in field strength as they interact with turbulent convection and global differential rotation, yet they continuously rebuild themselves, persisting in the bulk of the convection zone for thousands of days. These magnetic structures can even undergo a reversal of global magnetic polarity. We describe here the properties of these structures and the nature of such a reversal.

8:36AM F5.00004 New Astrophysics Research Opportunities at BYU , VICTOR MIGENES, Brigham Young University — MASER emission with astrophysical origin was proposed in the early 1960s. Since the discovery, a few years later, maser physics and high- spatial resolution research have become a major tool for studying the kinematical and dynamical conditions in a number of important astrophysical settings, like: star formation, late-type stars, supernovae remnants and other galaxies. Improvements in technology and interferometric techniques in radio astronomy have allowed the most detailed study of maser sources so far. MASER emission properties like high specific intensity, compact size, polarization and variability, among others, have been invaluable in helping us understand the conditions and physical processes in these regions. We discuss the status of present research and the new research opportunities at BYU.

8:48AM F5.00005 OH Megamasers in Galactic Merging Regions , KIRSTIN COOPRIDER, VICTOR MIGENES, Brigham Young University — OH Megamasers (OHM) very often appear in highly luminous infrared emission regions. One of these regions that are of great scientific significance is galactic mergers. OH masers are normally characterized by their presence in dusty star formation regions. However OH megamasers may not necessarily be represented only by their association with star formation, because of the possibility of a compact AGN. AGNs can also provide the driving mechanism for the masing process. Previously classified Starburst galaxies where OH masers are normally found, are now optically observed as AGN. OHMs may also be a reasonable judge as to the evolutionary stage of the merger. This project focuses on the radio observations that are part of a multi-frequency analysis of the merging regions surrounding the known OHMs. HI observations show where the gas is and help to determine the column density of the gas in the OHM regions. Hα maps the excited gas. Radio data will give position information of OHMS. Just as the environment provides a basis for the properties of the maser components, so do the maser components determine the properties of the environment.

9:00AM F5.00006 Rare Detections of OH MASERS in Star Forming Regions , DEREK FELLI, VICTOR MIGENES, BYU — MASERs (Microwave Amplification by Stimulated Emission of Radiation) appear from a variety of molecules and they originate from dense clumps of molecular gas. MASERs are some of strongest radio wave emitters in the observable universe. Due to their compact nature interferometry techniques is the best method to study the emission. The VLBA-NRAO instrument was used to study MASERs to further understand how stars form. Radio observations are used because at the early stages of star formation dust prevents optical studies. OH MASER emission has 4 strong transitions at 1.612, 1.665, 1.667 and 1.720 GHz. In star forming regions it is common to detect MASERs at 1.665 and 1.667 GHz. Detections at 1.612 and 1.720 GHz are rare in star forming regions but have been detected in Orion-KL, W3 and W75N which are high mass star forming regions. Detections of the 1.612 and 1.720 GHz transitions in this study may give further evidence that only high mass star forming regions produce these transitions though we don't understand why, yet. Because these transitions haven't been exhibited in low star mass forming regions, it may be the link to classify several unknown star forming regions as low mass or high mass star formation. We present and discuss some of our preliminary results.

Saturday, October 24, 2009 8:00AM - 9:12AM –
Session F6 Atomic Physics Hill Hall 204

8:00AM F6.00001 A laser-cooled single-atom-on-demand source for Si quantum computing[1] , SIU AU LEE, WILLIAM FAIRBANK, KATHERINE ZAUNBRECHER, WILLIAM CZAJKOWSKI, Colorado State University — A promising proposal by B. Kane for a scalable silicon quantum computer requires the placement of P-31 atoms 20 nm apart and 10 nm below the surface in pure Si-28 to 1 nm precision. Attempts to do this with 10-30 keV P-31 beams have not yet succeeded. This paper presents a scheme for laser cooling and trapping Si-31 atoms in a magneto-optical trap (MOT), detecting by fluorescence when there is only one atom in the trap, resonantly ionizing that one atom near threshold, and softly depositing the single 31Si+ ion in Si to nm precision at ~100 eV. A few hours after deposition Si-31 beta decays in situ to the desired species 31P+. The hyperfine structure and isotope shifts of the 221.7 nm cooling transition for the stable isotopes of Si have been measured with precision for the first time. Additional progress, including demonstration of sufficient power at 221.7 nm for the MOT will also be reported.

[1]This work is supported by the W. M. Keck Foundation.

8:12AM F6.00002 Detection of new auto-ionizing states of ^{28}Si using resonant ionization , WILLIAM CZAJKOWSKI, JON KLUCK, KATHERINE ZAUNBRECHER, SIU AU LEE, WILLIAM FAIRBANK, Colorado State University — We are developing a scalable, solid state, quantum computer based on the Kane proposal of using $^{31}P^+$ donor ions in Si as qubits. This involves the placement of P^+ into a Si substrate with nm precision. We plan to accomplish this by laser cooling and trapping single, ablated, radioactive, ^{31}Si atoms in a magneto-optical trap (MOT) prior to implanting them into a Si substrate. ^{31}Si subsequently beta decays into $^{31}P^+$, forming the qubit. To gain experience before handling short lived, low abundance radioactive materials the techniques to make these measurements are being developed on ^{28}Si. In this talk we will report on measurements of ^{28}Si resonance ionization spectroscopy near the first ionization limit, including newly discovered auto-ionizing states. These states were detected by scanning a pulsed dye laser across a beam of excited atoms. Using this method we generated a saturation curve and calculated the photoionization cross section for the lowest lying state above the ionization limit. Additionally we will report on initial studies of laser ablation of a solid silicon sample. Research supported by the W. M. Keck Foundation and the National Science Foundation. †Fellowship support provided by the U.S. Military Academy, West Point, NY.

8:24AM F6.00003 Polarizability of Pb III from spectroscopy of high-L Rydberg states of Pb II[1]

, MARK E. HANNI, JULIE A. KEELE, STEPHEN R. LUNDEEN, Colorado State University, WILLIAM G. STURRUS, Youngstown State University, CHARLES W. FEHRENBACH, Kansas State University, RESIS COLLABORATION — Using the Resonant Excitation Stark Ionization Spectroscopy technique[1], we measured resolved fine structure components of the n=20 to n'=52 transition in Pb^{+}, and determined the polarizability of Pb^{2+}. A critical part of the measurement consists of the determination of the L-value of one or more of the resolved excitation peaks. These measurements were motivated by a discrepancy between previous polarizability determinations based on contrasting methods[2].

[1] S.R. Lundeen and C.W. Fehrenbach, Phys. Rev. A 75, 032523 (2007)
[2] Nicholas Reshetnikov, et. al., Physica Scripta 77, 015301 (2008).

[1]Supported by the Chemical Sciences, Geosciences, and Biosciences Division of the Office of Basic Energy Science, U.S. Department of Energy.

8:36AM F6.00004 The Doubling of 846 nm Light to Produce 423 nm Light for use in Atom Interferometry[1]

, JAMES ARCHIBALD, BYU, JEREMEY BIRRELL, REBECCA TANG, CHRIS ERICKSON, LANDON GOGGINS, DALLIN DURFEE — We present progress on a 423 nm fluorescence probe/cooling laser for use in our neutral calcium atom interferometer. The finished system will include an 846 nm diode laser that is coupled to a tapered amplifier. This light will be sent to a buildup cavity where we will achieve second-harmonic generation (SHG) using either a BBO non-linear crystal or a periodically-poled KTP crystal. We will discuss the theoretical considerations relating to the doubling of light in a crystal and the construction of our buildup cavity. We will also discuss its proposed application for use in atom interferometry.

[1]Funding by BYU Office of Research and Creative Activities.

8:48AM F6.00005 Can spin-up go down in a Stern-Gerlach device? The propagator approach to Stern-Gerlach wavepacket dynamics

, BAILEY HSU, JEAN-FRANCOIS VAN HUELE, Brigham Young University — The Stern-Gerlach effect (SGE) is iconic for visualizing spin. We analyze the evolution of atomic wavepackets by constructing exact solutions using propagators in SGE field configurations in different approximations. We contrast our results with the standard presentation of the SGE in textbooks and literature and illustrate with visual animations in 2D and 3D.

9:00AM F6.00006 Center-of-Mass Technique applied to the Ideal Inelastic Collisions Case

, EDWARD DOWDYE, JR., Pure Classical Physics Research — Findings show that the law of conservation of kinetic energy directly applies to inelastic collisions as well as to elastic collisions. The kinetic energy transfer is consistent with the law of conservation of energy which states that energy can neither be created nor annihilated. In an ideal inelastic collision, two colliding masses, M_1 and M_2, will move jointly at their center-of-mass velocity, $V_{CM} = \frac{M_1V_1+M_2V_2}{M_1+M_2}$. As a consequence, the equation $\frac{1}{2}M_1V_1^2+\frac{1}{2}M_2V_2^2-\frac{1}{2}M_1\left(V_1-V_{CM}\right)^2-\frac{1}{2}M_2\left(V_2-V_{CM}\right)^2 = \frac{1}{2}\left(M_1+M_2\right)V_{CM}^2$ applies to the ideal inelastic collision. The quantities $\frac{1}{2}M_1V_1^2$ and $\frac{1}{2}M_2V_2^2$ are the initial kinetic energies of the masses M_1 and M_2, respectively, that would be available in the rest frame if the two masses were to come to a complete stop, $V_1= 0$ and $V_2 = 0$. The negative terms, $-\frac{1}{2}M_1\left(V_1-V_{CM}\right)^2$ and $-\frac{1}{2}M_2\left(V_2-V_{CM}\right)^2$, are the kinetic energies transferred into the center-of-mass frame as M_1 and M_2 go from velocities, V_1 and V_2 , respectively, to the velocity V_{CM}. The kinetic equation leads directly to the valid conservation of momentum equation $M_1V_1 + M_2V_2 = \left(M_1+M_2\right)V_{CM}$, a mathematical proof that the kinetic energy is totally conserved for the ideal inelastic collision. For details: http://www.extinctionshift.com/SignificantFindingsInelastic.htm

Saturday, October 24, 2009 8:00AM - 9:12AM – Session F7 Materials Physics I Hill Hall 202

8:00AM F7.00001 Finding one of Nature's missing crystal structures

, GUS HART, Brigham Young University — There are an infinite number of ways atoms can be arranged on a lattice. But, like the integers, the arrangements can be counted and some are "smaller" than others. These small crystal structures are popular in common alloys. But mother Nature refuses to use some other small crystal structures. Why? Maybe she really uses them and we just haven't looked in the right places. We have developed an algorithm for generating a complete list of the possible structures. Using a combination of computation and experiment, we are closing in on a never-before-observed crystal structure.

8:24AM F7.00002 Electric-field dependent measurements of 3D x-ray diffuse scattering in piezoelectric materials

, BENJAMIN FRANDSEN, Physics & Astronomy, Brigham Young University, STACEY SMITH, Chemistry & Biochemistry, Brigham Young University, BRANTON J. CAMPBELL, Physics & Astronomy, Brigham Young University, MATTHEW J. GARDNER, KEVIN D. SEPPI, Computer Science, Brigham Young University — Polar nano-regions (PNR) in relaxor materials $Pb(Zn_{1/3}Nb_{2/3})O_3$ and $Pb(Mg_{1/3}Nb_{2/3})O_3$ are of pressing applied interest due to their influence on the remarkable piezoelectric properties of their solid solutions with ferroelectric $PbTiO_3$. X-ray single-crystal diffuse-scattering techniques have recently been shown to provide qualitative insight into the local atomic structures of these materials. But in order to differentiate among the PNR models that have arisen, quantitative analyses are also needed, which require mapping out large high-precision volumes of reciprocal space as a function of electric field. In August of this year, we conducted a synchrotron x-ray diffuse scattering experiment at the Advanced Photon Source at Argonne National Laboratory to determine the effect of a strong electric field on the local atomic structure of a PNR. I will describe the preliminary results of this experiment.

8:36AM F7.00003 Negative thermal expansion in hexacyanoferrates(III) of divalent metals , S. ADAK, New Mexico State University, L. DAEMEN, H. NAKOTTE, D. WILLIAMS — Many Prussian Blue (PB) analogs are known to exhibit negative thermal expansion (NTE) behavior. However, detail studies of the NTE behavior in these compounds and the underlying mechanism behind such behavior are often missing in the literature. It is possible to systematically vary the charge and the ion size in the PB analogs. The octahedral units in PB analogs are linked with a linear cyanide ligand. This introduces more degrees of freedom in the (mostly) cubic structures. Therefore, the PB compounds offer an interesting playground to study NTE phenomenon and its possible correlations with crystal and electronic structures. The thermal expansion behavior of five PB analogs, hexacyanoferrates(III) of divalent metals with general formula$M_3^{II}[Fe^{III}(CN)_6]_2$ (M = Mn, Co, Ni, Cu, and Zn), has been studied using X-ray powder diffraction measurements. Polycrystalline samples of the studied compounds were prepared via standard chemical precipitation. The X-ray data collected at 300 and 84 K while cooling were analyzed using the Rietveld refinement technique. The crystal structures of the materials studied are cubic with space group$Fm\overline{3}m$ or $F\overline{4}3m$. The analysis indicates the occurrence of NTE in hexacyanoferrates(III) of Co, Cu, and Zn. The NTE coefficients were found to be in the range 15 x 10^{-6}K^{-1} – 31 x 10^{-6} K^{-1}. The other two compounds exhibit positive thermal expansion.

