and storage applications. This phenomenon results in a dramatic increase in electrical conductivity, free-carrier absorption, and infrared reflectivity. These results could be relevant to hydrogen sensing and other applications.

At moderate annealing temperatures (350°C), hydrogen permeates nanoparticles, leading to interesting phenomena. At higher temperatures, the particle size becomes comparable to the unit cell dimension of the ZnO lattice, and the phase coexistence of the metallic (Zn) and nonmetallic (O) species is observed. This phase coexistence is characterized by a Peierls distortion, which results in a 1d electron gas with a band structure that is different from the bulk material. The quasi-1d character of the electron gas leads to a high mobility and a high density of states at the Fermi level, which is essential for the high performance of electronic devices.

In our work, we have focused on hydrogen donors in bulk ZnO, combining IR spectroscopy with electrical measurements. As dimensions approach the nano-scale, ZnO suffers from a relatively high level of donor defects. These compensating impurities prevent p-type doping, which is essential for practical applications. In electronic devices, ZnO has emerged as a potentially important material for spintronic applications. Despite its numerous advantages and potential applications, the material remains largely underexplored.

ZnO has been used as a transparent conductor in solar cells, and is a preferred material in optoelectronic devices, where it is used for the fabrication of light-emitting diodes and lasers. In addition to optoelectronic and energy applications, ZnO is also used in high-temperature coatings and in the fabrication of nanoscale devices. The material's wide-bandgap and high carrier mobility make it an excellent candidate for energy-efficient white lighting. Another major advantage of ZnO is its high optical transparency, which makes it suitable for use in photovoltaic devices and in the fabrication of transparent electronics.

The versatility of ZnO is limited by its low thermal stability, which makes it difficult to grow large single crystals. However, large single crystals of ZnO can be grown using high-temperature techniques, such as chemical vapor deposition (CVD) and metal-organic chemical vapor deposition (MOCVD). These techniques allow for precise control of the crystal growth parameters, resulting in high-quality ZnO single crystals with low defect densities.

In conclusion, ZnO is a promising material for energy applications. Its wide-bandgap, high carrier mobility, and high optical transparency make it an excellent candidate for a variety of applications. However, further research is needed to overcome the material's low thermal stability and to develop new growth techniques for the production of large single crystals.
2:36PM B1.00002 Trace Impurities and Radiation Defects in Optical Materials. GALINA MALOVICHKO, VALENTIN GRACHEV, MARTIN MEYER, MARK MUNRO, VLADIMIR PANKRATOV. Montana State University — Trace impurities and radiation defects lead to inevitable performance degradation of devices based on optical materials. The results of the Electron Paramagnetic Resonance (EPR) study of defects in as grown and irradiated single crystals are reported. Among investigated optical materials are LiNbO$_3$, Li$_3$BO$_2$, KTiOPO$_4$ etc. Crystals from different vendors or grown by different ways have different concentrations of non-controlled impurities and, as a result, different physical properties, including radiation resistance. Intrinsic defects (vacancies and antisites), usually present in congruent non-stoichiometric crystals like lithium niobate and tantalate. Many EPR lines of non-controlled impurities in KTiOPO$_4$ crystals. We found that dominating types of defects formed under visible, UV and gamma photon irradiation are centers created by defects trapped electron or hole. The neutron and high energy electron irradiation creates stable Frenkel pairs - interstitial ions and vacancies. Computer simulation of observed spectra allowed us to determine spectroscopic characteristics and models for more than dozen trace impurities and radiation defects. Obtained data about atomic defects can be used for a selection of materials suitable for various applications.

2:48PM B1.00003 Where are Nature’s missing structures? GUS HART — It has long been claimed that predicting crystal structures of compounds using “first-principles” (direct solution of the Schrodinger equation using computers) will fundamentally change the way new materials discoveries are made. However, the ability to reliably predict new materials has been elusive. This ability is elusive for two reasons: the enormous search space of possible crystal structures; the relatively long time to construct the propagators of generally used charged spinless particles. We apply Schrödinger’s method to find the problem from a different angle: what intermetallic structures are likely based just on simple combinatoric arguments? Some of these likely candidates are indeed well-known intermetallic structures but many other are conspicuously absent. What are the physical reasons that some of these structures exist in Nature and others don’t?

3:00PM B1.00004 Current-Voltage Characteristics of ZnO and MgZnO Nanoparticle Films. CHRIS BERVEN, SIRISHA CHAVA, RAMEY ABDELRAHAMAN, ABBY HEIEREN, JOHN MORRISON, JESSE HUSO, LEAH BERGMAN, University of Idaho, Dept. of Physics, Moscow ID — We report on initial results on the measurement of the current-voltage (I-V) characteristics of films of ZnO and Mg$_x$Zn$_{1-x}$O ($x = 0.15$) nanoparticles. The nanoparticles were prepared using wet chemical techniques on insulating thermally grown SiO$_2$ (15 um thick) Si substrates. Contact to the nanoparticles was by laying down gold wires, about 2 mm apart, across the as-prepared nanoparticle films. On the top of the gold wires was put a glass cover slip on the back of which was painted conducting silver paint. On top of the cover-slip was a portion of a glass slide which was compressed down onto the cover slip and wires to ensure good electrical contact to the nanoparticles. This arrangement enabled the application of a gate voltage to the nanoparticle device. Our initial results show that the I-V characteristics are non-linear and gating can modulate the I-V characteristics. The ZnO device shows no hysteresis whereas the MgZnO device shows hysteresis in the I-V characteristics only for negative source-drain bias. The measurements were performed in a environmental chamber, in the dark at 18 mTorr and 2 x 10$^{-7}$ Torr, for the ZnO and MgZnO films, respectively.

3:12PM B1.00005 Coffee Break —

3:30PM B1.00006 From Stern-Gerlach to Rashba-Dresselhaus Propagators. BAILEY HSU, JEAN-FRANCOIS VAN HUELE, Brigham Young University — Propagators are used to describe the evolution of quantum systems in space. Schrödinger’s method, which uses the commutation between the relevant operators to construct the propagators is generally used for spinless particles. We apply Schrödinger’s method to find propagators for quantum systems with spin in electromagnetic configurations. We first consider neutral particles with magnetic moments in magnetic fields as used in Stern-Gerlach experiments and we construct the propagators and their effect on wave packets. We discuss the extension to charged particles in electromagnetic fields. In spintronics applications, bulk and structure inversion asymmetries lead to spin-orbit coupling interactions. We discuss the dynamics in the special cases of the Rashba and the Dresselhaus effect.

3:42PM B1.00007 Electrical spin measurements of doped phosphorus donors in crystalline silicon. HEATHER SEIPEL, THOMAS HERRING, CHRISTOPH BOEHME, University of Utah — With recent experimental demonstration of the electrical detection of electron spins of phosphorus donors as well as their hyperfine coupling to the $^{31}$P nuclear spin [Stegner et al., Nature Physics, doi:10.1038/nphys465, (2006).], a potential mechanism for a $^{31}$P in crystalline silicon (c-Si) nuclear spin readout based on spin-dependent $^{31}$P-P$_{eh}$ recombination is available. To further investigate the properties of this mechanism, we present pulsed electrically detected magnetic resonance (pEDMR) measurements on diffusion doped silicon samples. For their preparation, c-Si (100) wafers are diffused with a profile whose concentration at the surface leads to degenerately doped c-Si before it then drops off into the semiconducting region. Deep trenches are made with a plasma enhanced reactive ion etch where the choice of the trench depth determines the dopant concentration of the sample without changing any other sample preparation parameters. A study of the qualitative and quantitative nature of the observed pEDMR signals is presented for different etch depths taken close to the metal-insulator transition.

3:54PM B1.00008 Investigation of Exciton States in CdSe Quantum Dots via Hamiltonian Diagonalization Method. ZACHARY SCHULTZ, JOHN ESSICK, Reed College, Physics Department, Portland, OR 97202 — We analyze the electron-hole (“exciton”) states involved in visible-light absorption by a spherical CdSe quantum dot. Working within the effective mass approximation and assuming a dot size on the order of the bulk exciton Bohr radius $a_B$, we exploit a Hamiltonian diagonalization method, which accounts for the exciton’s kinetic $T$, direct Coulomb $U_{eh}$, and surface polarization $U_{ph}$ energies. Using a basis set composed of 54 composite infinite spherical-well wavefunctions, we obtain representations of exciton wavefunctions and their corresponding energies. For a dot radius $R = 0.80a_B$, we find that the energies associated with $T$, $U_{eh}$, and $U_{ph}$ are $+1.4E_R$, $-1.7E_R$, and $+1.4E_R$, where $E_R$ is the bulk CdSe exciton Rydberg energy. Our theoretical results are then used to predict the size-dependent visible-light absorption spectra of CdSe quantum dots. Comparisons of the theoretical spectra are made to absorption data we have taken on CdSe dots with known radii. We find that our theoretical model accurately describes the experimental data for dots with radii $R \geq 0.6a_B$. Finally, we explain why our model breaks down for dots with $R \leq 0.6a_B$ and comment on the accuracy obtained with use of a more limited basis set.

4:06PM B1.00009 Impedance studies of mixed ionic-electronic conjugated polymers. YONGJUN WANG, FUDING LIN, MARK LONERGAN, Department of Chemistry, The Materials Science and Institute, Oregon Nanoscience and Microtechnologies Institute, University of Oregon — A polymer fabricated by sandwiching an ionically functionalized polycrylate between two metal electrodes, is investigated with impedance analysis at temperatures ranging from 308K to 398K. Three processes-namely geometric capacitance charging, ion hopping and interfacial polarization-can be identified in the frequency region of 0.01 Hz to 1MHz. The temperature dependence of the conductivity and the hopping frequencies shows Arrhenius behavior with activation energies of 0.97 eV and 0.98 eV respectively. The similarity of these activation energies implies that the concentration of mobile charge carriers is independent of temperature and the conductivity is determined primarily by the charge carrier mobility. Ionic conductivity is found in the range $10^{-12}$ to $10^{-10}$ S/cm in the temperature span studied. These experiments lay the foundation for further investigations of charge transport at conjugated polymer interfaces with ionic functionality.
FRANCESCA SAMMARRUCA, University of Idaho — Recent efforts in my group have been aimed at exploring nuclear interactions in the medium through a combination of magnetron sputtering and gas-aggregation technique. High-resolution TEM images show that the nanoclusters are monodispersive with a nanocrystalline size < 10 nm. XRD patterns are identical to the bulk ZnO wurtzite structure. XPS detected the dopant elements, which are uniformly distributed in dopant nanoclusters. High-resolution XPS showed oxidation states of dopant Ti in +4, and Co in +2 with isovalence, while V in +4 and +5, and Ni in +2 and +3 with mixed valances. These analyses indicate that dopant elements do not exist as independent aggregates but are incorporated into the ZnO structure. All the doped ZnO nanoclusters are ferromagnetic above room temperature. Magnetic moments of Ni and V-doped ZnO (1.5µB or 3.5µB per dopant atom) are much larger than Ti or Co doped ZnO clusters (0.2µB or 0.6µB per dopant atom). Double exchange interactions due to the mixed valance states are the reason that Ni or V-doped ZnO clusters have much larger magnetic moments than the Ti or Co-doped clusters. Both magnetic and UV optical properties of doped ZnO nanoclusters are dopant concentration dependent.

Friday, May 18, 2007 2:00PM - 4:30PM — Session B2 Nuclear Physics PSUB Bear River Room

2:00PM B2.00001 Recent Advances in Our Understanding of Nuclear Forces, RUPRECHT MACHELDT, University of Idaho — The attempts to find the right (underlying) theory for the nuclear force have a long and stimulating history. Already in 1953, Hans Bethe stated that “more man-hours have been given to this problem than to any other scientific question in the history of mankind.” In search for the nature of the nuclear force, the idea of sub-nuclear particles was created which, eventually, generated the field of particle physics. I will review this productive history of hope, error, and desperation. Finally, I will discuss recent ideas which apply the concept of an effective field theory to low-energy QCD. There are indications that this concept may provide the right framework to properly understand the nuclear force.

2:36PM B2.00002 The Importance of Polarization Observables in Extracting Baryon Resonances: The NSTAR Program at Jefferson Lab using Polarized Photon Beams and Polarized Targets1. PHILIP COLE, Idaho State University — I shall report on the NSTAR program in Hall B of Jefferson Lab on using polarization observables as an incisive tool for extracting baryon resonances. The scientific purpose of this program is to improve the understanding of the underlying symmetry of the quark degrees of freedom in the nucleon, the nature of the parity exchange between the incident photon and the target nucleon, and the mechanism of associated strangeness production in electromagnetic reactions. With the high-quality beam of the tagged and collimated of circularly- and linearly-polarized photons onto unpolarized and polarized proton and deuteron targets, and coupled with the nearly complete angular coverage of the Hall-B spectrometer, we will extract the differential cross sections and polarization observables for the photoproduction of vector mesons and kaons at photon energies ranging between 1.1 and 2.1 GeV.

3:12PM B2.00003 Coffee Break —

3:30PM B2.00004 What can we learn from microscopic studies of dense nuclear matter?2. FRANCESCA SAMMARRUCA, University of Idaho — Recent efforts in my group have been aimed at exploring nuclear interactions in the medium through a broad spectrum of microscopic theoretical studies of the properties of dense and strongly asymmetric nuclear matter, where asymmetry may refer to isospin and/or spin. An example is the possible existence of a transition to a ferromagnetic state in spin-polarized nuclear/neutron matter. I will present and discuss recent progress and its relevance with respect to a better understanding of the nuclear force.

3:42PM B2.00005 φ-meson Photoproduction By Using a Beam of Linearly-Polarized Photons3, JULIAN SALAMANCA, PHILIP COLE, Idaho State University — The observables afforded by linearly-polarized photons provide the necessary means towards delineating the contributions of the various hadronic processes, which give rise to vector meson photoproduction. And in particular, We shall describe how φ meson production affords an incisive tool for exploring the nature of the parity exchange at threshold energies, the strangeness content of proton, as well as extracting signatures for the violation of Okubo-Zweig-Iizuka observation (OZI rule). Our goal will be measure the \( \bar{\psi}p \to \phi p \) reaction, with \( \phi \to K^+K^- \), in the photon energy range of 1.7G to 2.1 GeV by using the Coherent Linear Bremsstrahlung Facility in Hall B of Jefferson Laboratory (Newport News, VA). The data were collected during the g8b run in the summer of 2005.

3:54PM B2.00006 Field desorption as the basis for a neutron generator ion source, DAVID CHICHESTER, Idaho National Laboratory, KRISTIN HERTZ, Sandia National Laboratories, PAUL SCHWOEBEL, University of New Mexico, CHRIS HOLLAND, SRI Inc., JOHN BRAINARD, Sandia National Laboratories — Compact accelerator neutron generators used in research and industry rely upon the creation of a plasma to generate deuterium and/or tritium ion beam beams. As an alternative, research is currently underway to examine the feasibility of using a plasma-free ion source using field desorption as the ion generation mechanism. Making use of standard MEMS manufacturing techniques in conjunction with new design innovations, we are developing silicon field desorption micro arrays which incorporate metallic nano-emitter tips capable of desorbing hydrogen species ions under extreme electric fields. Research is underway to understand the field desorption characteristics of these arrays and assess their applicability for use within sealed neutron tubes. This presentation will briefly describe the technology and illustrate it’s potential for use in neutron generators.