8:48AM F7.00004 Trends in core-level shifts at bimetallic interfaces formed by group-10 metals deposited on W(110) , D.M. RIFFE, Utah State University — The monolayer bimetallic interface formed by the deposition of Ni, Pd, or Pt on W(110) provides a quintessential setting for investigating the chemical interactions between early and late transition metals. Perhaps surprisingly, these group-10 metals behave as noble metals in this setting. To study the chemical interactions in detail we have obtained core-level photoemission data from W(110) surface atoms for group-10 metals deposited at submonolayer to monolayer coverages. Commonalities among the bimetallic interfaces include the following: (i) a separate substrate core-level shift can be identified for each overlayer phase (1D, pseudomorphic, and/or commensurate); (ii) commensurate overlayers produce only one substrate core-level shift, even though not all substrate atoms are equivalently coordinated; (iii) the difference in substrate shifts induced by pseudomorphic and commensurate overlayers contains a large structural contribution; (iv) for a pseudomorphic overlayer the ratio of the group-10-atom to W-atom core-level shift (when referenced to binding energies at the respective clean surfaces) is 4 for all three systems; (v) a partial-shift Born-Haber-cycle analysis semiquantitatively describes the substrate shifts induced by both the pseudomorphic and commensurate layers; and (vi) the corresponding core-level shifts on W(110) are very similar to those induced on W(111).

9:00AM F7.00005 Ordered Magnesium-Lithium alloys , RICHARD TAYLOR, Brigham Young University, STEFANO CURTAROLO, Duke University, GUS HART, Brigham Young University — Emerging technologies increasingly depend on the production of ultra-lightweight materials. Magnesium-lithium (MgLi) alloys are the lightest metallic alloys, having densities near that of plastics, and are strong enough to be used in a variety of high- performance applications. Although considerable work has been done on the MgLi system, little is known regarding potential ordered phases. An analysis of the system with first-principles methods revealed an unexpected wealth of stable zero- temperature phases. Of particular practical interest are configurations containing more than 13 atomic percent lithium, as they will be more ductile due to partial or complete formation on a cubic lattice. The analysis was extended to finite temperature using a Monte Carlo algorithm on large lattices with periodic boundary conditions. Discontinuities in specific heat measurements revealed order-disorder transition temperatures in the range 200-400K. Given the comparatively low melting point of Li (∼450K), kinetics at these temperatures may be sufficient to permit spontaneous partial ordering for Li rich alloys.

Saturday, October 24, 2009 8:00AM - 9:00AM –
Session F8 Symposium on Physics Education II: K-16 Hill Hall 209

8:00AM F8.00001 Addressing CSAP Physics Standards: Content for Middle School Instructors , GRANT DENN, RICHARD KRANTZ, Metropolitan State College of Denver — As part of the NSF funded Rocky Mountain Middle School Math and Science Partnership (RMMSMSP), we developed a class for middle school teachers entitled "Forms and Transfer of Energy" which directly addressed content as stated in the Colorado Standards Assessment Program (CSAP). Specifically, we built lectures and activities based on Colorado Grade 8 benchmarks 2.8 (energy forms and transfer), 2.9 (electricity and energy) and 4.2 (renewable and non-renewable resources.). This talk reviews some of the activities we used to demonstrate energy transformation.

8:12AM F8.00002 Colorado School of Mines Society of Physics Students Outreach Program , SHIRLEY MOORE, MARTY OTZENBERGER, Society of Physics Students — Since the reinstatement of CSM's chapter of the Society of Physics Students last year, we have been dedicated to spreading the knowledge of physics through outreach while providing both social and professional events for students and the community. We did many things last year that we intend to repeat this year. In August we participate in Celebration of Mines, doing interesting demonstrations while informing new students about our organization. In autumn, a haunted physics lab is built, SPS and the CSM Physics Department hold Physics Week, and volunteers judge science fairs at local schools. In spring, a workshop is held for students to apply for summer internships and REUs and students enjoy a fun night of bowling. SPS also prepares demonstrations for the Associated Students of CSM to use in their Into the Streets volunteer event and co-organizes Mitchell Elementary School's Family Math and Science Night. Last year, we hosted the Colorado/Wyoming AAPT and SPS Zone 14 meeting. This year, we will host an E-days dunk tank and soapbox derby. At the end of the year, a department barbeque is held to finish off the spring semester. For our efforts, we accepted a Marsh White award for demonstrations in addition to a SOCK and outstanding chapter award from SPS national.

8:24AM F8.00003 The High Road/Low Road Demonstration or Birds on a Wire , JACOB CADY, CHAD MIDDLETON, Mesa State College — Consider two separate tracks of equal horizontal distances and initial and final heights. One track remains at this initial height while the other angles down, levels out, and then angles back up in order to regain its original height. Question: If two identical balls are set rolling with equal initial speeds, which ball completes the track in a shorter time interval? In this manuscript, the dynamics of a ball on each track are analyzed using basic Newtonian mechanics. We calculate the time necessary to complete each path in terms of the parameters of the track and the initial velocities of the balls. We derive an expression for the time difference between the two tracks and compare this to data taken on a set of high road/load road tracks, hence demonstrating the fact that the ball traversing the low road always wins the race.

8:36AM F8.00004 Using Just in Time Teaching In An Upper-Division Elective: Experiences and Thoughts , JEFF LOATS, Metropolitan State College of Denver — Having used Just in Time Teaching (JiTT) for 5 years in introductory courses I am now using it in an upper-division course (nuclear & particle physics) for the first time along with Peer Instruction & "clickers". A brief anecdotal discussion of my experiences and student attitudes towards these techniques and how they fit into the upper-division curriculum.

8:48AM F8.00005 The Tortured History of Gauss's Law , ROSS SPENCER, Brigham Young University — American physics textbooks contain the following equation, which is called Gauss's law:

$$\oint \mathbf{E} \cdot d\mathbf{S} = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

It is odd, however, that biographies of Karl Friedrich Gauss (1777-1855) contain no mention of this law. A brief history of this important result will be presented in which it will be shown that what we call Gauss's law today was originally guessed at by Joseph Priestly (1733-1804) after he read a letter from Benjamin Franklin (1706-1790), then was derived, forgotten, and re-derived several times in two different contexts by many of the luminaries of physics in the eighteenth and nineteenth centuries.

Saturday, October 24, 2009 9:30AM - 11:18AM – Session G1 Plenary Session II Green Center Metals Hall

9:30AM G1.00001 The Role of Physicists in the 21st Century , CHERRY MURRAY, APS President, Harvard University — Some call the 19th Century the golden age of physics, and the 20th Century the golden age of biology as well as the information age. What is in store for physics as a discipline in the 21st century? I will present my thoughts on the excitement of new explorations we couldn't do before as well as some challenges for the field. I will also talk about the role of physics and physicists in addressing today's multidisciplinary societal challenges.

10:06AM G1.00002 Creating a Star in the Laboratory: The National Ignition Facility , RICHARD BOYD, Lawrence Livermore National Laboratory — The National Ignition Facility, completed in 2009, is the world's largest laser. As such it is expected to compress a pellet of ^{2}H and ^{3}H to achieve a temperature exceeding 100 million K and density of up to 1000 g cm^{-3}, both seven times their values at the core of the Sun. These should produce ignition and energy gain. NIF plans to encourage programs in basic research, with nuclear astrophysics being part of that program. This presentation will describe the basic operation of NIF, as well as the motivation for and some details of several nuclear astrophysics experiments that might be conducted at NIF. Finally I will discuss how NIF might impact the world's energy future. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344, LLNL-ABS-416423.

10:42AM G1.00003 New Physics beyond the Standard Model: from the Earth to the Sky , SHUFANG SU, University of Arizona — The Standard Model in particle physics has been very successful in explaining the strong, weak and electromagnetic interactions of fundamental particles. There are, however, motivations for new physics beyond the Standard Model. The origin of electroweak symmetry breaking and generation of masses are still unresolved issues. The existence of dark matter and the explanation of matter-antimatter asymmetry also call for new physics beyond the Standard Model. In this talk, I will discuss recent developments in theoretical particle physics and how to discover those new physics scenarios in both high energy colliders and dark matter detection experiments.

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H1 Astroparticle Symposium IV: UHE Cosmic Rays – Anistropy Studies Green Center 211

11:20AM H1.00001 Intrinsic anisotropy of the UHECR from the Pierre Auger Observatory , KASEY ACKERMAN, Colorado State University, PIERRE AUGER COLLABORATION — Using a differential two-point correlation method, we examine the distribution of arrival directions of the highest energy cosmic rays detected with the Pierre Auger Observatory. We compare this distribution against a hypothesis of isotropy. The number of pairs of events at a small angular scale is consistent with an isotropic distribution only 3 percent of the time. We also study the number of pairs at a small angular scale as a function of the energy of the cosmic rays. Data show an anisotropic distribution only at energies above 57 EeV.

11:32AM H1.00002 Two Point Autocorrelation Analysis of Auger Highest Energy Events Backtracked in Galactic Magnetic Field , YEVGENIY PETROV, Colorado State University, PIERRE AUGER COLLABORATION — Searches for sources of the highest-energy cosmic rays traditionally have included looking for clusters of event arrival directions on the sky. The smallest cluster is a pair of events falling within some angular window. In contrast to the standard two point (2-pt) autocorrelation analysis, this work takes into account influence of the galactic magnetic field (GMF). The highest energy events, those above 50EeV, collected by the surface detector of the Pierre Auger Observatory between January 1, 2004 and May 31, 2009 are used in the analysis. Having assumed protons as primaries, events are backtracked through BSS_S, BSS_A, ASS_S and ASS_A versions of Harari-Mollerach-Roulet (HMR) model of the GMF. For each version of the model, a 2-pt autocorrelation analysis is applied to the backtracked events and to 10^5 isotropic Monte Carlo realizations weighted by the Auger exposure. Scans in energy, separation angular window and different model parameters reveal clustering at different angular scales. Small angle clustering at 2-3 deg is particularly interesting and it is compared between different field scenarios. The strength of the autocorrelation signal at those angular scales differs between BSS and ASS versions of the HMR model. The BSS versions of the model tend to defocus protons as they arrive to Earth whereas for the ASS, in contrary, it is more likely to focus them.

11:44AM H1.00003 Search for Large-Scale Anisotropy of Ultrahigh Energy Cosmic Rays with HiRes Stereo Data , GORDON THOMSON, University of Utah, PETER TINYAKOV, HYLKE KOERS, Free University of Brussels, HIGH RESOLUTION FLY'S EYE COLLABORATION — We report on a search for correlations between local large-scale structure and arrival directions of ultrahigh energy cosmic rays, detected by the High Resolution Fly's Eye (HiRes) experiment operating in stereoscopic mode. HiRes has observed cosmic rays with energies up to just over 100 EeV. The highest energy events have a relatively nearby horizon, and one expects that they should point back to their sources to a few-degree accuracy, or at least toward local large-scale structure. HiRes currently has the largest exposure of any experiment in the northern hemisphere. The experiment and search methods will be described and results will be presented.

11:56AM H1.00004 Predictions of the small scale clustering properties of ultra-high energy cosmic rays , PATRICK YOUNK, Colorado State University — I present theoretical estimates of the small scale clustering properties of ultra-high energy cosmic rays (UHECR) assuming that: (1) the UHECR sources are extragalactic, and (2) the Greisen-Zatsepin-Kuz'min effect is operational. I show that assumptions on the particle charge and intervening magnetic fields have a large effect on the predicted small scale clustering. Therefore, a measurement of the small scale clustering can be used to constrain the parameter space that describes the allowed distribution of particle charge and the allowed structure of the intervening magnetic fields. I show how such constraints can be determined in the near future.

12:08PM H1.00005 Search for coincidences with gamma-ray bursts in Pierre Auger Observatory data , DAVID THOMAS, Colorado State University, PIERRE AUGER OBSERVATORY COLLABORATION — We analyze extensive air shower data collected by the Pierre Auger Observatory to search for coincidences between the arrival directions of ultra-high energy cosmic rays and the positions of gamma-ray bursts. We also analyze the trigger rate data from individual surface detector stations to search for an increase of the average trigger rate over the entire surface detector array in correlation with gamma-ray bursts.

12:20PM H1.00006 Analysis Techniques used for Telescope Array Surface Detector Data[1] , DMITRI IVANOV, BENJAMIN STOKES, Rutgers University, GORDON THOMSON, University of Utah, TELESCOPE ARRAY COLLABORATION — The Telescope Array experiment is the largest cosmic ray experiment in the northern hemisphere. It consists of a surface detector (SD) of 507 scintillation counters and three fluorescence stations overlooking the SD. We are analyzing the SD data using a new technique, which consists of generating a Monte Carlo (MC) simulation of the SD that has all the characteristics of the actual data, comparing the MC with the data to verify the accuracy of the MC, and calculation of the SD aperture from the MC information. Our analysis based solely upon the data, our method of generating CORSIKA showers without the problems caused by thinning, and comparisons of MC with data will be shown.

[1]Supported by NSF-PHY-0649681

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H2 Fluids & Capillary Phenomena Green Center 215

11:20AM H2.00001 RF Liquid Measurement Of Capillary Tubes , BASHUDEV POUDYAL, BRIAN MAZZEO, KARL WARNICK, Brigham Young University — Electromagnetic measurements of capillary tubes containing liquids can reveal solution properties for industrial, biological, and chemical processes. An analytical model was created for a perpendicular arrangement of SMA cables and a capillary tube. Numerical simulations in Ansoft High Frequency Structural Simulator were performed on the simple arrangement. The transmission parameters of the capillary tube were simulated between two lumped ports over a frequency range from 1 GHz to 20 GHz. Sensitivity of the transmission parameters to solution conditions were calculated for DI water and other variations of conductivity and permittivity. Experiments were performed on a capillary tube in a perpendicular arrangement using an HP 8720B Network Analyzer. The transmission parameters were measured and the resulting data was compared with the simulations. This measurement method can be adapted to different tube and solution conditions.