4:06PM B2.00007 Using Thin Films to Rapidly Screen Potential Scintillators, BRIAN MILBRATH, Pacific Northwest National Laboratory, JAC CAGGIANO, DEAN MATSON, LARRY OLSEN — Growing crystals of inorganic scintillators is a time-consuming and expensive process, slowing the discovery of new radiation detection materials. To that end, we have begun an investigative program to discern the usefulness of thin polycrystalline films for scintillator characterization. As a first step, we made 10 micron thick films of Eu-doped CaF\(_2\) by electron beam deposition, which took approximately 1.5 hours per sample. After confirming composition with XPS and crystal structure with GIXRD, photoluminescence measurements were performed and found to be in agreement with literature values. Photopake comparisons can be performed using alpha sources. The method provides a quick way to explore and optimize the proper dopant amount. The crystal structure of the thin films results in grain sizes of approximately 15 nm. Light yields were approximately 10% of those found in commercial, single-crystal materials. Recently, we have begun to make thin Ce halide films. Rare-earth halide scintillators are an area of much current activity due to the favorable energy resolutions and light yields some of them possess. Preliminary results from our Ce halide studies will be presented along with our CaF\(_2\)(Eu) results.
Friday, May 18, 2007 2:00PM - 4:25PM – Session B3 Particle Physics PSUB Clearwater Room

2:00PM B3.00001 Radio Detection of Ultra High Energy Neutrinos, GARY VARNER. University of Hawaii — Observation over the last 40 years of several dozen cosmic ray events with energies exceeding the Greisen-Zatsepin-Kuzmin (GZK) cutoff poses among the most intriguing and intractable problems in high energy astroparticle physics. This GZK process itself produces neutrinos that are strongly believed to be both spectrally and spatially correlated to high energy cosmic ray particles above 100 EeV. In the 1960’s Askaryan predicted that the interaction of such high energy neutrinos would lead to coherent Cherenkov radiation due the spatially compact nature of such showers. In June 2006 Askaryan’s predictions were verified for EeV showers in a 10 ton ice target at 76°S. The ANTARES experiment, a long-duration balloon operating at an altitude of 37km, flew for a month during Dec. 2006 - Jan. 2007 and a preliminary report on this flight will be presented. In the longer term, a large-scale terrestrial radio array opens the possibility to probe deep inelastic neutrino-nucleon scattering at center of mass energies well above those of any proposed future collider. Two prototype systems were deployed in Antarctica this austral summer, and RF surveys of salt domes continue as will be shown.

2:40PM B3.00002 Counting B Mesons at BaBar, GRANT MCGREGOR, University of British Columbia, THE BABAR COLLABORATION — The primary goals of the BaBar Collaboration are to probe the standard model of particle physics through high precision studies of charge-parity (CP) violation and rare B meson decays. The BaBar detector is located at the Stanford Linear Accelerator Center. To date, we have recorded over 300 million B meson decays. With such high statistics in the study of B decays and CP violation, it is of utmost importance to have an understanding of precisely how many B mesons are produced and the uncertainties in this number. This is because the B meson count is used as a normalization in the vast majority of B-physics analyses with BaBar. We report on recent work to understand in detail the number of B mesons recorded and to improve the efficiency and systematic uncertainties in B meson counting.

3:05PM B3.00003 Coffee Break —

3:25PM B3.00004 Search For Baryon number violation in tau lepton decays, CASEY BOJECKO, University of British Columbia, BABAR COLLABORATION — A search for baryon number violating decays of the tau lepton has been performed. Specifically decays involving three charged tracks one of which is a proton. Decays of interest are of the form \(\tau \to \mu e\pi\) or \(\tau \to \ell\ell\) where \(\ell\) is either a \(\mu\) or \(e\) lepton. The search was conducted using 384 fb\(^{-1}\) of \(\tau\) data collected from the BaBar detector at the SLAC PEP-II storage rings. No evidence of the signal has been found, upper limits on the branching fractions are found to be of the order of \(10^{-17}\).

3:40PM B3.00005 High precision test of the equivalence principle, STEPHAN SCHLAMMINGER, TODD WAGNER, KI-YOUNG CHOI, JENS GÜNLACH, ERIC ADELBERGER, University of Washington — The equivalence principle is the underlying foundation of General Relativity. Many modern quantum theories of gravity predict violations of the equivalence principle. We are using a rotating torsion balance to search for a new equivalence principle violating, long range interaction. A sensitive torsion balance is mounted on a turntable rotating with constant angular velocity. On the torsion pendulum beryllium and titanium test bodies are installed in a composition dipole configuration. A violation of the equivalence principle would yield to a differential acceleration of the two materials towards a source mass. I will present measurements with a differential acceleration sensitivity of \(3 \times 10^{-18}\) m/s\(^2\).

3:55PM B3.00006 Electroweak Physics and the International Linear Collider\(^1\), JAMES BRAU, Center for High Energy Physics, University of Oregon, Eugene — One major achievement of Twentieth Century physics was the development of a precise theory of the electroweak interaction. Soon the Large Hadron Collider (LHC) will begin operations at CERN and confront the limits of this theory. The first indications of the physical basis for electroweak unification are anticipated. Recently the Global Design Effort released its Reference Design Report for the International Linear Collider (ILC), and is preparing the effort toward the ILC Engineering Design. The ILC is a critical facility for advancing Terascale physics discovery.

4:10PM B3.00007 Correlations of Coupled Logistic Maps, JOHN HARRISON, GUS HART, Brigham Young University — Most systems in the world around us are non-linear and often chaotic. Moreover, many systems influence or are influenced by other physical systems. Understanding the behavior of coupled chaotic systems is essential to understanding the many facets of the physical world of our everyday experience. The simplest chaotic system, the logistic map, shows unusual correlations when coupled to a second logistic map. We use a Master-Slave coupling, where the first map influences the second, but not the other way. We observe two forms of correlation between the master and slave due to coupling strength. With low coupling the correlations are complex and very interesting. With higher values of coupling the two maps “lock”, becoming synchronized. I intend to discuss some of the intricacies of the correlations at low couplings.

Friday, May 18, 2007 2:00PM - 4:00PM – Session B4 Health and Biological Physics PSUB Selway Room

2:00PM B4.00001 Research and Education of Environmental Health Physics at Idaho State University, ROY DUNKER, —
LN crystals are discussed. Double Resonance (ENDOR). Structures of the Nd$^{3+}$ of intrinsic defects or/and charge compensation defects in the near neighborhood of Nd$^{3+}$ with congruent ones allowed us to distinguish four non-equivalent centers, as well as line splitting caused by hyperfine interaction of neodymium electrons with were studied with the help of the electron paramagnetic resonance, EPR. Tremendous narrowing of the EPR lines in stoichiometric samples in comparison have reduced contents of intrinsic defects and lower disorder (stoichiometric samples). Both congruent and stoichiometric crystals doped with neodymium melt with lithium deficiency, contain some percent of intrinsic defects. Samples grown under special conditions from melts, to which potassium has been added, some areas, such as geology and stellar physics, where information about Be-7 can be used to understand other processes. I will then describe the efforts that heavier elements. Be-7 is naturally found in two locations that are of interest to us: in the core of the sun as part of the fusion cycle, and in the atmosphere of the atom through chemical bonding, application of high pressure, or ionization. And because Be only has 4 electrons this effect is much stronger than in NAKATA, BYU — There are about 95 radioactive isotopes that decay exclusively through electron capture. The energy available for decay is not adequate for could obtain MR values of 8% at room temperature and the resistances of these junctions were found to be 500Ω to 50 kΩ range. We magnetoresistance(MR) ratio of these junctions at room temperature by applying magnetic field in plane and perpendicular to the direction of current. We plasma sputtering deposition with shadow mask technique. We used the RF plasma in-situ oxidation method to oxidize the thin Al layer. We measured the experimental evidence of magnetoelectric properties of MTJ's. Co(30nm)/Al$_2$O$_3$(1.5nm)/NiFe(30nm) tunnel junctions were fabricated on a Si wafer using DC plasma sputtering deposition with shadow mask technique. We used the RF plasma in-situ oxidation method to oxidize the thin Al layer. This result from parallel to antiparallel in an applied field. Tunnel magneto resistance (TMR) is defined as the relative difference in tunnel resistance between parallel and antiparallel oriented magnetizations of electrodes. The larger this TMR effect, the more sensitive the MTJ will be as magnetic read out device. This result has attracted considerable attention due to its potential applicability in digital storage industry and as magnetic field sensors. In this study we present our experimental evidence of magnetoelectric properties of MTJ's. Co(30nm)/Al$_2$O$_3$(1.5nm)/NiFe(30nm) tunnel junctions were fabricated on a Si wafer using DC plasma sputtering deposition with shadow mask technique. We used the RF plasma in-situ oxidation method to oxidize the thin Al layer. We measured the magnetoresistance(MR) ratio of these junctions at room temperature by applying magnetic field in plane and perpendicular to the direction of current. We could obtain MR values of 8% at room temperature and the resistances of these junctions were found to be 500Ω to 50 kΩ range. C1.00001 Critical Single-Point Mutations and Protein Folding Pathways. ROY CAMPBELL, Walla Walla College — Single-point mutations can have a dramatic effect on protein structure. Treating a mutation as a perturbation of a protein’s folded structure may not reveal a significant effect on that structure. The dependence of a protein’s structure on a mutation may only be understood when the mutation’s effect on the folding pathway is known. A united-residue model (Liwo et al., PNAS, 102, 2967, 2005) was used to study the effect of single-point mutations on protein folding pathways. C1.00002 Magnetoelectric Properties of Magnetic Tunneling Junctions SHILPA CHAVA, AVISHESH DHAKAL, WEI JIANG YEH, University of Idaho, PHYSICS TEAM — Magnetic tunneling junctions(MTJ's) consisting of two ferromagnetic layers separated by a thin insulating barrier show large tunnel magnetoresistive effects when the magnetizations of the ferromagnetic layers change their relative orientation from parallel to antiparallel in an applied field. Tunnel magneto resistance (TMR) is defined as the relative difference in tunnel resistance between parallel and antiparallel oriented magnetizations of electrodes. The larger this TMR effect, the more sensitive the MTJ will be as magnetic read out device. This result has attracted considerable attention due to its potential applicability in digital storage industry and as magnetic field sensors. In this study we present our experimental evidence of magnetoelectric properties of MTJ's. Co(30nm)/Al$_2$O$_3$(1.5nm)/NiFe(30nm) tunnel junctions were fabricated on a Si wafer using DC plasma sputtering deposition with shadow mask technique. We used the RF plasma in-situ oxidation method to oxidize the thin Al layer. We measured the magnetoresistance(MR) ratio of these junctions at room temperature by applying magnetic field in plane and perpendicular to the direction of current. We could obtain MR values of 8% at room temperature and the resistances of these junctions were found to be 500Ω to 50 kΩ range. C1.00003 The Radioactive Decay of Beryllium-7 KELLEN GIRAUD, GRANT HART, BRYAN PETERSON, TAKESHI NAKATA, BYU — There are about 95 radioactive isotopes that decay exclusively through electron capture. The energy available for decay is not adequate for electron-positron pair production, the only other possible route for an atom that is neutron-poor to decay. Beryllium-7 is the lightest isotope that decays only through electron capture. Because Be-7 requires the presence of electrons to decay it is possible to modify the decay rate by modifying the electronic structure of the atom through chemical bonding, application of high pressure, or ionization. And because Be only has 4 electrons this effect is much stronger than in heavier elements. Be-7 is naturally found in two locations that are of interest to us: in the core of the sun as part of the fusion cycle, and in the atmosphere due to cosmic ray interactions with atmospheric gases. I will present an overview of where the Be-7 comes from, what happens to it after it is formed, and some areas, such as geology and stellar physics, where information about Be-7 can be used to understand other processes. I will then describe the efforts that are currently underway at BYU to trap a non-neutral plasma comprised of ionized Be-7 to investigate the effect of ionization on the decay rate. C1.00004 EPR and ENDOR of Nd$^{3+}$ in congruent and stoichiometric LiNbO$_3$. GALINA MALOVICHKO, MARK MUNRO, Montana State University — Since many years Lithium Niobate (LN) is of great interest for both fundamental science and applications because of the unusual richness of its ferro-, pyro- and piezoelectric properties. Conventional LN crystals, grown from a congruent melt with lithium deficiency, contain some percent of intrinsic defects. Samples grown under special conditions from melts, to which potassium has been added, have reduced contents of intrinsic defects and lower disorder (stoichiometric samples). Both congruent and stoichiometric crystals doped with neodymium were studied with the help of the electron paramagnetic resonance, EPR. Tremendous narrowing of the EPR lines in stoichiometric samples in comparison with congruent ones allowed us to distinguish four non-equivalent centers, as well as line splitting caused by hyperfine interaction of neodymium electrons with nuclear spins of magnetic isotopes $^{143}$Nd and $^{144}$Nd. One of the centers has axial C$_3$ symmetry, whereas others have lowest C$_1$ symmetry due to presence of intrinsic defects or/and charge compensation defects in the near neighborhood of Nd$^{3+}$. Narrow EPR lines allowed us also to investigate Electron Nuclear Double Resonance (ENDOR). Structures of the Nd$^{3+}$ centers derived from the EPR/ENDOR data and effects produced by micro- and macro-imperfections of LN crystals are discussed.
Photovoltaic and Nuclear Detection Devices

Radiation interactions with materials cause a change in electronic and physical properties of the material, which affect the performance of the devices. It is a key issue in the employment of these materials in medical, space, security and other scientific applications. In our research we have determined the defects and their generation rate induced by gamma rays of energy 0.11-22 MeV, in CuInS2. We have used a simple model consisting of classical physics principles and Monte Carlo simulation software. The simulation results are in agreement with other published results done for other semiconductor materials. Our collaborators at INL will investigate different techniques for fabrication of thin films of CuZnTe and CuInS2 by using Radiofrequency Pulsed Plasma Enhanced Chemical Vapor Deposition and Pressurized Solvent techniques. Next, defects will be induced in the thin-film samples by exposure to a bremstrahlung gamma-ray beam. The dose rate will range from 5 to 25 kGy. Qualitative and quantitative measurements of the defects in the crystals will be done by gamma-ray spectroscopy and PICTS (Photo induced current transient spectroscopy).

Comparison of Several Approaches to the Nuclear Incompressibility Modulus

David Hudson, 10 Hitching Post Rd., Bozeman, MT — The nuclear incompressibility modulus (K) is an important factor for determining the equation of state of nuclear matter. It is however, not a directly measurable quantity. In this presentation, I compare two complementary approaches for determining K. One is the excitation of Giant Monopole and Giant Dipole Resonances by alpha particle scattering. The other is by alpha decay. The role of various assumptions and input uncertainties in the analysis and their relation to the value of K will be discussed.

Dark Matter Self Interaction Limits: Determination and Implications

Paul Lessard, The Evergreen State College — The first studies of the lensing events around the Bullet cluster have shown that the dark matter halos of galaxy clusters are collisionless. This rather fortunate structure in the universe becomes an excellent laboratory for setting limits on the source of dark matter particle interaction. Markevitch et al. in 2004 explored three simple methods for determining the dark matter self interaction cross section to mass ratio. A new strong and weak lensing derived density map of the cluster has been created, advancing the accuracy of these limits. A subsequent Markevitch et al. paper was released April of this year with a full n-body simulation of the collision putting giving us the best, although not the strongest, limit on the dark matter self interaction cross-section to mass ratio. Furthermore we are now at such a point as to ask what these limits tell us. Axions and SUSY wimps theoretically fall well under this threshold leaving their DM candidacy untouched if not strengthened. Other candidates like Q-balls however, are not guaranteed to fall below this limit. It is my goal to characterize Q-ball dark matter scenarios coincident with this new experimental limit.