11:32AM H2.00002 Liquid "Wires" for Microfluidics , NATHAN KELLIS, Brigham Young University, AARON MAZZEO, Massachusetts Institute of Technology, BRIAN MAZZEO, Brigham Young University — We demonstrate liquid "wires" in a simple solution measurement device. This device highlights the possibility of fabricating liquid circuits. These "wires" were formed by filling micro-milled PMMA channels with 5M NaCl solution. Wires were connected to these salt solution channels; the impedance of a test channel filled with solution was measured by an HP 4294A Impedance Analyzer. Deionized water, 2-propanol, and 5M NaCl were measured. Numerical simulations were performed on the channel cross-section to determine the predicted impedance of the device. The simulated results were compared to the experimental data. Graphs of simulations and experiments are presented for the frequency range 1 KHz to 110 MHz. The data show electrode polarization at the electrode-electrolyte interface, as well as parasitic capacitance inherent in the experimental arrangement.

11:44AM H2.00003 Simulation of ion transport in the first vacuum stage of an Inductively Coupled Plasma Mass Spectrometer[1] , STEVEN SCHMIDT, ROSS SPENCER, Brigham Young University — An Inductively Coupled Plasma Mass Spectrometer (ICP-MS) is an instrument used to detect trace elements in a sample and analyze its composition. In an effort to better understand this instrument the United States Department of Energy is funding research to investigate the details of its operation. A computer code called FENIX utilizing the Direct-Simulation Monte-Carlo (DSMC) algorithm has been developed and is being utilized to understand the operation of this machine. The transport of trace ions in the presence of an ambipolar electric field through the first expansion region will be presented.

[1]Work supported by the US Department of Energy.

11:56AM H2.00004 Thermal Conductivity of Superfluid Helium in Porous Vycor Glass[1] , WILLIAM TIERNAN, Mesa State College, SILVIA IONESCU, University of Massachusetts at Amherst, MICHAEL RAY, University of Massachusetss at Amherst, ROBERT HALLOCK, University of Massachusetts at Amherst — We report measurements of the thermal conductivity of superfluid helium in porous vycor glass. Measurements were performed at selected temperatures from 1.4 to 2.2 K and at helium pressures between 1 and 23 bar. Comparison with empty cell thermal conductivity measurements show that the superfluid contribution to thermal conductivity is very small. Our results are consistent with predictions that the normal He component should be clamped in the $\sim$7 nm vycor pores and demonstrates that our sample had no larger channels to provide a normal fluid counterflow.

[1]Supported at Umass by NSF 06-50092.

12:08PM H2.00005 Modeling Ion Flow in an Inductively Coupled Plasma Mass Spectrometer using Navier-Stokes Equations , MATTHEW ZACHRESON — The Inductively Coupled Plasma Mass Spectrometer is a device which allows high-temperature argon gas to expand into vacuum to create an ion beam from the trace ions entrained in the flow. The steady-state drift/diffusion fluid equations have been used to model the transport of these trace ions in the first vacuum stage of this device. The effect of an ambipolar electric field has been included and is found to be important. Discrepancies exist, however, between the calculation results and experimental data collected in the vacuum region, especially where the ion flow interacts with a post-nozzle shock wave.

12:20PM H2.00006 An all optical method for lab-on-a-chip temperature measurements

, ADAM GOERING, DAN ADAMS, JEFF SQUIER, CHARLES DURFEE, KIM WILLIAMS, Colorado School of Mines — We demonstrate the use of Spatially and Spectrally Resolved Interferometry (SSRI) to measure minute temperature changes in picoliter volumes. The SSRI technique allows the measurement of refractive index changes as a function of temperature, frequency, and one spatial dimension within a microfluidic device. Integration of optical fibers and inexpensive light sources facilitate the progress of this method toward "lab on a chip" applications. Additionally, careful construction of microfluidic devices, in combination with SSRI will enable in-situ control of thermal gradients across the channel. Broad applications of this technology could include the measurements of reaction enthalpies, development of accurate temperature measurements in microfluidic devices, and precise characterization of temperature gradients.

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H3 Optical Techniques in Neutrino Physics Green Center 249

11:20AM H3.00001 Light Injection tests in P0D neutrino detector

, TIMOTHY WALTON, Colorado State University — The T2K experiment will measure neutrino mixing by sending a neutrino beam, created at the Japan Proton Accelerator Research Center (JPARC) in Tokai, Japan, over 290 km underground to the Super-Kamiokande detector. The neutrino beam at JPARC will be monitored by ND280 experiment which contains the Pizero Detector (P0D). The P0D contains around 11,000 scintillator bars, each with a wavelength shifting fiber connected to an avalanche photo diode sensor. These sensors, called MPPCs, are monitored by an LED light injection system developed at Colorado State University. We show the initial results of a study of the response of the MPPC sensors to the LED light pulses. We find unexpectedly large signal variation in some groups of MPPCs, and we determine the cause to be slight random height variations in the fibers themselves.

11:32AM H3.00002 Study of Charge Integration Electronics in Pi-Zero Detector of a Long-Baseline Neutrino Oscillation Experiment

, RAJARSHI DAS, Colorado State University — The Pi-Zero Detector (P0D), a part of Long Baseline Neutrino Oscillation experiment, uses a beam produced and characterized in Tokai, Japan and measured 295 km away in Kamioka. The P0D consists of around 10,000 scintillator bars with wavelength-shifting fibers attached to a Multi-Pixel Photon Counter that measures the energy deposited by neutrino interactions in the bar. The charge output from each photon counter is integrated during a few hundred nanoseconds windows, stamped with hit time, and then read out into a data acquisition system. We also use a Light Injection system to introduce a controlled amount of light into the fibers by pulsing a set of LEDs. Here we present a study of the signals measured in a sequence of integration windows from individual photon counters as well as distributions of hit times. Our results indicate a substantial effect for integration windows following a large signal and demonstrate the need to have further studies of integration electronics so we can eliminate possible effects of background to the interaction signals.

11:44AM H3.00003 Searching for the Mass of the Neutrino (Spectroscopy of Ba+ ions in Liquid ^{136}Xe)[1]

, KENDY HALL, CESAR BENITEZ, BILL FAIRBANK, Colorado State University, ENRICHED XENON OBSERVATORY (EXO) COLLABORATION — The goal of the Enriched Xenon Observatory (EXO) collaboration is to detect neutrino-less double beta decay using a ton size liquid ^{136}Xenon detector with zero background. Such detection can only be achieved if the daughter $^{136}Ba^+$ ion that is present at decay site is tagged. The EXO collaboration is working towards several techniques to tag the Ba^+ ion. In-situ laser tagging of Ba^+ ions in a liquid xenon test apparatus is being developed at Colorado State University (CSU). Ba^+ ions are implanted in the liquid xenon by ablating a barium sample with a 1064nm Nd-YAG pulsed laser. In-situ laser tagging can only be accomplished if the spectroscopy of Ba^+ ions in liquid xenon is understood. This work's goal is to confirm the spectra of Ba+ ions in liquid xenon. The most recent results of the experiments at CSU will be presented.

[1]Supported by DOE under Grant No. DE-FG02-03ER41255.

11:56AM H3.00004 Double beta decay daughter ion detection in a solid xenon matrix for EXO[1]

, BRIAN MONG, SHON COOK, WILLIAM FAIRBANK, Colorado State University, ENRICHED XENON OBSERVATORY COLLABORATION — $0\nu\beta\beta$ experiments are the possibly the most sensitive means available to measure the absolute mass of the neutrino as long as backgrounds can be sufficiently suppressed. The Enriched Xenon Observatory (EXO) experiment may be able to eliminate all backgrounds by detecting the daughter of the $0\nu\beta\beta$ ($^{136}Xe \rightarrow ^{136} Ba + 2e^-$) through optical fluorescence. We propose to grab the ion in the detector by freezing it in xenon ice on a cold probe, possibly an optical fiber, and then detecting it in the ice. We present progress in the detection of barium ions generated by an ion beam, and detected in a solid xenon matrix using CW laser excitation and efficient fluorescence detection.

[1]Supported by the NSF under Grant No. PHY-0652347 and DOE under Grant No. DE-FG02-03ER41255.

12:08PM H3.00005 Application of Multiphoton Ionization of Liquid Xenon for Purity Measurements[1]

, JULIO CESAR BENITEZ MEDINA, KENDY HALL, WILLIAM FAIRBANK, Colorado State University — Detection of fluorescence from single Ba^+ daughter ions in liquid xenon is a potential key method of background discrimination in the Enriched Xenon Observatory (EXO) double beta decay experiment. An important requirement is to have ultrapure liquid in order to ensure Ba^+ ion survival for many seconds. To measure the purity of liquid Xenon we produce electrons using a 355 nm and 266nm Nd-YAG pulsed laser. By varying the laser energy, we have demonstrated that these are two- and three-photon ionization processes, respectively. As the electrons travel in the liquid some may be lost by attachment to impurities. By measuring the fraction of electrons that survive, we can determine the purity of the liquid. Having a focused beam allows us to select where the electrons are created.

[1]Supported by DOE under Grant No. DE-FG02-03ER41255.

12:20PM H3.00006 Two-Dimensional Angular Scattering Instrument for Aerosol Characterization , MATTHEW BERG, NRC Postdoc, STEVEN HILL, GORDEN VIDEEN — We describe the development of a novel light scattering apparatus to study single aerosol particles. The apparatus collects a particle's scattered light over two angular dimensions in the near-forward direction. Single particles are trapped in an electrodynamic levitator or dispersed in an aerosol flow and illuminated one-by-one by a 30ns pulsed 532 nm Nd:YAG laser. The optical arrangement uses a simple spatial filter to remove unscattered light from the near-forward direction, allowing collection of the scattered light within a two-dimensional angular range from 0.1∼15 degrees centered on the forward direction. This angular range enables a simple power-law analysis of the scattered intensity, which can be used to obtain estimates of the particle size without recourse to complicated data analysis.

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H4 Industrial Applications of Physics Green Center 263

11:20AM H4.00001 Listening to the Earth with Gravity Meters , TIMOTHY NIEBAUER, Micro-g LaCoste — Gravity meters have long been used to gain static information about the earth. For example, gravity provides information about the shape of the earth for geodetic purposes as well as subsurface density anomalies that can be used to locate oil, gas, and other minerals. Gravity is also very sensitive to vibrations in the earth induced in the earth by earthquakes. Gravity meters can potentially detect seismic energy at lower frequencies than is possible with traditional seismometers. This talk will introduce and explain the differences between different types of gravity meters; from spring-based systems to absolute free-fall ballistic techniques. It will also describe how gravity can be used to monitor gas and water injections into reservoirs. Finally, we will show some new results of measurements with a new gravity meter, called the gPhone. The gPhone provides a complementary methodology for listening to the subtle bass tones excited by earthquakes at frequencies outside the bandwidth of traditional seismometers.

11:44AM H4.00002 Microwave-Assisted Magnetization Switching: Competition between Pumping and Damping , ZIHUI WANG, KE SUN, WEI TONG, MINGZHONG WU, MING LIU, NIAN X. SUN, COLORADO STATE UNIVERSITY TEAM, UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA COLLABORATION, NORTHEASTERN UNIVERSITY (BOSTON) COLLABORATION — In the presence of microwaves, magnetization reversal in magnetic materials can be realized with relatively low magnetic fields. This effect is called microwave-assisted magnetization reversal (MAMR). This presentation reports for the first time (1) the demonstration of MAMR in large-damping materials and (2) the observation of a saturation effect for the enhancement in MAMR. The experiments were carried out on $Fe_{70}Co_{30}$ thin films with ferromagnetic resonance techniques. A reduction in the switching field was observed in the presence of microwaves. The level of such a reduction depends on the frequency and power of the microwaves. With increasing the microwave duration, the switching field decreases first but then approaches a lower-limit. This saturation of the switching field reduction was interpreted in terms of the pumping-damping competition. The interpretation was supported by the measurements of the switching field as a function of the microwave duration for different conditions.

11:56AM H4.00003 High Resolution Optical Scans of Pixelated Silicon Avalanche Photodiodes[1] , WILLIAM JOHNSTON, ROBERT WILSON, Colorado State University — Pixelated avalanche photodiodes are increasingly used in applications where photomultiplier tubes have previously been employed. These pixelated avalanche photodiodes have 100's of pixels which each act as a single-photon detector. A high-resolution optical scanner has been constructed that can measure the uniformity of response of different pixels, the uniformity of response across individual pixels, and crosstalk between pixels on a single device. This scanner features a micron-sized photon beam and is able to position the photodiode with micron level precision. Initial measurements performed on a Hamamatsu multi-pixel photon counter (MPPC) will be presented.

[1] I would like to acknowledge James R. Sites for his assistance on this project.

12:08PM H4.00004 Flyin' Ions: Simulated and Physical Testing of a Time of Flight Mass Spectrometer , NICHOLAS MORRILL, Brigham Young University, TODD KING, STEPHANIE GETTY, MARY LI, STEVEN FENG, NICK COSTEN, LARRY HESS, VINCENT HOLMES, DAN STEWART, GREG HIDROBO, CLE HUNT, INGE TEN KATE, STEVE CAGIANO, WILL BRINKERHOFF, DANNY GLAVIN, PAUL MAHAFFY, NASA, NASA GSFC TEAM — Development of a miniature time-of-flight mass spectrometer for NASA was aided by computational simulation via SIMION 8.0 ©. A novel electron source using carbon nanotubes for generation of ions was implemented. Over all design was compatible with micro-fabrication techniques.