Beam Dynamics Studies in the RACE Project: MH1 transport line – low power regime operation

Carlos Maidana, Alan Hunt, Idaho State University, Dept. of Physics, Denis Beller, Idaho Accelerator Center — As part of the Reactor Accelerator Coupling Experiments (RACE) a set of preliminary studies were conducted to design a transport beam line that could bring a 25MeV electron beam from a linear accelerator to a neutron-producing target inside a subcritical nuclear system. Because of the relatively low energy beam, the beam size and a relatively long beam line (implicating a possible divergence problem) the MH1 transport line was designed. Beam dynamics studies followed the beam optics ones and we present in this paper the first results of such studies.

Analyzing Flare Ribbons to Determine Magnetic Reconnection Flux and its Relationship to Flux Rope Formation

Jada Maxwell, The Evergreen State College, Jiong Qiu, Richard Canfield, Montana State University — Is the helical structure of a magnetic cloud (MC) largely pre-existing before its eruption or formed in situ by magnetic reconnection in the solar corona during the eruption? The flux of magnetic reconnection in the low solar corona can be evaluated through the flare ribbons observed in the chromosphere. Using data from TRACE and SOHO MDI, we measure the total magnetic reconnection flux swept up by flare ribbons in events associated with coronal mass ejections (CME). We compare this to MC flux measured in situ at 1 AU and find a near linear scaling pattern between MC poloidal flux and total reconnection flux. This relationship suggests that low corona reconnection is highly relevant to flux rope flux for the samples in our study. We note that this relationship does not distinguish events with or without filament eruption. Therefore, filaments may not play a role of carrying a significant amount of pre-existing flux.

Is increased Nuclear Energy a practical response to Global Warming?

Jeanne Stevens, The Evergreen State College — With the threat of global warming there has been renewed interest in nuclear energy as a carbon-free energy source. There are currently 15 nuclear power plants planned for completion in the U.S. by 2014. In the last 30 years, however, investment and public support for nuclear energy has been minimal. Some factors that led to this loss of interest - high economic costs, risk of accident and radiation exposure, and the challenges of storing nuclear waste - have been analyzed in several recent publications. Comparing the costs and risks of nuclear energy to the benefits in reduced carbon emissions is the goal of this report. Coal plants contribute the most carbon dioxide of all types of power plants. The method of this study is a direct comparison of coal plants and nuclear plants in four areas: the current cost per kWh, the predicted annual cost for health issues, the statistically predicted deaths, and the clean-up costs assuming each facility is as “green” as possible. A normalized cost/risk value is then calculated for each plant type. Discussion for how these values are likely to vary is included.

Development of a low cost 3D Particle Image Velocimetry for sub-sonic wind tunnel applications in Idaho State University

Carlos O. Maidana, Idaho State University - Dept. of Physics and College of Engineering, Marco P. Schoen, Kalyan Jinnuri, Brian G. WilliÄms, Idaho State University - College of Engineering, Lawrence Beaty, Idaho State University - College of Technology — PIV is a non-intrusive technique that provides instantaneous velocity vector measurements in a cross section of a flow. The stereo or 3D PIV technique is a topic of current interest due to its capability of 3D mapping of the vector field. We present in this paper an approach to build a low cost 3D PIV system for sub-sonic wind tunnel applications as well as the related basic CFD studies.
C1.00014 Metallic Nanoporous Films Fabricated by Etching, SHILPA CHAVA, JULIA TILLES, WEI JIANG YEH, University of Idaho, PHYSICS TEAM — Nanoporous metal films possess unique surface, structural, and bulk properties that underlie their importance in a wide range of applications such as catalysis, sensing, microfluidic control and filtration. In this presentation, we report our preliminary experimental results of metallic porous materials obtained by dealloying. The purpose of this research is to develop new strategies and techniques for the fabrication of nanoporous structures by selective chemical etching of different alloys. We have investigated two different chemical reactions: one is gold nanoporous films obtained from dissolving the silver component from the silver-gold alloy and the other is lead porous material obtained by etching out tin from lead-tin alloy. It was found that after dissolving the silver component, the remaining atoms gather together in clusters creating a rough surface, thereby causing the gold to evolve into porous material. We were able to tune the size of porous from about 10nm up to few 100 nm. When tin was etched off from lead-tin sheets, different microstructures were found by etching at different times. When it was etched for a short period of time, needle shaped structures with size of about a few 100's of nm were found. As we increased etching time, grain shaped structures formed.

Friday, May 18, 2007 6:00PM - 7:00PM —
Session 1A NWSS Business Meeting PSUB Snake River Room

6:00PM 1A.00001 Business Meeting —

Friday, May 18, 2007 7:00PM - 10:00PM —
Session 2A Banquet PSUB Ballroom

7:00PM 2A.00001 Banquet Speaker, SHARON WEINBERGER, —

Saturday, May 19, 2007 9:00AM - 12:22PM —
Session D1 Plenary Session II PSUB Salmon River Room

9:00AM D1.00001 The Sudbury Neutrino Observatory: Past, Present and Future, JARET HEISE1, Queen’s University/Sudbury Neutrino Observatory — The Sudbury Neutrino Observatory (SNO) is a 1000-tonne heavy-water Cherenkov detector situated 2 km underground in INCO’s Creighton mine near Sudbury, Ontario, Canada. The third phase of operation finished in November 2006, completing the physics program for the experiment. Results from the first two phases will be summarized and details of the third phase which employs an array of low-radioactivity proportional counters will be discussed in addition to topics relating to detector decommissioning.

The laboratory that currently houses the SNO experiment is undergoing an expansion to become SNOLAB, an international facility that is in an advanced stage of construction and will soon provide twice the space available for deep underground experiments over the existing SNO installation. SNOLAB will host the next generation particle-astrophysics experiments in pursuit of low-energy solar neutrinos, neutrinoless double beta decay, cosmological dark matter and supernova neutrinos.

One such experiment is the successor to SNO called SNO+, which is proposing to use liquid scintillator in place of heavy water to study low-energy pep and CNO solar neutrinos and potentially geo-neutrinos originating from radioactivity in the Earth. A second phase of the experiment would allow sensitivity to neutrinoless double beta decay by adding 136Xe to the liquid scintillator target volume. Aspects of SNOLAB and SNO+ will also be presented.

1 on behalf of the SNO Collaboration

9:36AM D1.00002 Controlling Light at the Nanoscale ALEXANDER A. GOVYADINOV, Physics Department, Oregon State University — The ability to control and process optical radiation at deep subwavelength scale will fundamentally improve a number of applications including high-resolution sensing, imaging, lithography, and signal processing. We explore the perspectives offered by nanoplasmonic metamaterials for manipulation of optical signals at the nanoscale. We first show that in contrast to conventional dielectric waveguides, plasmonic and anisotropy-based systems support confined optical modes even when the waveguide size is much smaller than the operating wavelength. The effective modal index in these nano-thick structures is inversely proportional to the waveguide size, and can be either positive or negative, providing a versatile mechanism for manipulating the phase velocity at the nanoscale. We next demonstrate that in contrast to diffraction-limited systems, in nano-scale systems the combined effect of waveguide- and material-induced dispersions provides new versatile controls for pulse manipulation. In particular we demonstrate that the group velocity in such waveguides can be changed from negative to large or small (in comparison with c) positive values by a relatively weak modulation of either material properties or waveguide dimensions or both. We finally explore the prospects of active plasmonic metamaterial in provide a unique platform for independent manipulation of group and phase velocities of electromagnetic radiation in sub-wavelength domain.

Contributors: A.A. Govyadinov, V.A. Podolskiy; Special thanks: J. Elser, R. Wangberg, B. Weston

10:12AM D1.00003 Coffee Break —

10:34AM D1.00004 Good defect, bad defect: electronic properties of CuGaSe2 solar cells JENNIFER HEATH, Linfield College — The Cu(In,Ga)Se2 (CIGS) alloys are promising materials for the absorber layer in solar cell devices. Single junction devices using CIGS absorbers have achieved 19.5% efficiencies. This is remarkable for a device with a thin film, non-crystalline absorber, and for this reason the CIGS electronic properties and especially the nature of defects and grain boundaries are of interest. In this talk, I will discuss several types of electronic defects in CIGS films: those that are beneficial—including defects that allow the material to be intrinsically doped; those that are neutral—apparently grain boundaries fall in this category; and those that may act negatively as traps and recombination centers, limiting device efficiencies. The higher Ga alloys have larger bandgaps, necessary for a multilayer tandem solar cell device. However, solar cells made from higher bandgap CIGS tend to perform more poorly than expected from studies of their low bandgap counterparts. We have studied a series of CuGaSe2 solar cell devices, using techniques based on the measurement of capacitance including admittance spectroscopy and drive-level capacitance profiling, as well as current-voltage measurements as a function of temperature and illumination intensity. These studies allow us to better understand the limitations to device performance, and the population of sub-bandgap traps that are present in the CIGS film. Our studies suggest that the p-n interface is particularly problematic in these devices.

11:10AM D1.00005 Deep Science: The Deep Underground Science and Engineering Laboratory, R.G.H. ROBERTSON, University of Washington — This abstract not available.
11:46AM D1.00006 Quantum Entanglement of Matter and Light\textsuperscript{1} , BORIS BLINOV, University of Washington, Department of Physics, Seattle, WA 98195 — A peculiar phenomenon called the entanglement is responsible for those features of quantum mechanics which Albert Einstein called “the spooky action at a distance.” Indeed, quantum systems in an entangled state seem to violate either the locality, or physical reality, or even both. Local measurements performed on one part of an entangled system instantly influence the outcome of local measurements on the other part. I will describe experiments in which quantum states of matter (in the form of trapped atomic ions) and light (in the form of single photons) are entangled. The matter-light system offers many advantages for fundamental studies of quantum mechanics, as well as applications in quantum computation and quantum information.

\textsuperscript{1}Supported by the University of Washington Royalty Research Fund

Saturday, May 19, 2007 2:00PM - 4:42PM –

Session E1 Education  PSUB Selway Room

2:00PM E1.00001 Research as a guide for improving student understanding of time dependence in quantum mechanics\textsuperscript{1} , ANDREW D. CROUSE, Physics Department, University of Washington, Seattle — The Physics Education Group at the University of Washington is engaged in a long term effort to investigate student understanding of quantum mechanics. One component of this investigation is to examine student ideas about time dependence. We have identified some specific difficulties, developed curriculum to address those difficulties, and implemented the curriculum in junior level physics courses at the University of Washington. An iterative process of assessing and refining that curriculum is underway. Elements drawn from this body of research will be discussed.

\textsuperscript{1}This work has been supported in part by the National Science Foundation.

2:36PM E1.00002 Coordinating the Development of Heat and Temperature Facet Clusters with Science Education Standards\textsuperscript{1} , HUNTER CLOSE, Seattle Public Schools and Seattle Pacific University — The Department of Physics and the School of Education at Seattle Pacific University, together with FACET Innovations, LLC, have just completed the second year of a five-year NSF TPC project, Improving the Effectiveness of Teacher Diagnostic Skills and Tools. We are working in partnership with school districts in Washington State to use formative assessment as a means to help teachers and precollege students deepen their understanding of foundational topics in physical science. We utilize a theoretical framework of knowledge-in-pieces to identify and categorize common student modes of reasoning in the topical areas of Properties of Matter, Heat and Temperature and Physical and Chemical Changes. In this talk, we describe the development of some facet clusters of student ideas in Heat and Temperature. Part of optimizing these diagnostic tools is ensuring that they are consistent with national and state science standards, research on student learning, and assessment practices used in the science portion of the Washington Assessment of Student Learning (WASL). A strong unifying theme for these standards and assessments is transfers and transformations of energy in all processes of nature, whether they occur in physical, earth/space, or living systems. This approach brings the concepts of heat, temperature, and energy into a broader context than is usually explored in traditional treatments of these ideas in physics. We discuss some challenges in developing formative assessment tools that synthesize and respect these different perspectives.

\textsuperscript{1}Supported in part by NSF grant #ESI-0455796, The Boeing Corporation, and the SPU Science Initiative.

3:12PM E1.00003 Coffee Break –

3:30PM E1.00004 Who Benefits from PER?: PER as a component of teacher preparation . BRIAN PYPER, BYU-Idaho — At BYU-I, we have been able to provide authentic PER experiences for about a half-dozen undergraduate pre-service science teachers. Although some interesting experiments have come out of this research group, perhaps of more interest is the impact these experiences have had on the preparation of these students anticipating careers in public education. This presentation will focus on discussing the initially very positive results of this experience and future plans for the possibility of providing this experience for as many of our pre-service teacher candidates as possible.

4:06PM E1.00005 Technology Talks: clickers and gender in the classroom\textsuperscript{1} , SHANNON WILLOUGHBY, Montana State University — Clickers are gaining popularity around college campuses, but research on clicker use in the classroom has been limited thus far. However, the manner in which clickers are used in the classroom seems to vary widely. Mark James\textsuperscript{1} studied use of grading incentive in different sections of astronomy, with students in some sections getting points simply for clicking any answer, and other sections earning more points for clicking the correct answer. In our study, different sections again had different grading schema and groups were recorded periodically during discussions. Two points were given for a correct answer (1 point for incorrect) in section one, and two points for any answer in section two. Similar to James’ results, we have found that students in section 1 are more likely overall to choose the correct answer than students in section 2. In section 2, students are more likely to choose the answer they think is correct, possibly because there is no threat of losing points due to choosing incorrectly. Talking amongst group members was encouraged in both sections, and 7 randomly chosen groups were recorded during the semester. There were 3 recording all semester. The recorded data was broken down by gender, in order to measure how gender dynamics affected the dialogue. Preliminary results show that group members were all contributing equally to the discussions, regardless of the overall gender makeup of the group, or the section (and hence the grading scheme). This result seems to be at odds with that found by Adams\textsuperscript{2} et al. (2002), which involved classroom observations of student groups. Additional data will be analyzed from this course and further compared to the findings of Adams.

\textsuperscript{1}In collaboration with Anneke Metz and Eric Gustavson, Montana State University, Bozeman.


Saturday, May 19, 2007 2:00PM - 4:30PM –

Session E2 Condensed Matter Physics II  PSUB Bear River Room
2:00PM E2.00001 Surface Plasmon Optical Transmission Sensors, KAREN L. KAVANAGH, Simon Fraser University — Periodic nanohole arrays in Au films have been fabricated by Ga focussed ion beam patterning. Extraordinary optical transmission is observed with resonances at specific frequencies determined by the array hole spacing. The most widely held explanation is that surface plasmon resonances are essential for this behavior. We have further shown that the transmission can be polarized and tuned depending on the shape of the holes. Raman scattering of adsorbed molecules and spontaneous emission from semiconductor quantum dots coupled to the Au arrays is enhanced by as much as two orders of magnitude. Arrays have been fabricated on glass or plastic insulators making them potentially useful for biosensors in microfluidics applications where transmission mode geometries may be preferable. In collaboration with: Alex Brolo, and Reuven Gordon, University of Victoria.