12:20PM H4.00005 Demonstration of a high average power table-top soft x-ray laser at 13.9 nm[1] , DALE MARTZ, DAVID ALESSI, YONG WANG, BRAD LUTHER, MARK BERRILL, SCOTT DOMINGUE, DAVID KEMP, JORGE ROCCA, Colorado State University, NSF CENTER FOR EXTREME ULTRAVIOLET SCIENCE AND TECHNOLOGY, COLORADO STATE UNIVERSITY TEAM — We have demonstrated a significant increase in the average power of table-top soft x-ray lasers at a wavelength of 13.9 nm. We present results of a Ni-like Ag amplifier operating at 2.5 Hz with a peak energy of $\sim$ 10 uJ per pulse. The results were obtained in a plasma generated by rapidly heating a solid target with 3-5J picosecond laser pulses from a titanium sapphire laser system. To obtain the increased average power of 20 uW, we upgraded our Ti:sapphire laser system with a high-energy Nd:Glass slab pump laser that can operate at a 2.5 Hz repetition rate. High repetition rate EUV lasers enable new applications in science and the development of unique metrology and processing tools for industry. The increase in the average power allows new applications of intense coherent soft x-ray light on a table-top.

[1] This work was supported by the NSF Center for Extreme Ultraviolet Science and Technology under NSF Award Number EEC-0310717.

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H6 Solitons and Quantum Dynamics Hill Hall 204

11:20AM H6.00001 Soliton solutions to the nonlinear Schrödinger equation , SAMUEL RIVERA, APS — Solitary wave (soliton) solutions are considered for the nonlinear Schrödinger equation $iu_t + u_{xx} + 2|u|^2u = 0$. Their physical importance is studied, and a Mathematica program is presented producing such soliton solutions and their updated animations.

11:32AM H6.00002 Rotons and Slitons in a Magnetic Cactus: Dynamical Phyllotaxis

, CRISTIANO NISOLI, T- Division, CNLS Los Alamos National Laboratory, NATHANIEL GABOR, Department of Physics, Cornell University — Phyllotaxis, the study of mathematical patterns in the arrangement of leaves on stems, spines on cacti, petals on flowers, et cetera, fascinated mankind since the dawn of times. Similar patterns emerge in the the statics of simple physical systems. Here we reproduce experimentally the striking number-theoretical patterns found in the phyllotaxis of living beings in the statics of a simple mechanical apparatus. Then we show that its dynamics reveal unusual excitations beyond botany: multiple classical rotons and a large family of interconverting topological solitons. Applications at different scales and in different areas of physics are proposed and discussed.

[1] C. Nisoli *et al*, Phys. Rev. Lett. **102**, 186103 (2009).
[2] C. Nisoli Phys. Rev. E **80**, 026110 (2009).

11:44AM H6.00003 Observation of Chaotic Solitons in Magnetic Film-Based Feedback Rings

, ZIHUI WANG, AARON HAGERSTROM, WEI TONG, MINGZHONG WU, RICHARD EYKHOLT, BORIS KALINIKOS, COLORADO STATE UNIVERSITY TEAM, CHINESE ACADEMY OF SCIENCES COLLABORATION, ST.PETERSBURG ELECTROTECHNICAL UNIVERSITY COLLABORATION — Chaos and solitons are two important branches of nonlinear science. Usually one believes that chaos and solitons have no direct relation per se. Recent simulations, however, have indicated the existence of solitons that exhibit chaotic behavior with time. This presentation reports the first experimental observation of chaotic solitons. The experiments were carried out with a magnetic film strip-based feedback ring. At some ring gain level, the ring eigenmode with the lowest decay rate is self-generated and one obtains a continuous spin wave. A further increase in the ring gain leads to the generation of additional modes through a 4-wave process. In the time domain, this corresponds to the formation of a single spin wave pulse that circulates in the ring. At some higher gain level, this pulse develops into a chaotic soliton – a soliton pulse whose amplitude changes with time in a chaotic manner. The pulse has a hyperbolic secant shape and a flat phase profile across the pulse width, which are the signatures of solitons. The overall time-domain signal resulting from the circulation of the pulse exhibits a finite correlation dimension and a positive Lyapunov exponent, which are evidence of chaotic motion.

11:56AM H6.00004 Non-strange chaotic attractors equivalent to their templates

, JOHN STARRETT, New Mexico Institute of Mining and Technology — We construct systems of three autonomous first order differential equations with bounded two dimensional attracting sets M. The flows on M are chaotic and have one dimensional Poincaré sections diffeomorphic to unimodal maps of the interval. Because the attractors are two dimensional rather than fractal, they are topologically equivalent to the templates of suspended horseshoes. These systems and their attractors are useful as simplified models of solutions to chaotic systems – for instance, the attractor of the cubic system is equivalent to the template of the parametrically forced pendulum. Thus, we are able to relate the well known dynamics of, say, the cubic map to the periodic orbit set of the forced pendulum.

12:08PM H6.00005 Excitation of Chaotic Surface Spin Waves in Magnetic Film Feedback Rings through Three-Wave Processes

, AARON HAGERSROM, MINGZHONG WU, RICHARD EYKHOLT, Department of Physics, Colorado State University — Surface spin waves in magnetic thin films can undergo three-wave splitting and confluence processes. In a splitting process, a surface spin wave produces two volume spin waves at about half of its frequency. In a confluence process, two half-frequency volume waves interact to produce a surface wave. This presentation reports the excitation of chaotic surface spin waves in magnetic thin film-based active feedback rings through these three-wave nonlinear interactions. Previous work has demonstrated such chaotic excitation in feedback rings. Neither the development of spectral modes nor the fractal dimensions of chaotic signals, however, have been reported. Experiments were performed with a 5 μm-thick yttrium iron garnet film and a static magnetic field of about 120 Oe. At some ring gain level, a single ring eigenmode was excited. As the gain was increased, one observed the excitation of additional modes, an increase in the frequency spacing between these modes, a period-doubling bifurcation, and the onset of chaos. One also observed a shift of the main mode to lower frequencies with increasing the gain. The correlation dimensions of the chaotic signals were found to be in the 2-4 range. It was also found that the correlation dimension increases with the ring gain.

12:20PM H6.00006 Open Source TEBD: software for entangled quantum many-body dynamics

, MICHAEL WALL, LINCOLN CARR, Colorado School of Mines — Matrix product state (MPS) based methods have proven in recent years to be the most efficient means of studying strongly correlated one dimensional systems. Among these methods is time-evolving block decimation (TEBD), which allows for studies of entangled quantum many-body dynamics in situations that may be far from equilibrium. Open Source TEBD is an open source effort which aims at making this algorithm available to a wider audience. In this talk I will discuss the conceptual and theoretical background of TEBD and MPS based methods in general, demonstrate the capabilities of the software package, and discuss future prospects for the open source effort.

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H7 Materials Physics II Hill Hall 202

11:20AM H7.00001 Inhomogeneous Broadening in Perturbed Angular Correlation Spectroscopy[1]

, AUSTIN BUNKER, MIKE ADAMS, JEFFERY HODGES, TYLER PARK, MICHAEL STUFFLEBEAM, WILLIAM EVENSON[2], PHIL MATHESON, Utah Valley University, MATTHEW ZACATE, Northern Kentucky University — Our research concerns the effect of a static distribution of defects on the net electric field gradient (EFG) within crystal structures. Defects and vacancies perturb the distribution of gamma rays emitted from radioactive probe nuclei within the crystal. These defects and vacancies produce a net EFG at the site of the probe which causes the magnetic quadrupole moment of the nucleus of the probe to precess about the EFG. The net EFG, which is strongly dependent upon the defect concentration, perturbs the angular correlation (PAC) of the gamma rays, and is seen in the damping of the perturbation function, $G_2(t)$, in time and broadening of the spectral peaks in the Fourier transform. We have used computer simulations to study the probability distribution of EFG tensor components in order to uncover the concentration dependence of $G_2(t)$. This in turn can be used to analyze experimental PAC data and quantitatively describe properties of the crystal.

[1] Work supported in part by NSF grant DMR 06 06006 (Metals Program).
[2] retired

11:32AM H7.00002 Finding probability distributions for electric field gradient components with inhomogeneous broadening in perturbed angular correlation spectroscopy[1] , TYLER PARK, MIKE ADAMS, AUSTIN BUNKER, JEFFERY HODGES, MICHAEL STUFFLEBEAM, WILLIAM EVENSON[2], PHIL MATHESON, Utah Valley University, MATTHEW ZACATE, Northern Kentucky University — Materials contain defects, which affect crystal properties such as damping of the correlation signal,$G_2(t)$, in time and broadening of the frequency spectrum in perturbed angular correlation (PAC) experiments. We attribute this inhomogeneous broadening (IHB) to the random static defects that produce a distribution of electric field gradients (EFGs). Our goal is to find a relationship between the amount of broadening and the concentration of defects. After simulating the EFGs from random configurations of defects, we map our results from the V_{zz}-V_{xx} plane to a coordinate system optimized for the EFG distribution through a Czjzek transformation, followed by a conformal mapping. From histograms in this space, we can define probability distribution functions with parameters that vary according to defect concentration. This allows us to calculate the broadened $G_2(t)$ spectrum for any concentration, and, in reverse, identify concentrations given a broadened $G_2(t)$ spectrum.

[1]Work supported in part by NSF grant DMR 06-06006 (Metals Program).
[2]retired

11:44AM H7.00003 Defect Concentration Dependence of Inhomogeneous Broadening in PAC Spectroscopy[1] , MIKE ADAMS, AUSTIN BUNKER, JEFFERY HODGES, TYLER PARK, MICHAEL STUFFLEBEAM, WILLIAM EVENSON[2], PHIL MATHESON, Utah Valley University, MATTHEW ZACATE, Northern Kentucky University — Defects in crystals affect the electric field gradient (EFG) tensor components at radioactive probe nuclei. We consider the net EFG from a random distribution of vacancies combined with a single trapped vacancy in a near neighbor position. The net EFG perturbs angular correlation (PAC) and provides information about the concentration of vacancies. For various concentrations (.1 to 15 percent) we have simulated PAC spectra in simple cubic, body centered and face centered cubic crystal structures. Using the probability distributions we found for the EFG tensor components we reconstruct $G_2(t)$ for various defect concentrations. We take these reconstructions and compare them with the simulated $G_2(t)$ functions to check for self-consistency. We can then use the simulated probability distributions to examine the concentration dependence of experimental broadened PAC spectra. This work will be applied initially to broadened PAC data from β-Mn, Al-doped β-Mn, and Sr_2RuO_4.

[1]Work supported in part by NSF grant DMR 06-06006 (Metals Program).
[2]retired

11:56AM H7.00004 Role of Grain Boundaries in the Conductivity of Vanadium Dioxide Thin Films , FELIPE RIVERA, RICHARD VANFLEET, ROBERT DAVIS, Brigham Young University — Vanadium dioxide (VO_2) single crystals undergo a structural first-order metal to insulator phase transition at approximately 68°C. This phase transition exhibits a resistivity change of up to 5 orders of magnitude in bulk specimens. We observe a 2-3 order of magnitude change in thin films of VO_2 presumably due to the large number of grain boundaries in the film. The interface between grains was studied by TEM and appears amorphous. Electron energy loss spectroscopy shows VO_2 like spectra with no additional surface oxidation.

12:08PM H7.00005 Molecular Dynamic Simulation of Laser Melting of Nanocrystalline Gold , ZHIBIN LIN, REMRSEC and Dept. of Physics, Colorado School of Mines, ELODIE LEVEUGLE, Thales Group, France, EDUARDO BRINGA, Dept. of Physics, Universidad Nacional de Cuyo, Argentina, LEONID ZHIGILEI, Dept. of Materials Science and Engineering, Univ. of Virginia — We present the mechanisms and kinetics of short pulse laser melting of single crystal and nanocrystalline Au films based on the results of atomic-scale simulations. The simulations are performed for a broad range of laser fluences with a computational approach that combines the molecular dynamics method with a continuum-level description of laser excitation and subsequent relaxation of conduction band electrons. At high fluences, grain boundary melting in nanocrystalline films results in a decrease of the size of crystalline grains at the initial stage of the laser heating and is followed by a rapid (within 1-3 ps) collapse of remaining crystalline parts of the film as soon as the lattice temperature exceeds the limit of the crystal stability against the onset of homogeneous melting. At low laser fluences, the initiation of melting at grain boundaries can steer the melting process along the path where the melting continues below the equilibrium melting temperature and the crystalline regions shrink and disappear under conditions of substantial undercooling. This unusual melting behavior is explained based on thermodynamic analysis of the stability of small crystalline clusters surrounded by undercooled liquid.

12:20PM H7.00006 Vibrational structure of the alkali metal surfaces , R. WILSON, D.M. RIFFE, Utah State University — Many physical properties of solids are phonon dependent. While numerous theoretical and experimental investigations have successfully characterized bulk vibrational structure, further characterization of surface phonons is needed. The behavior of surface phonons is important to the understanding of nano-structures, the interpretation of experimental measurements used to study solids, and the understanding of a variety of physical phenomena that solids exhibit. We present the calculation of vibrational modes on the (110) and (100) of alkali metal surfaces with the use of an Embedded Atom Method (EAM) inter-atomic potential. Vibrational dependent properties in the bulk that are calculated by the EAM potential are in good agreement with experiment, providing credibility to the EAM potential's accuracy. Surface properties such as entropy, specific heat, vibrational density of states, and Debye temperatures are calculated from the vibrational modes. The surface phonons are found to be highly polarized, resulting in anisotropic thermal behavior at and near the surface. A database of bulk and surface Debye temperatures is being created as a resource.