2:36PM E2.00002 Impurity-controlled valence, spin, and orbital state in Sr3Ru2O7, SUMAN HOSSAIN, University of British Columbia — Impurity doping is one of the most effective means of tuning the properties of materials. We have discovered a possible way for orbital hierarchy inversion, valence control, and magneto-crystalline anisotropy rotation in complex oxides, by embedding ‘localized’ impurity orbitals in a ‘delocalized’ host matrix. Here we present a comprehensive analysis of experimental and theoretical results on Sr3(Ru1−xMnx)2O7 by a combination of angle-resolved photoemission (ARPES), x-ray absorption spectroscopy (XAS), density functional theory (LSDA), and cluster multiplet calculations. We find that Mn impurities do not exhibit the same 4+ valence of Ru ions, but behave as Mn3+ acceptors. The extra electron occupies in-plane eg orbitals instead of the out-of-plane t2g→3d orbital predicted by crystal field theory. We will show evidence of spin-orbit coupling which might lead to orbital magnetism.

3:12PM E2.00003 Coffee Break

3:30PM E2.00004 Ultra-soft Magnetic Thin Films Deposited by Obliquely Energetic Fe Nanoclusters, DANIEL MEYER, M. FAHEEM, AMIT SHARMA, ALAN MCCONNAUGHERY, JAMIE HASS, RYAN SOUZA, YOU QIAN, University of Idaho — We have generated magnetically ultra-soft films by energetic cluster impact. The charged nanoclusters (~40% of all particles) were accelerated onto substrates held at potentials of 0, 5, and 15 kV. The substrates were tilted at an angle of 30 degrees to the incident beam to generate elliptically shaped particles and thereby induce shape anisotropy. Visible changes of the film structure were observed for increasing potential with 0 kV sample being black due to the porous nature of the soft landed clusters. For the 5 and 15 kV samples, the films take on a metallic sheen due to the increased density. Dramatic magnetic softening of the films was observed for samples with applied potentials, and hence higher packing fractions, in agreement with the random anisotropy model. The coercivity (Hc) at 0 kV was measured to be 78 Oe. Along the easy axis the Hc of the 5 and 15 kV samples were 0.497 and 0.651 Oe respectively. Along the hard axis the Hc were 2.06 and 2.46 Oe. The Hc perpendicular to the substrates was 9.86 and 6.7 Oe. Hence, definite shape anisotropy is observed for the 5 and 15 kV samples with approximately a 70% increase in coercivity of the hard axis relative to the easy axis. In this experiment we have demonstrated a novel technique for directly controlling film morphology and thereby ability to tailor magnetic characteristics for applications in high frequency inductors.

3:42PM E2.00005 Algorithms for the Control of Low Dimensional Chaos in the presence of System Parameter Drift, THOMAS OLSEN, KJELL SCHRODER, Lewis & Clark College, Portland, OR, KATHERINE CARRIKER, BONITA SQUIRES, KARA YEDINAK, RICHARD WIENER, Pacific University, Forest Grove, OR — The chaotic formation of Taylor-Vortex pairs in Modified Taylor-Couette flow with hourglass geometry may be controlled by the application of Recursive Proportional Feedback control [1]. We consider other algorithms that might be effective in the same context. We continue our studies of their effectiveness. We present numerical simulations and analysis to determine the stability and robustness of these new algorithms as the parameters that define the system drift.

3:54PM E2.00006 Spin propagation in vacuum and in two-dimensional electronic systems, JEAN-FRANCOIS VAN HUELE, BAILEY HSU, Brigham Young University — The spin degree of freedom is an important tool to understand and manipulate the complexity of quantum systems. It is also a physical system that is evolving in space and time and gives rise to spin currents that may or may not be associated with the dynamics of electromagnetic particles. We review the ways at our disposal to describe and analyze space-time evolution of single and multiple spins in electromagnetic fields that are either externally applied in vacuum or that are generated in confined environments through spin-orbit couplings.

4:06PM E2.00007 Spin-Orbit Mediated Anisotropic Spin-Spin Coupling, SUHAS GANGADHARIAH, JIANMIN SUN, OLEG STARYKH, University of Utah — We study spin-spin interaction between electrons localized in spatially separated quantum dots. We show that in the presence of single electron spin-orbit interaction (of Rashba type) in the dots and Coulomb interactions between electrons, a new anisotropic coupling between spins emerges. Unlike the standard exchange this coupling does not require overlap of the wavefunctions, and as a result becomes dominant for large distance between the dots.

4:18PM E2.00008 Spin-orbit induced spin-density wave in a quantum wire, JIANMIN SUN, SUHAS GANGADHARIAH, OLEG STARYKH, University of Utah — We study an interacting quantum wire in the presence of magnetic field and spin-orbit interaction. We show that in weak spin-orbit and strong magnetic field, the spin-density wave (SDW) state is stabilized when the magnetic field and spin-orbit axes are orthogonal. The spin ordering takes place along the direction of spin-orbit axis and perpendicular to the magnetic field. We next analyze charge transport in the presence of single weak impurity. We find with the SDW state stabilized single particle backscattering off a nonmagnetic impurity becomes irrelevant. The sensitivity of the SDW state, and hence the charge transport, to the mutual orientation and magnitude of the magnetic and spin-orbit terms can be used for the experimental verification of this novel spin-orbit mediated state.

Saturday, May 19, 2007 2:00PM - 4:27PM – Session E3 Atomic, Molecular, and Optical Physics PSUB Clearwater Room
2:00PM E3.00001 Continuous Measurement of Atomic Motion. DANIEL STECK, University of Oregon — Quantum mechanics is fundamentally a theory of measurement, and recently a paradigm in quantum optics has arisen for describing the continuous measurement of quantum systems. Interesting phenomena can happen in continuously observed systems, due to the interplay of the dynamical evolution and the measurement process. In particular, the evolution of a quantum system under a continuous measurement process is both nonlinear and stochastic. I will describe our interests in continuous measurements of atomic motion, especially in applying continuous measurements to realizing quantum feedback control of atomic motion and to understanding the quantum-classical transition. I will also describe our experimental progress towards studying these systems. Finally, I will end with a model of a continuous measurement of the position of an atom that operates via the imaging of scattered laser light—a “continuous Heisenberg microscope”—that has a surprising result: the information gained via the measurement in an intuitively “good” setup is much less that you would expect by considering the efficiency of the measurement.

2:45PM E3.00002 Hartree simulations of multi-electron atoms ionization in strong laser fields , MATT KALINSKI, Utah State University — The recent success of classical simulations of the ionization process of few electron atom is an argument that normal electron exchange and correlations effects are negligible for certain conditions of strong field ionization and only the Coulomb effects are essential [1]. The numerical convenience of solving the Schrödinger equation with nonlinearity instead of classical equations of the motion has been recently proved by us in case of so-called Trojan electrons in strong CP fields with Shay logarithmic quantum mechanics [2]. We present Hartree simulations of the ultra-strong-field time-dependent ionization of model one dimensional atoms with up to 10 active electrons involved (10 dimensional configuration space). N coupled Schrödinger equations is solved simultaneously on the Cartesian grid with our new nonlinear split-operator method. The continuum states are taken into account with delta grid representations of both wavefunction and the Coulomb interaction integral is calculated as the direct solution of the Poisson equation with the ultra-fast Fast Fourier convolution method developed by us to treat the supersolid formation in Bose-Einstein condensate. We calculate n-electron ionization rates for ultra-strong ultra-short few cycle pulses. [1] P. J. Ho and J. H. Eberly, Phys. Rev. Lett. 95, 193002 (2005). [2] M. Kalinski, contributed paper, APS DAMOP meeting, Lincoln, Nebraska, May, 2005

3:00PM E3.00003 Coffee Break —

3:30PM E3.00004 Ultra-bright compact sources of correlated photons based on SPDC in periodically-poled KTP , RAY BEASUSEIL, MARCO FIORENTINO, SEAN SPILLANE, HP Laboratories, TONY ROBERTS, PHIL BATTLE, MARK MUNROE, ADVIR — Photon pairs generated using spontaneous parametric down-conversion (SPDC) have been a central ingredient for a number of quantum optics experiments ranging from the generation of entanglement to demonstrations of quantum information processing protocols. The flux of pairs generated by SPDC sources has been steadily growing over the years opening the door to practical applications of correlated and entangled photon pairs. SPDC sources based on periodically poled waveguides have shown a great potential to generate large numbers of correlated pairs with a few µW of pump. These works, however, lack a clear explanation of the increased pair rate in waveguides and do not directly compare the waveguide result with bulk. Naively, field confinement in waveguides is not expected to enhance pair generation rate, since SPDC is a scattering phenomenon that only involves one pump photon and therefore does not benefit from higher photon densities created by focussing. In this talk we present a theoretical and experimental comparison of spontaneous parametric down-conversion in periodically poled waveguides and bulk KTP crystals. We measured a waveguide pair generation rate of 2.9 · 10^9 pairs/s per mW of pump in a 1-nm band: more than 50 times higher than the bulk crystal generation rate.

3:45PM E3.00005 Tunneling between 2D electron layers with correlated disorder: anomalous sensitivity to spin-orbit coupling , VLADIMIR ZYUZIN, EUGENE MISHCHENKO, MIKHAIL RAIKH, University of Utah — Tunneling between two-dimensional electron layers with mutually correlated disorder potentials is studied theoretically. Due to this correlation, the diffuse eigensates in different layers are almost orthogonal to each other. As a result, a peak in the tunnel f-V' characteristics shifts towards small bias, V'. If the correlation in disorder potentials is complete, the peak position and width are governed by the spin-orbit coupling in the layers; this coupling lifts the orthogonality of the eigensates. Possibility to use inter-layer tunneling for experimental determination of weak intrinsic spin-orbit splitting of the Fermi surface is discussed.

4:00PM E3.00006 The Lennard-Jones oscillator in quantum Hamilton-Jacobi theory , M.K. BALASUBRAMANYA, Texas A&M University-Corpus Christi, M.W. ROTH, University of Northern Iowa — We present a new scheme for calculating the energy eigenvalues of an oscillator modeled using the Lennard-Jones (12,6) potential for the zero angular momentum case. The eigenvalues so obtained are compared with those calculated numerically.

4:15PM E3.00007 Spectroscopic measurements of Ba+ , JOSEPH PIRTEL, RYAN BOWLER, SANGHOON CHONG, Undergrad, MATT DIETRICH, GARY HOWELL, ADAM KLECEWSKI, NATHAN KURZ, Grad, VIKI MIRGON, PHIL NELSEN, JOANNA SALAKA, Undergrad, GANG SHU, TIAN WANG, Grad, BORIS BLINOV, PI — Our goal is to measure the atomic structure of Ba^+ to a new degree of accuracy. We confine and laser-cool a single barium ion in an RF quadrupole. We intend on measuring the branching ratios for the 6P_{1/2} -> 5D_{3/2}, and the 6P_{3/2} -> 5D_{3/2} decays in Ba^+. The measurement is achieved by first exiting the ion to the 6P_{3/2} state with a short duration of a 455 nm shelving laser. We then allow the ion to decay, which will result in one of three states: 5D_{3/2}, 5D_{3/2}, and 6S_{1/2}. Next we use a 650 nm laser to re-pump the ion out of the 5D_{3/2} into the 6P_{1/2} and another 493nm to transition from 6S_{1/2} to 6P_{1/2}. If the ion fluoresces in this 6S_{1/2} - 6P_{1/2} - 5D_{3/2} cycle then we know the original decay out of 6P_{3/2} was into either 5D_{3/2} or 6S_{1/2}. By incrementally increasing the duration of the 455 nm excitation the probability of decay into the 6S_{1/2} is exponentially decreased. With enough data points we can extrapolate the saturation between the probabilities of fluorescent and non-fluorescent cycles. The branching ratio between the decays into the 5D_{3/2} and 5D_{3/2} states is the ratio of these probabilities in this limit. Our future experiments include the precision RF spectroscopy of the 5D_{3/2} state in ^137Ba and the measurement of the 65S_{1/2} state lifetime.

Saturday, May 19, 2007 2:00PM - 4:06PM –
Session E4: Astronomy, Cosmology, Gravity PSUB South Fork Room

2:00PM E4.00001 LISA: Our infrasonic ear to the universe , SUKANTA BOSE, Washington State University — The Laser Interferometer Space Antenna (LISA) is a space mission proposed by NASA and ESA for detecting gravitational-wave signals in the sub-milli-hertz to deci-hertz band. LISA will observe a myriad of sources, from galactic compact binaries in our galaxy to supermassive black hole mergers at cosmological distances. In the process, it will map the distribution of the galactic binary population, perform tests of strong gravity, and provide an independent estimate of the Hubble constant. In addition to discussing how LISA will achieve these goals, I will address the primary challenges facing LISA phenomenology, such as (1) the problem of detecting signals from individual sources while battling the source confusion noise from thousands of galactic binaries and (2) modeling the evolution of extreme mass-ratio binary inspirals. I will conclude by discussing the unique role LISA will play in complementing other observatories of the time in pursuit of some interesting astrophysical discoveries.
Solar dynamo modeling and prediction. MAUSUMI DIKPATI, HAO/NCAR — Global-scale solar dynamo models have evolved significantly over the past half century. The model that can most successfully reproduce many global solar cycle features is the so-called ‘flux-transport’ dynamos. Along with the differential rotation (Omega-effect) and helical turbulence (alpha-effect), another important ingredient in this class of models is the meridional circulation, which works as a conveyor belt and governs the dynamo cycle period as well as the memory of the Sun’s past magnetic fields. After describing the physical processes involved in a flux-transport dynamo, we will show how a predictive tool can be built from it that can be used to predict mean solar cycle features by assimilating magnetic field data from previous cycles. We will present our timing and amplitude predictions for upcoming cycle 24. We will close by discussing the sensitivity of our model in predicting N/S asymmetry in solar cycles.

This work is partially supported by NASA grants NNH05AB521 and NNH06AD51I, and NCAR director’s opportunity fund. The National Center for Atmospheric Research is sponsored by the National Science Foundation.

Pulsar Kicks from Electrons in a Large Magnetic Field. ERNEST HENLEY, Univ. of Washington, M.B. JOHNSON COLLABORATION, L.S. KISSLING COLLABORATION — We derive the momentum asymmetry given to a proto-neutron star during a time (10-20 s) that the neutrino sphere is near the surface of the star, using the modified Urca process. The electrons are in Landau levels due to the strong magnetic field, and this leads to an asymmetry in the neutrino momentum and thus to a pulsar kick. Our kicks reach 1000 km/s for a $T = 8.5 \times 10^{10} K$.


Laboratory Detection of Cold Dark Matter as Sidereal Dilaton Scattering Data. GEORGE SOLI, Integrated Detector Systems — An experiment designed to prove that the one-way group-velocity of slow-photons does not exist, produces a surprising positive result. The one-way velocity is larger than simple Newtonian velocity addition of the photon’s velocity and Earth’s velocity relative to the CMB, indicating that the photons must be interacting with something at rest relative to the CMB. That something turns out to be CDM that is the dilaton or Goldstone boson of scale-invariance symmetry-breaking, that is at rest relative to the CMB with a mass greater than our photon’s vacuum excitation energy of $3.3 \mu$eV. This non-classical scattering interaction with dilatonic CDM is mediated by the magnetic fine structure constant (137) discovered as a Morse function critical point in the higher dimensional anti de Sitter space used to model the scattering interaction. The vacuum excitation energy saturates the Ford-Roman quantum inequality implying that the Goldstone boson is also negative pressure dark energy, solving the dark matter-energy coincidence problem. This CDM also solves many other cosmological problems. It has already been argued in the literature that Einstein thought of our measured slow-photon magnetic flux tubes first.