Saturday, October 24, 2009 11:20AM - 12:32PM – Session H8 Particles, Fields and Beams Hill Hall 209

11:20AM H8.00001 $\rho - \phi$ Relative Production Phase Using Dimuons , VALERIA FRISULLO, JOHN CUMALAT, University of Colorado, FOCUS COLLABORATION — The $\rho - \phi$ production phase is determined using a sample of quasielastically photoproduced $\mu^+\mu^-$ events obtained in the FOCUS experiment at Fermi National Accelerator Laboratory. The measurement is accomplished by correcting for the Bethe-Heitler dimuon production and by fitting for interference between the $\rho \rightarrow \mu^+\mu^-$ and $\phi \rightarrow \mu^+\mu^-$ final states. This result represents the first direct measurement of the $\rho - \phi$ production phase. A preliminary study of the $\omega \rightarrow \mu^+\mu^-\pi^0$ decay channel is also presented.

11:32AM H8.00002 A study of early data B-physics at CMS , BRIAN R. DRELL, KEVIN STENSON, KEITH A. ULMER, University of Colorado, Boulder — We present plans for the reconstruction of three b-hadron decay modes: $B^0 \to K^0_S J/\psi$, $B^+ \to K^{*+}(K^0_S \pi^+)J/\psi$, and $\Lambda^0_b \to \Lambda^0 J/\psi$ with dimuon final states in early data from the CMS detector at the LHC. Our analysis will include measurements of lifetimes and transverse momentum differential cross sections. Techniques used in analysis of these decay modes will eventually be used for reconstruction of rare b decay modes with similar topology once the LHC reaches higher integrated luminosity.

11:44AM H8.00003 Using Diamond Sensors to Track Charged Particles , JOHN CUMALAT, KEVIN STENSON, STEPHEN WAGNER, University of Colorado, Boulder — Reverse biased silicon sensors are currently the instrument of choice for tracking charged particles in high energy experiments. Exposure to high intensity radiation causes silicon sensors to deteriorate and they will need to be replaced. Diamond has a much higher radiation tolerance than silicon. In addition, diamond is mechanically hard, has a high thermal conductivity and a fast signal collection time. We are conducting research on the use of polycrystalline Chemical Vapor Deposition (pCVD) diamond sensors as a possible choice for an inner Large Hadron Collider pixel tracking detector. We will report on our recent diamond measurements.

11:56AM H8.00004 Supersymmetry Simulation in the Large Hadron Collider , WILL FLANAGAN, URIEL NAUENBERG, SHI-LEI ZANG, BERNADETTE HEYBURN, University of Colorado, CMS COLLABORATION — Our group is investigating possible tests of supersymmetry at the Large Hadron Collider at CERN. More specifically, we are studying supersymmetry with electromagnetic events at the Compact Muon Solenoid. We are using supersymmetry with gauge-mediated symmetry breaking (GMSB). Our analysis is focused on Monte Carlo simulation of such events in order to prescribe "observables" for when the LHC becomes operational later this year. We will present some of our preliminary results as well as some exciting prospects for our future work.

12:08PM H8.00005 Exclusive decays of χ_{bJ} and η_b into two charmed mesons[1] , EMANUELE MEREGHETTI, REGINA AZEVEDO, University of Arizona, LONG BINGWEI, European Centre for Theoretical Studies in Nuclear Physics and Related Areas and University of Arizona — We develop a framework to study the exclusive two-body decays of bottomonium into two charmed mesons and apply it to study the decays of the C-even bottomonia. Using a sequence of effective field theories, we take advantage of the separation between the scales contributing to the decay processes, $2m_b \gg m_c \gg \Lambda_{QCD}$. We prove that, at leading order in the EFT power counting, the decay rate factorizes into the convolution of two perturbative matching coefficients and three non-perturbative matrix elements, one for each hadron. We calculate the relations between the decay rate and non- perturbative bottomonium and D-meson matrix elements at leading order, with next-to-leading log resummation. The phenomenological implications of these relations are discussed.

[1]This research was supported by the US Department of Energy under grants DE-FG02-06ER41449 and DE-FG02-04ER41338.

12:20PM H8.00006 The Inert Dark Matter , ETHAN DOLLE, SHUFANG SU, University of Arizona — The lightest neutral scalar in the Inert Higgs Doublet Model is a natural candidate for WIMP dark matter. In this paper, we analyzed the dark matter relic density in the Inert Higgs Doublet model. Various theoretical and experimental constraints are taken into account. We found that there are five distinctive regions that could provide the right amount of the relic density in the Universe. Four out of those five regions have a light particle spectrum which could be studied at the Large Hadron Collider.

Saturday, October 24, 2009 12:35AM - 1:50AM –
Session J1 Luncheon Presentation Green Center Friedhoff Hall

12:35AM J1.00001 Lunch –

1:30AM J1.00002 Research Funding Opportunities for Early Career Scientists , RICHARD WIENER, Research Corporation for Science Advancement — This talk will describe opportunities for early career faculty members in the physical sciences to obtain funding for scientific research and educational projects. I will discuss programs offered by Research Corporation for Science Advancement, a private nonprofit foundation, which include opportunities for scientists at primarily undergraduate institutions and at research universities. I will emphasize strategies for successful grant writing. The target audience is early career academic scientists in Astronomy, Physics, and related fields, as well as graduate students and postdoctoral researchers considering careers in these academic disciplines.

Saturday, October 24, 2009 1:50PM - 3:02PM –
Session K1 Astroparticle Symposium V: UHE Cosmic Rays - Auger North and Exotics
Green Center 211

1:50PM K1.00001 The Northern Site of the Pierre Auger Observatory , DAVID NITZ, Michigan Technical University and Pierre Auger Collaboration — The Pierre Auger Observatory is a multi-national project for research on ultra-high energy cosmic rays. The Southern Auger Observatory (Auger South) in Mendoza province, Argentina, was completed in 2008 with an instrumented area of 3,000 km^2. Science results form Auger South motivate the completion and extension of the investigations begun there by constructing the Northern Auger Observatory (Auger North), with a much larger acceptance for the extremely rare cosmic ray events above a few times 10^{19} eV. Auger North will have an instrumented area of 8,000 square miles (20,000 km^2) in Southeast Colorado, USA. The presentation covers the science of Auger North, the layout and the technical implementation, as well as current R&D efforts underway in Colorado.

2:14PM K1.00002 Development of Atmospheric Monitoring System for Auger North
, JOHN CLAUS, CLINT ALLEN, ADAM BOTTS, BRYCE CARANDE, MIKE CALHOUN, LUCAS EMMERT, LEVI HAMILTON, T.J. HEID, JOHN KOOP, SARAH MORGAN, SHAY ROBINSON, JOHN SHERMAN, LAWRENCE WIENCKE, CSM PIERRE AUGER TEAM — The Pierre Auger Northern Fluorescence Detector will measure air-showers over distances of 40 km. Vertical Aerosol profile of the atmosphere at the Pierre Auger Northern site will be measured using the side-scatter method over the 40 km baseline. An atmospheric monitoring telescope (AMT) will use a 3.5 m^2 mirror optimized for UV reflection to focus light from a laser onto a cluster of phototmultiplier tubes. The AMT has been built and final testing and modifications are being carried out before its installation later this year. A remotely programmed, 355 nm YAG laser with a final beam energy of 5 mJ is being used. The automation of the laser and the AMT is controlled via a single board computer (SBC). This talk will present an overview of this R&D program.

2:26PM K1.00003 Identification of clear atmospheric conditions in a search for exotic candidates at the Pierre Auger Observatory , DAVID STARBUCK, dstarbuc@mines.edu — Stable periods of clear and cloudless atmospheric conditions were identified using data from the Pierre Auger Observatory's Central Laser Facility. The objective of this study is to assist in a search for exotic signatures. This search uses longitudinal profiles reconstructed from data recorded by fluorescence detectors. Longitudinal profiles that show exotic behavior are usually caused by cloudy or hazy atmospheric conditions. Signatures that fit this description can be eliminated by limiting the search to periods of clear atmospheric conditions.

2:38PM K1.00004 Measuring the speed resolution of extensive air showers at the Southern Pierre Auger Observatory , KATHLEEN GESTERLING, University of New Mexico, FRED SARAZIN, Colorado School of Mines, PIERRE AUGER OBSERVATORY COLLABORATION — Ultra-high energy cosmic rays induce extensive air showers (EASs) in Earth's atmosphere which are assumed to propagate at the speed of light. The fluorescence detector (FD) at the Southern Pierre Auger Observatory detects the light signal from the EAS and directly measures the energy of the cosmic ray. When two or more FD sites observe an event, the geometry of the shower can be calculated independently of the velocity it is traveling. It is then possible to fit the time profile recorded in the FD using the shower speed as a free parameter. The analysis of a collection of stereo events allowed us to determine with what speed resolution we can measure EASs with sensitivity to subluminal components. Knowing the speed resolution we can look for objects propagating significantly below the speed of light.

2:50PM K1.00005 Using Bayesian Inference to Determine Upper Limits on Exotic Cosmic Ray Composition Fractions , DAVID SCHUSTER, Colorado School of Mines — A method for determining cosmic ray composition fractions using Bayesian inference is presented. By systematically comparing observables from simulated extensive air showers to a given set of data, this method sets an upper limit on the compositional makeup of the data. The method is demonstrated on a simulated dataset of known composition and applications to a search for exotic particles in the Southern Pierre Auger Observatory dataset are discussed.

Saturday, October 24, 2009 1:50PM - 3:02PM –
Session K2 Alloys Green Center 215

1:50PM K2.00001 New potential structure for jewelry application. Does it exist in Pt-Mo, Pt-Hf, or other systems? , ERIN GILMARTIN, JACQUELINE CORBITT, GUS HART, Brigham Young University — The only known intermetallic structure with an 8:1 stoichiometry is that of Pt_8Ti. It is intriguing that an ordered phase would occur at such low concentrations of the minority atom, but this structure occurs in about a dozen binary intermetallic systems. The formation of an ordered phase in an alloy can significantly enhance the performance of the material, particularly the hardness. We have taken a broad look at possible systems where this phase forms. Using first-principles, we calculated the stability of this structure relative to experimentally known phases for more than 70 Pt/Pd binary systems. We find the Pt_8Ti structure is a possible ground state in more than 20 cases. Our experimental collaborators have verified our prediction in Pt-Mo and observed order-hardening in Pt-Hf. We discuss the discovery of new ground states via the cluster expansion that are likely to be verified experimentally and their impact on Pt- and Pd-based jewelry and catalysts.

2:02PM K2.00002 Crystal structure of $UNi_{0.5}Sb_2$, KARUNAKAR KOTHAPALLI, New Mexico State University, MILTON TORIKACHVILI, San Diego State University, HEINZ NAKOTTE, New Mexico State University — We report the single crystal neutron diffraction studies done to resolve the room-temperature structure of Uranium antimonide, $UNi_{0.5}Sb_2$. The time-of-flight single-crystal neutron diffraction experiments at room temperature were done on the Single Crystal Diffractometer, SCD, at Los Alamos Neutron Science Center. Previous X-ray single crystal and neutron powder diffraction studies could not unambiguously resolve the structure because of the presence of hkl/2 type reflections. The studies were done on a 2 x 1 x 0.5 mm^3 crystal and half-indexed reflections were observed corroborating the observations in previous studies. The crystal structure that accounts for all the observed reflections is determined to be tetragonal $P4_2/n$ m c with lattice parameters a, b, c being 4.333(2) Å, 4.333(2) Å and 17.868(6) Å respectively. A preliminary study shows no crystal structure distortion below at 10K and the compound orders antiferromagnetically.

2:14PM K2.00003 Thermal and electrical transport properties of $UCu_{4+x}Al_{8-x}$, FARZANA NASREEN, New Mexico State University, MILTON TORIKACHVILLI, San Diego State University, KARUNAKAR KOTHAPALLI, New Mexico State University, VIVIEN ZAPF, NHMFL Pulse Field Facilty-LANL, HEINZ NAKOTTE, New Mexico State University — The $UCu_{4+x}Al_{8-x}$ family crystallizes in the tetragonal $ThMn_{12}$- type structure in the range from 0.1≤ x≤ 1.95. It has been reported that the Cu-poor compounds show antiferromagnetic long-range order, followed by a transition at x=1.15 to a heavy fermion behavior. We report on the results of thermal conductivity and the Seebeck coefficient as a function of temperature (1.8-300K). Thermal conductivity data are consistent with previously published electrical resistivity data. The Seebeck coefficient measurements, S, confirm the peaks at T_N for the antiferromagnetic compounds. We also measured electrical resistivity as function of very low temperature from 75mK to 4K and in magnetic field up to 6Tesla for UCu_6Al_2, $UCu_{5.75}Al_{6.25}$, $UCu_{5.5}Al_{6.5}$ and $UCu_{5.25}Al_{6.75}$. $UCu_{5.75}Al_{6.25}$which was reported as non-Fermi liquid (NFL) compound shows quantum critical point induced by magnetic field. These results provide some insight about the underlying mechanisms to the apparent NFL behavior in $UCu_{5.75}Al_{6.25}$ compound.

2:26PM K2.00004 Platinum-Palladium Crystal Structures , WESTON PRATT, BYU — Being able to predict Platinum-Palladium ordering is important in discovering new alloys that have commercial and industrial applications. Using direct quantum mechanical calculations coupled with a lattice-based Hamiltonian called a cluster expansion, we can predict which crystal structures are thermodynamically stable for. In addition, a Monte Carlo simulation can be used in this model to determine the order-disorder transition temperatures. Knowing which structures are thermodynamically stable and their respective transition temperatures may help develop useful platinum palladium alloys.

2:38PM K2.00005 New structures in Pd-rich ordered alloys[1] , JACQUELINE CORBITT, ERIN GILMARTIN, GUS HART, BYU-Provo — An intriguing intermetallic structure with 8:1 stoichiometry was discovered in the 1950s in the Pt-Ti system. Since then a handful of other Pt/Pd/Ni-X binary systems have been observed to exhibit this curious structure (Pt_8Zr, Pd_8Mo,Ni_8Nb, etc). Precipitates of this ordered structure can significantly increase the hardness of an alloy. For jewelry applications involving Pt and Pd, international hallmarking standards require that the alloys be at least 95% pure by weight. However, Pt- and Pd-rich alloys are often soft when purity is high if the minority atoms are disordered. Because the 8:1 structure maintains a high weight percentage of Pt/Pd, it can satisfy purity standards while increasing performance. Recent calculations and experiments suggest that the 8:1 structure may form in about 20 previously unsuspected Pt/Pd binary systems. Using first-principles calculations and cluster expansion modeling, we have performed a ground state search to find the stable structures in Pd-Nb, Pd-Cu, and Pd-Mg, and predict the temperatures at which the new structures may form.

[1]We would like to acknowledge NSF funding.

2:50PM K2.00006 Thermodynamically stable superstructures in binary alloys , LANCE NELSON, Brigham Young Universty — Adding a second metal to another can induce the formation of ordered superstructures. These ordered phases have properties that are desireable in many industrial, manufacturing and technological applications. Our goal is to find which of the thousands of possible superstructures are thermodynamically stable through the use of computational tools. Owing to the many superstructures that are possible, as well as the complex nature of some of these, DFT calculations become impractical for searching for these superstructures. We employ a cluster expansion method, which uses energy information from a relatively small number of structures and fits that information to a set of interaction types. Because the resulting expansion provides a fast way to compute energies, we can use it to calculate the energies of the thousands of other superstructures. Specifically, I discuss the use of the cluster expansion on two binary alloys: AgPd and MgZn. Palladium alloys are of interest in the fabrication of jewelry, and a stable ordered phase at some concentrations would be a breakthrough for the jewelry manufacturers. Magnesium alloys are of interest because of their strength and light weight. They are being used increasingly in the manufacturing of things such as airplanes and automobiles. A cheap alloying agent that promotes the formation of an ordered structure would be a breakthrough.

Saturday, October 24, 2009 1:50PM - 3:02PM –
Session K3 Laser Science Green Center 249

1:50PM K3.00001 Tunable Mid-Infrared Source based on Difference-Frequency Mixing of Soliton-Shifted Pulses , DAVID WINTERS, PHILIP SCHLUP, RANDY BARTELS, Colorado State University — We present a compact, fiber-based mid-infrared comb source tunable across the 9.5 to 15 μm region. The system begins with a single erbium fiber laser (1550nm) coupled into a 25 m length of polarization maintaining telecommunication fiber. The incident intensity is sufficient to launch a soliton within the first meter of fiber, which is then coherently red-shifted as it co-propagates with the residual laser pulse. The two pulses are then mixed in a nonlinear crystal to create mid infrared light by difference frequency generation (DFG). As the soliton red-shift is proportional to both input power and fiber length, the soliton center wavelength, and thus the DFG center wavelength, can be continuously tuned. The mid infrared power is linearly proportional to the 1550nm pump power, allowing power scaling using standard telecom amplifiers. Design parameters and experimental results will be discussed.

2:02PM K3.00002 Demonstration of an all-diode-pumped soft x-ray laser[1] , FEDERICO FURCH, BRENDAN REAGAN, BRADLEY LUTHER, ALDEN CURTIS, SHAUN MEEHAN, JORGE ROCCA, NSF ERC for Extreme Ultraviolet Science and Technology, Colorado State University — We have demonstrated an 18.9 nm, Ni-like molybdenum, transient collisional soft x-ray laser, pumped by a compact, all-diode pumped chirped pulse amplification system. The solid state pump laser is based on cryo-cooled Yb:YAG and produces 8.5 ps pulses with up to 1 J energy at 10 Hz repetition rate. This diode-pumped laser has the potential to greatly increase the repetition rate and average power of soft x-ray lasers on a significantly smaller footprint.

[1]This work was supported by the Engineering Research Centers Program of the National Science Foundation under NSF Award Number EEC-0310717 and by NSF grant 0521649.

2:14PM K3.00003 Soft x-ray interferometry study of radiation cooling and jet collimation in dense laboratory plasmas , DUNCAN RYAN, Colorado State University, MICHAEL PURVIS, JONATHAN GRAVA, JORGE FILEVICH, JORGE ROCCA, ERC EUV TEAM — Collimated jets were observed in Al, Cu and Mo laboratory plasmas with peak densities of 10^{20} cm^{-3}. Short laser pulses of 10^{12} W cm^{-2}, 120 ps duration and 0.5-1.0 J at 800 nm were used to create dense plasmas from solid targets. Expansion of the plasmas from 90° triangular-grooved targets was probed using soft x-ray interferometry. Results were compared to simulations from the hydrodynamic code HYDRA. Radiation cooling was found to significantly increase the collimation of the jets. The collimation was furthermore observed to increase with higher Z materials. Preliminary results are also reported on similar studies of 90° concave conical targets at laser intensities of 3×10^{13} W cm^{-2} with peak densities of $> 10^{21}$ cm^{-3}.

2:26PM K3.00004 Talbot nano-patterning with a table-top soft X-ray laser[1] , LUKASZ URBANSKI, PRZEMYSLAW WACHULAK, Colorado State University, ARTAK ISOYAN, FAN JIAN, YANG-CHUN CHENG, University of Wisconsin, JORGE ROCCA, CARMEN MENONI, Colorado State University, FRANCO CERRINA, University of Wisconsin, MARIO MARCONI, Colorado State University, COLORADO STATE UNIVERSITY COLLABORATION, UNIVERSITY OF WISCONSIN COLLABORATION — We demonstrate a novel high resolution soft X-ray (SXR) patterning approach based on the generalization of the Talbot effect. This effect was used to print periodic structures of arbitrary patterns with nanometer resolution over a large area. The coherent illumination of a tiled mask produced self images of arbitrary motifs allowing for a non-contact replication technique that opens a new avenue for nanofabrication. Compact soft X-ray laser sources recently developed enable this new nanopatterning technique demonstrated with a table-top SXR laser at $\lambda = 46.9$ nm. Shorter wavelength SXR lasers emitting in the 13 nm region would allow printing of millimeter square areas with sub-10 nm resolution.

[1]Ultraviolet Science and Technology under Award NSF EEC-0310717, NSF UW Nanoscale Science and Engineering Center No. DMR-0425880.

2:38PM K3.00005 Cavity ring-down spectroscopy in the ultraviolet region using calcium fluoride prism retroreflectors , BRIAN LEE, AZER YALIN, Colorado State University — Cavity ring-down spectroscopy (CRDS) is a highly sensitive laser absorption technique that is useful for trace species detection of atoms and molecules in a range of applications. High sensitivity CRDS detection requires highly reflective mirrors, typically multilayer dielectrics. Such mirrors are available in many spectral regions, though not in the ultraviolet (UV) where optical absorption in the mirror layers tends to limit reflectivities. In our electric propulsion research, detection of boron nitride (BN) via ground state boron atoms near 250 nm is of particular interest. In order to improve the sensitivity of UV CRDS for BN detection, we are developing the use of prism retroreflectors made from calcium fluoride (CaF2). In addition to higher cavity finesse at 250 nm, total internal reflection allows for broadband CRDS with a single experimental setup. We have obtained super-polished UV grade CaF2 samples in order to make transmission measurements. The measurements are obtained by placing the CaF2 samples as loss elements within a CRDS cavity. In this contribution, we present the measurement setup and results of initial CaF2 material characterizations.

2:50PM K3.00006 Precise Characterization of a Laser Current Driver , DAYLIN TROXEL, Brigham Young University — I will be presenting a characterization of our unique low-noise laser current driver. Our current driver improves on the typical model used in laboratories, giving extra current stability and lower noise. I will discuss our techniques for measuring the noise and drift and the results we obtained. The current driver has a lower noise and drift than any other current driver with a published value, so it has value in making precision measurements. Many other labs have expressed interest in our design as there is a need for this type of current driver in many applications. The current driver demonstrates some interesting applications of electronics principles and uses of electric components, as well as practical considerations in designing circuitry.

Saturday, October 24, 2009 1:50PM - 3:02PM – Session K4 Thin Films and Surfaces Green Center 263

1:50PM K4.00001 Reconstruction of many-body excitation configurations via nonlinear absorption in semiconductor quantum wells , RYAN P. SMITH, ANDREW FUNK, JILA, University of Colorado, HANNO STEINER, Philipps-University, Marburg, Germany, JARED K. WAHLSTRAND, JILA, University of Colorado, MARTIN SCHAEFER, MACKILLO KIRA, STEPHAN KOCH, Philipps-University, Marburg, Germany, STEVEN CUNDIFF, JILA, University of Colorado, PHILIPPS-UNIVERSITY, MARBURG, GERMANY COLLABORATION — Detailed electronic many-body configurations are determined by analyzing quantitatively measured time-resolved nonlinear absorption spectra of resonantly excited GaAs quantum wells with a fully consistent microscopic theory. The measured reflection and transmission probabilities across a broad spectrum allowed a model of the sample structure to be fixed using a transfer matrix calculation. Quantitative comparison of co-linear and co-circular polarization pump-probe excitation schemes reveal consequences of spin selection rules on scattering. An observed strong transient probe gain is attributed to the optically induced coherent polarization under low dephasing conditions. Radiative and internal sources of dephasing are quantified. Unexpectedly, it is found that true exciton populations do not significantly contribute to spectral broadening whereas the strong resonance blue shifts are dominated by the excited carrier densities.

2:02PM K4.00002 $Ge_{0.98}Sn_{0.02}$/Si $p-i-n$ Heterostructure Photodiodes for Telecommunications Applications , JAY MATHEWS, JOSE MENENDEZ, Department of Physics, Arizona State University, Tempe, AZ, 85287-1504, USA, SHUI-QING YU, Department of Electrical Engineering, University of Arkansas, Fayetteville, AR 72701, USA, RADEK ROUCKA, JUNQI XIE, JOHN KOUVETAKIS, Department of Chemistry and Biochemistry, Arizona State University, Tempe, AZ, 85287-1604, USA — In this study, $p-i-n$ heterostructure photodiodes were fabricated from $Ge_{0.98}Sn_{0.02}$ films grown directly on Si substrates using complementary metal-oxide-semiconductor (CMOS) compatible processes. The devices characterized with respect to their dark currents and their quantum efficiency in the near IR. The structures were grown on boron-doped (p-type) Si(100) with resistivity 0.01 Ωcm. A 350nm thick layer of intrinsic $Ge_{0.98}Sn_{0.02}$ was deposited first as the active region, followed by 64nm of phosphorus-doped (n-type) $Ge_{0.98}Sn_{0.02}$. The current-voltage characteristics of the devices yielded distinctly diode-like behavior. The measured photoresponse yielded higher quantum efficiencies than comparable pure-Ge devices over a broader spectrum as a result of the lower direct band gap and broadening of the absorption edge due to alloying. The significant responsivity obtained at wavelengths as long as 1750 nm confirms the advantages of the GeSn approach for telecom applications.

2:14PM K4.00003 Hybrid plasmon/dielectric waveguide for integrated silicon-on-insulator optical elements[1] , JONATHAN BANKS, DAVID FLAMMER, CHARLES DURFEE, TOM FURTAK, REUBEN COLLINS, Department of Physics, Colorado School of Mines, RUSSELL HOLLINGSWORTH, ITN Energy Systems, Inc. — We present a hybrid plasmon/dielectric single-mode single-polarization waveguide on silicon-on-insulator wafers. The structure is fabricable using VLSI processing techniques and minimizes losses due to surface roughness and metallic losses. Because only a single mode and single polarization is admitted, birefringent effects are eliminated. Both simulations and experimental verification of the modes are presented. Simulations show the waveguide can be tuned for either very long propagation lengths or sub-wavelength confinement by changing a patterned metal line width and oxide thickness, which are easily done with VLSI methods. Simulations show sub-wavelength confinement modes with propagation lengths greater than 100 microns, and micron-scale confinement modes with 7mm propagation lengths. This structure naturally forms an MOS capacitor that may be used for active device integration.

[1]We gratefully acknowledge financial support from the Air Force Office of Scientific Research, Award # FA9550-06-1-0548.

2:26PM K4.00004 Binding of N_2, O_2, CO and H_2O_2 on graphene in the presence of Co , SHYAM KATTEL, BORIS KIEFER, Physics Department, New Mexico State University — One of the largest challenges in the current century is the production of energy to meet the increasing societal demands. Bio-inspired carbon based catalytic materials have been invoked as a possible solution to this challenge. We use density-functional-theory (DFT) to study molecule-Co-graphene interactions. Our results show that the most stable Co binding site is above the center of C6 hexagons of the graphene sheet (H) site in agreement with previous work. For molecule-Co-graphene interactions we find that N_2, O_2 and CO physiosorb onto the Co-graphene system only if the molecule and Co are on the same side of a graphene sheet. Therefore unaltered graphene is unlikely to be a catalytically active. In contrast we observe that H_2O_2 chemisorbs. These two different behaviors may explain selectivity of some catalytic materials toward O_2. We also observe that Co modifies the charge density only locally and which indicates that electronic transport properties of the underlying carbon structure are not enhanced and remain a bottleneck for the development of carbon based catalytic materials.

2:38PM K4.00005 New Lowest Energy Graphene Allotropes Utilizing 8 Membered Defect Rings , DAVID APPELHANS, MARK LUSK, Colorado School of Mines — The combination of Stone-Thrower-Wales (STW) and the recently identified Inverse-Stone-Thrower-Wales (ISTW) defects in graphene allow a wide range of graphene allotropes to be constructed. This is accomplished by applying combinations of these defects in a periodic template on pure graphene. For instance, the three lowest energy Haeckelite structures can be constructed in this way as has a new class of low energy graphene allotropes, Dimerites, which use only ISTW defects. All of these Haeckelites and Dimerites, though, are composed of 5-, 6-, and 7-membered rings. We have focused on 8-membered rings and predict a new family of carbon allotropes. One of these, Appelite R568, is only 194 meV/atom higher in energy than graphene. This is the lowest energy graphene derivative predicted. We outline a pathway of defect creation leading to the structure.

2:50PM K4.00006 Spin Dynamics for Wavepackets in Monolayer Graphene and Rashba systems , BAILEY HSU, JEAN-FRANCOIS VAN HUELE, Brigham Young University — Spintronics, a technology to manipulate spin degrees of freedom in addition to the charge of an electron, has attracted considerable interest for its potential to increase computational power. Two current candidates for promising spintronics devices are graphene and materials with Rashba spin-orbit coupling. The Hamiltonians for these two systems involve combinations of momentum operators and spin operators. In this talk, we use the quantum propagator method to analyze the spin dynamics for localized wavepackets in these two physical systems and we discuss the occurences of interesting localization features with animated 2D plots.

Saturday, October 24, 2009 1:50PM - 3:02PM – Session K5 Theoretical Particle Physics Green Center 265

1:50PM K5.00001 Universal Long-time Relaxation Behavior of a Nuclear Spin Lattice , ERIC SORTE, BRIAN SAAM, University of Utah — We report experimental results indicating that isolated macroscopic systems of interacting nuclear spins possess the fundamental property that spin decays, starting from different initial configurations, quickly evolve towards the same long time behavior. We show that the generic functional form of the long time behavior of the infinite temperature spin correlation function decays with either a simple exponential or exponential multiplied by a cosine, even though the characteristic timescale of the functional form of this decay is considered non-Markovian. The results corroborate predictions made by a theory based on a strong conjecture that, as a result of chaos generated by the correlated spin dynamics, a Brownian-like Markovian description can be applied to the long time properties of ensemble average quantities on a non-Markovian timescale.

2:02PM K5.00002 Lattice Computation of Nucleon Strangeness , WALTER FREEMAN, DOUGLAS TOUSSAINT, University of Arizona, MILC COLLABORATION — The matrix element $\langle N|s\bar{s}|N\rangle$, the "nucleon strangeness," is of interest to the general understanding of hadronic physics, as it gives the amount by which the presence of a nucleon disturbs the vacuum strange quark condensate. Moreover, knowledge of this quantity is also mportant to the interpretation of proposed dark matter detection experiments, since many dark matter scenarios have a large contribution to the scattering cross-section from Higgs exchange with heavy quarks in nuclear matter. Due to the extreme difficulty of measuring it experimentally, it must be calculated from first principles using lattice QCD, but previous calculations have produced inconsistent or imprecise results. Using the Feynman-Hellman theorem, we relate the matrix element in question to the derivative $\frac{\partial M_N}{\partial m_s}$. We then evaluate this derivative by analyzing the existing library of MILC gauge configurations and hadron propagators, and thus determine $\langle N|s\bar{s}|N\rangle$ to greater precision than previously possible. We have evaluated this quantity at a variety of light quark masses and lattice spacings and extrapolate to the physical point; at the physical point, $\frac{\partial M_N}{\partial m_s} = 0.69(7)_{stat}(9)_{sys}$ in the $\overline{MS}(2GeV)$ regularization. We are currently working on a technique to further reduce these errors by partitioning the lattice and only considering the quark condensate in the relevant fraction, but this requires recalculation of hadron propagators which is ongoing.

2:14PM K5.00003 Angular Momentum Decomposition in QED and QCD , HIKMAT B.C., MATTHIAS BURKARDT, NMSU — We calculate the orbital angular momentum of the "quark" in the scalar diquark model as well as that of the electron in QED(to order α). We compare the orbital angular momentum obtained from the Jaffe - Manohar decomposition to that obtained from the Ji relation and estimate the importance of the vector potential in the definition of orbital angular momentum.

2:26PM K5.00004 Mirror Symmetry: FJRW-rings and Landau-Ginzburg Orbifolds , PEDRO ACOSTA, Brigham Young University — For any non-degenerate, quasihomogeneous superpotential W and an admissible group of diagonal symmetries G, Fan, Jarvis and Ruan have constructed a quantum cohomological field theory (FJRW-theory) that gives, among other things, a Frobenius algebra $\mathcal{H}_{W,G}$ ((a,c) ring) and correlators associated with the superpotential. This construction is analogous to a theory of the Gromov-Witten type. The FJRW- theory is a candidate for the mathematical structure behind $\mathcal{N}=2$ superconformal Landau-Ginzburg orbifolds. In this presentation I will give an overview of this theory and discuss the Berglund-Hübsch-Krawitz mirror symmetry conjecture: For a given invertible superpotential W there exists an invertible superpotential W^T such that the Frobenius algebra $\mathcal{H}_{W,G}$ is isomorphic to the (c,c) ring of W^T, and the Frobenius algebra $\mathcal{H}_{W^T,G^T}$ is isomorphic to the (c,c) ring of W.

2:38PM K5.00005 Some Pins for Cosmic Ladder - New Correlations on Hubble Diagram[1] , KARAN MOLAVERDIKHANI — After Hubble's law detection, scientists tried to measuring and improving the Hubble Constant for finding a better estimation of Universe Age. Development of some new methods and applying new observational technologies help them to find a better view of Universe. They found a Ladder for reaching the End of World. The steps of this Cosmic Distance Ladder are Radar measurement, Parallax, Main Sequence Fitting, Cepheids, Tully Fisher relation, Type Ia supernovae and finally Hubble's law. But we can't use the Near Tools instead Far Tools, because they haven't enough accuracy on that range. Also, using the Near Tools (like luminosity flux or size and type of galaxies) are easier than using the standard candles on cosmic ladder. On the other hand, with applying the Tools at the different ranges, we can allocate a new point of view for using them as new Tools. We find some relations between relative distance-redshift (Near Tools) and velocity-redshift (today cosmic distance ladder result) and expand these relations to using in High Redshift zone. With choosing about one million galaxies (at any type and any redshift) in SDSS and surveying their behavior on these diagrams, we got a bunch of correlations on Hubble Diagram especially on z>1 and offer some pins for extension the Ladder.

[1]We gratefully acknowledge the SDSS and SDSS-II collaborations.

2:50PM K5.00006 Influence of spin on the fragment Anisotropies

A.N. BEHKAMI, Fars Science and Research Center, Islamic Azad University, Iran, M. GHODSI, Physics Department of Babolsar University, Iran — Several selected fission fragment angular distributions when at least one of the spins of the projectile or target is appreciable have been investigated. The known experimental data for example$^{11}B+^{209}Bi$ was analyzed by means of the Couple Channel spin formulism. This formulism suggests that the projectile spin has sizable effect on the angular anisotropies within the limits of energy near the fusion barrier. The analysis of the fission fragment angular distributions has also made using the statistical secession model (SSM). Variance K_o^2 of the K distribution are compared with their corresponding S_o^2 values. It turns out that the variances from these two models differ by about 20% for most cases studied. However, in the case of $^{12}C+\ ^{237}Np$ the value of K_o^2 is comparable with its corresponding S_o^2 value. This suggests that the effect of the projectile spin on angular anisotropies is more noticeable. The effect of the choice of the level density parameter of the compound nucleus on angular anisotropies has also been investigated. It is found that angular anisotropies are very sensitive to level density parameter. It turns out that the experimental anisotropies are well produced with the model calculation using higher values of the level density predicted by Fermi gas model. This effect will be presented and discussed.

Saturday, October 24, 2009 1:50PM - 3:02PM – Session K6 Carbon Nanotubes Hill Hall 204

1:50PM K6.00001 Explaining the Purification of Single-Walled Carbon Nanotubes by 248 nanometer UV Light

ABRAM VAN DER GEEST, Colorado School of Mines, KATHERINE HURST, JOHN LEHMAN, NIST - Boulder, MARK LUSK, Coloado School of Mines — It has been experimentally observed that amorphous carbon is removed from as-prepared, bulk, single-walled carbon nanotubes by illumination with 248 nm (5 eV) UV light. The process via which this occurs, though, has not yet been rigorously identified. We use a combination of experiments and modeling to explain how localized surface plasmon pairs can be induced at the surfaces of nanotubes. The 248 nm light is near the resonant frequency of one of these plasmon pairs for small diameter nanotubes, and this causes a large electric field enhancement in the vicinity of the tubes. The enhanced field increases the rate at which sp-2 bonds in the amorphous carbon are excited into a state from which the carbon is more easily oxidized. Electromagnetic catalysis by embedded nanoparticles describe these processes. Classical electromagnetics, in conjunction with density functional theory, is used to quantify the field enhancement and the relationship between laser wavelength and nanotube radius which will result in cleaning. Cleaning is defined as the removal of a-C from SWCNT by optical processes. The absorption spectra in the region of 5 eV, for amorphous carbon, is also described by using density functional theory to study the effects of deformation on related molecules such as ethylene and benzene.

2:02PM K6.00002 Using Carbon Nanotubes for Nanometer-Scale Energy Transfer Microscopy[1]

JESSICA JOHNSTON, EYAL SHAFRAN, BEN MANGUM, CHUN MU, JORDAN GERTON, University of Utah, Department of Physics and Astronomy — We investigate optical energy transfer between fluorophores and carbon nanotubes (CNTs). CNTs are grown on Si-oxide wafers by chemical vapor deposition (CVD), lifted off substrates by atomic force microscope (AFM) tips via Van der Waals forces, then shortened by electrical pulses. The tip-attached CNTs are scanned over fluorescent CdSe-ZnS quantum dots (QDs) with sub-nm precision while recording the fluorescence rate. A novel photon counting technique enables us to produce 3D maps of the QD-CNT coupling, revealing nanoscale lateral and vertical features. All CNTs tested (>50) strongly quenched the QD fluorescence, apparently independent of chirality. In some data, a delay in the recovery of QD fluorescence following CNT-QD contact was observed, suggesting possible charge transfer in this system. In the future, we will perform time-resolved studies to quantify the rate of energy and charge transfer processes and study the possible differences in fluorescence quenching and nanotube-QD energy transfer when comparing single-walled (SW) versus multi-walled (MW) CNTs, attempting to grow substrates consisting primarily of SW or MWCNTs and characterizing the structure of tip-attached CNTs using optical spectroscopy.

[1]NSF Grant # DBI-0845193

2:14PM K6.00003 Controlled Placement of Carbon Nanotubes using Massively Parallel Indirect Dielectrophoresis[1]

BRIAN DAVIS, HIRAM CONLEY, DAVID JONES, CALEB HUSTEDT, LAWRENCE BARRETT, DEAN R. WHEELER, MATTHEW R. LINFORD, ADAM T. WOOLEY, JOHN N. HARB, ROBERT C. DAVIS, Brigham Young University — Dielectrophoresis has been used to place nanotubes, nanorods, nanowires, and other nanostructures between surface patterned metal electrodes. This technique can deposit a varying number of structures between each set of electrodes. We have developed a method to control the number of deposited singled-walled carbon nanotubes by tuning the impedance of capacitively-coupled electrodes through parameters such as electrode geometry and AC driving frequency. Controlled placement of nanotubes at high yield is a prerequisite for the use of carbon nanotube devices in modern integrated circuitry.

[1]We acknowledge BYU Mentoring and NSF Grant #0708347 for funding this project.

2:26PM K6.00004 Strength and Mechanical Properties of Carbon Nanotube Templated Materials

TAYLOR WOOD, ROBERT DAVIS, RICHARD VANFLEET, JUN SONG, Brigham Young University — The type of material a structure is made of limits its kinds and extent of practical applications. Carbon nanotubes have an unusually high strength-to-weight ratio and thus present an exciting material for use in reinforcing the structural integrity of microstructures. However, despite their desirable properties, carbon nanotubes have proved difficult to incorporate in materials as strengthening elements. Our group has developed a method for patterning and infiltrating, or filling, carbon nanotube forests to make structures. This filling of the space between the carbon nanotubes locks the structure together. Carbon infiltration proceeds by flowing an ethylene/argon mixture across a sample at a temperature of 900 C, thus depositing amorphous carbon and creating a carbon/nanotube composite material. Using cantilever structures, we have begun to measure key mechanical properties of this composite material. We are able to determine the maximum applied force that a carbon-infiltrated microstructure can withstand which allows us to calculate mechanical properties, such as the Young's modulus of the composite material.

2:38PM K6.00005 Analysis of Silicon Carbide Coated Carbon Nanotubes

ADAM KONNEKER, JUN SONG, RICKY WYMAN, RICHARD VANFLEET, DAVID ALLRED, ROBERT DAVIS, Brigham Young University — The purpose of this research is to explore the use of silicon carbide coated carbon nanotubes in microelectromechanical systems or MEMS. In our research group at Brigham Young University, we are developing a method of MEMS fabrication through the use of carbon nanotube (abbreviated CNT) "scaffolds." Traditional MEMS fabrication techniques are use chemical etching to create three dimensional structures. Our group is seeking to overcome some of the shortcomings of this method by using patterned vertically aligned CNT's filled with bulk materials to create new MEMS devices. This technique allows the creation of MEMS devices with geometries that cannot be created using standard methods. This research focuses on the use of chemical vapor deposition to fill the CNT arrays with silicon carbide, which is a very durable and robust material that could have a wide range of applications in MEMS. We will report on preliminary results of silicon carbide production as determined by electron microscopy and X-ray spectroscopy.

2:50PM K6.00006 Structural Optimization of CNTs for MEMS Devices , STEVEN NOYCE, KELLEN MOULTON, ROBERT DAVIS, RICHARD VANFLEET, BRIAN JENSEN, Brigham Young University — MicroElectroMechanical Systems (MEMS) fabricated from a carbon nanotube (CNT) scaffolding are extremely versatile devices. They provide a means to create high aspect-ratio structures out of nearly any material, and minimize the required effort. In order for these great properties to be exploited, however, the nanotube framework must be perfected. Many aspects of CNT synthesis have been extensively studied in the past, yet rarely have they been viewed from the standpoint of using them as a basis for filled MEMS devices. Seldom has such absolute structural perfection and replicative fidelity been required of CNT forests. To achieve these lofty requirements, variables such as catalyst thickness, substrate preparation, and CNT synthesis conditions were carefully varied. Measurements were made on many resultant properties, such as sidewall straightness and fabrication robustness. These findings vastly improve the nanotube framework, opening new avenues for research in CNT MEMS.

Saturday, October 24, 2009 1:50PM - 2:50PM –
Session K7 Materials Physics III Hill Hall 202

1:50PM K7.00001 A shadow-edge contact for epitaxial nanostructures on silicon , SAMUEL K. TOBLER, PETER BENNETT, Arizona State University Physics Dept — We have developed a method to apply a thin (5 nm) metal film with a sharp edge (100 nm) onto the surface of a silicon sample in ultrahigh vacuum, to provide a counter-electrode for the study of electrical properties of epitaxial nanostructures. Film sheet resistance, Rs, is monitored continuously during deposition, to identify "electrical closure" of small grains. Film roughness, σ, is measured ex situ using Atomic Force Microscopy and in situ using Scanning Tunneling Microscopy. We find that Pt is more suitable than Au, attaining $Rs \approx 300\Omega/sq$ and $\sigma \approx 10nm$ versus $Rs \approx 1000\Omega/sq$ and $\sigma \approx 50nm$ for Au.

2:02PM K7.00002 The Search for Effective p-Type Material in GaN-Based Devices: Past, Present, and Future , REID JUDAY, ALEC FISCHER, FERNANDO PONCE, Arizona State University, RUSSELL DUPUIS, Georgia Institute of Technology — In the continued drive towards viable, large-scale solid state lighting, GaN and its alloys with In and Al have risen to the forefront of current research. Regardless of GaN's success in LEDs and laser diodes, certain technological obstacles have remained. Since the beginning of GaN fabrication, the ability to reliably and effectively create p-type material has been a major concern. Mg is the most widely used and successful acceptor in GaN and appears to behave even more favorably in $In_xGa_{1-x}N$ with small values of x (< 0.1). It is commonly accepted, however, that Mg-H complexes form during growth, inhibiting hole formation. This talk will focus on comparing the techniques most commonly used to activate p-GaN, such as thermal annealing and low-energy electron beam irradiation in a scanning electron microscope, as well as the properties of low-indium content p-type InGaN thin films.

2:14PM K7.00003 Experimental discrimination of geminate versus non-geminate recombination in a-Si:H , SANG-YUN LEE, THOMAS HERRING, DANE MCCAMEY, Department of Physics and Astronomy, University of Utah, USA, CRAIG TAYLOR, Colorado School of Mines, Department of Physics, USA, KLAUS LIPS, Helmholtz-Zentrum Berlin fuer Materialien und Energie, Abteilung Silizium-Photovoltaik, Germany, JIAN HU, FENG ZHU, ARUN MADAN, MV Systems, Inc., USA, CHRISTOPH BOEHME, Department of Physics and Astronomy, University of Utah, USA — Hydrogenated amorphous silicon (a-Si:H) is an important material for solar cells, thin film transistors, and other devices. An open fundamental question in a-Si:H is which excess charge carrier recombination processes are geminate (correlated) or non-geminate (non-correlated). While both mechanisms cause photoluminescence (PL), only non-geminate recombination impacts photocurrent (PC). To answer this question, we have conducted pulsed Optically and Electrically Detected Magnetic Resonance (pODMR and pEDMR) spectroscopy on a-Si:H. The results allow an assignment of non-geminate and geminate processes to various previously known recombination mechanisms.

2:26PM K7.00004 Investigation of Interactions of Atomic Hydrogen with Amorphous Carbon Films , BHAVIN N. JARIWALA, CRISTIAN V. CIOBANU, SUMIT AGARWAL, Colorado School of Mines — Hydrogenated amorphous carbon (a-C:H) films are generally deposited using plasma enhanced chemical vapor deposition from hydrocarbon feed gases. The structure and properties of these films are defined by the sp^2-to-sp^3 hybridization ratio and the H content. Interaction of H generated in the plasma results in local and overall transformations to a diamond-like structure due to various reactions. We have employed classical molecular-dynamics (MD) simulations based on the modified extended Brenner potential and experiments to study atomic H interactions with a-C:H thin films. Using MD, we first developed a procedure for creating realistic a-C:H thin films and formulated a scheme to characterize the sp^2-to-sp^3 hybridization ratio. These films were then impinged with H atoms at random locations and the specific chemical reactions of the H atoms with the a-C:H surface were identified through a detailed analysis of the MD trajectories. The reaction mechanisms for the hydrogenation reaction, H-atom abstraction and chemical erosion through desorption of stable hydrocarbon species have been identified and shown to be consistent with experimental measurements. Support from NSF award number DMR-0820518 is gratefully acknowledged.

2:38PM K7.00005 An initial analysis of short- and medium-range correlations potential non-Pt catalysts in CoNx , JOE PETERSON, HEINZ NAKOTTE TEAM, TIMOTHY OLSON TEAM, ANNA LLOBERT COLLABORATION, THOMAS PROFFEN COLLABORATION — A potential show stopper for the development of fuel cells for the commercial automotive industry is the design of low-cost catalysts. The best catalysts are based on platinum, which is a rare and expensive noble metal. Our group has been involved in the characterization of potential materials for non-Pt catalysts. In this presentation, I will present some preliminary neutron scattering data from a nanocrystalline powder sample of CoNx. It is apparent that the diffraction data cannot be analyzed with standard Riedveld refinement, and we have to invoke pair distribution function (PDF) analysis. The PDF provides insight into short-range correlations, as it measures the probabilities of short- and mid-range interatomic distances in a material. The analysis reveals a strong incoherent scattering response, which is indicative of the presence of hydrogen in the sample. After correcting for the incoherent scattering, one obtains the normalized scattering function S(Q), whose Fourier transform yields the PDF.

Saturday, October 24, 2009 1:50PM - 3:02PM –
Session K8 Nuclear Physics Hill Hall 209

1:50PM K8.00001 Importance truncation in the No-Core Shell Model[1] , MICHAEL KRUSE, University of Arizona, PETR NAVRATIL, Lawrence Livermore National Laboratory, BRUCE BARRETT, University of Arizona — The No-Core Shell Model is an ab-initio technique, capable of calculating observable quantities of light nuclei (A <= 12) very accurately. However, for heavier nuclei, the computational requirements become unfeasible. The problem lies in the massive size of the basis space employed. Importance truncation allows us to make a good a priori guess of which basis states might be relevant for certain observables. We are thus able to dramatically reduce the size of the required basis, opening up the possibility to perform structure calculations of heavier nuclei and also astrophysical reactions.

[1]M.K.G.K and B.R.B: NSF grants PHY0244389 and PHY0555396. P.N. acknowledges support in part by the U.S. DOE/SC/NP (Work Proposal N. SCW0498) and USDOE Grant DE-FC02-07ER41457; Prepared by LLNL under Contract No. DE-AC52-07NA27344.

2:02PM K8.00002 Effective three-body monopole interaction in the valence cluster approximation for the p-shell , SYBIL DE CLARK, ALEXANDER LISETSKIY, BRUCE BARRETT, MICHAEL KRUSE, University of Arizona — No-core shell model calculations of binding energies using the two-body cluster approximation can omit higher-body correlations in small model spaces. To try and remedy this, we include higher-body correlations up to six nucleons in a two-body effective hamiltonian suitable for standard shell model (SSM) calculations, by performing two successive unitary transformations. The obtained effective hamiltonian contains a core, one-body and two-body pieces (due respectively to interactions among the core nucleons, between a valence and core nucleons and between two valence nucleons). We investigated the size of these interactions as a function of isospin for nuclei with A = 8 to 16 and compared the ab-initio results with the SSM results. The differences grow larger with A, indicating the need for three- and higher-body terms in the effective hamiltonian with increasing A. Taking the effective three-body monopole interaction into account for A>7, we found greatly improved results.

2:14PM K8.00003 A Quadrupole Band-Pass Filter for a White Proton Source , JONATHON MORROW, JERRY PETERSON, University of Colorado — The LANSCE facility at Los Alamos National Laboratory uses a beam of 800 MeV protons as a source of continuous (white) beams of neutrons, used for a wide range of basic and applied science. The same source also provides a white source of protons, which would be very useful for research, if some degree of energy resolution were available. We are designing a quadrupole magnet system that will provide such energy resolution by focusing only the desired momentum onto a sample, with protons of more or less momentum more widely diffused. Results will be given for designs based on simple thin lens optics to understand the criteria and general trends. A full design will require use of magnetic beam transport codes and a specific magnet system.

2:26PM K8.00004 Liquid Lithium Pendant Droplet for Laboratory Nuclear Astrophysics Beam Experiments , MARK CALTON, JOHN ELLSWORTH, Brigham Young University Physics and Astronomy — Exposing and maintaining a clean surface of a small quantity of lithium metal in vacuum may be accomplished by a liquid lithium hanging droplet. Finding little literature on the subject, I have been experimenting to test this idea and will report on my efforts.

2:38PM K8.00005 Lithium Gadolinium Borate Scintillator for Low Flux Neutron Detection in Laboratory Nuclear Astrophysics , JACOB A.J. SIEBACH, JOHN E. ELLSWORTH, LAWRENCE B. REES, Brigham Young University, Physics and Astronomy — Lithium gadolinium borate crystal embedded in a plastic scintillator promises to enhance low flux neutron detection through paired pulse scintillation. The signal from this detector contains an energy pulse and a capture gate pulse. We report here efforts to develop a method to recognize the neutron gate signal, extract energy information, and calibrate this new scintillator.

2:50PM K8.00006 Using X-ray Fluorescence to Date Petroglyphs , JAMES MCNEIL, Colorado School of Mines — Petroglyphs were created by ancient peoples of the Colorado Plateau who pecked figures of cultural or religious significance into the desert varnish, the ubiquitous dark patina covering the rock surfaces of the region. Manganese (Mn) is a significant elemental component of desert varnish that is often at trace levels in the substrate rock. As such, F. Lytle has shown that under certain conditions, it may be possible to estimate the age of petroglpyhs using Mn levels. In this work we use x-ray fluorescence to measure Mn levels in the desert varnish of petroglyphs and then use dated graffiti to attempt to calibrate the Mn level with age. Preliminary results from petroglyph panels in eastern Utah will be presented.

Saturday, October 24, 2009 3:30PM - 5:12PM –
Session L1 Awards and Plenary Session III Green Center Metals Hall

3:30PM L1.00001 Research Opportunities at LANSCE in Neutron Scattering: The Legacy of Louie Rosen[1] , ALAN HURD, Los Alamos National Laboratory — Many are surprised to know that the Four Corners Region is a powerhouse in neutron scattering, and the future portends increased competitive advantage for those who use the Lujan Neutron Scattering Center at LANSCE. Connected to the world's first—and until 2010 the world's only—megawatt proton accelerator, the Lujan Center has one of the highest intensity neutron pulses in the world. Its suite of 14 instruments offers 11 materials research stations and 3 stations for nuclear physics. Importantly, the Enhanced Lujan Program scheduled for 2010-2014 will see a doubling in science capacity and quality as new instrument concepts are realized. The general user community is encouraged to become involved with instrument concept development. This presentation is dedicated to Louie Rosen, the father of the LANSCE accelerator, who passed away in August 2009.

[1]This work was funded by Basic Energy Sciences under DOE contract DE-AC52-06NA25396.

4:06PM L1.00002 Tunable Terahertz Metamaterials , ANTOINETTE J. TAYLOR, Los Alamos National Laboratory — In recent years terahertz (1 THz = 10^{12} Hz) technology has become an optimistic candidate for numerous sensing, imaging, and diagnostic applications. Nevertheless, THz technology still suffers from a deficiency in high-power sources, efficient detectors, and other functional devices ubiquitous in neighboring microwave and infrared frequency bands, such as amplifiers, modulators, and switches. One of the greatest obstacles in this progress is the lack of materials that naturally respond well to THz radiation. The potential of metamaterials for THz applications originates from their resonant electromagnetic response, which significantly enhances their interaction with THz radiation. Thus, metamaterials offer a route towards helping to fill the so-called "THz gap." In this work we present a series of novel planar THz metamaterials. Importantly, the critical dependence of the resonant response on the supporting substrate and/or the fabricated structure enables the creation of active THz metamaterial devices. We show that the resonant response can be controlled using optical or electrical approaches, enabling efficient THz switches and modulators which will be of importance for advancing numerous real world THz applications.

4:42PM L1.00003 Awards Presentation , JEAN-FRANCOIS VAN HUELE, Brigham Young University — .