2012 Annual Meeting of the California-Nevada Section of the APS
San Luis Obispo, California
http://www.aps.org/meetings/meeting.cfm?name=CAL12
Friday, November 2, 2012 10:00AM - 11:45AM –
Session A1 Plenary Session I Chumash Auditorium 065-0 - Chair: Sergey Savrasov, University of California, Davis

10:00AM A1.00001 Welcome LYNN COMINSKY, Sonoma State University, Chair of APS-CAL section, NILGUN SUNGAR, California Polytechnic State University, San Luis Obispo, Chair of the Physics Department –

10:15AM A1.00002 The sometimes surprising behavior of magnetic spins on a complex surface, BARBARA JONES, IBM Almaden Research Center — We have studied the unusual charge and spin properties of magnetic atoms (Mn, Co, Fe, Ti, Gd) on a complex surface as constructed by STM. This surface, a lattice of N atoms on Cu(100), was designed to be insulating in order to inhibit the Kondo effect (in which the Cu electrons would completely screen the spin). However, the magnetic adatom may be drawn down into the surface, or stay high above and attract surface atoms to it, with very different resulting properties. We show illustrations from our electronic structure calculations of these systems. The various magnetic atoms exhibit behavior ranging from spin chains to large-anisotropy atomic-scale molecular magnets to a Kondo effect for Co and Ti. Finally, when two magnetic atoms are close to one another, their magnetic spins can interact, with complex and interesting results. We show the unexpected results of a close-spaced 2D lattice of magnetic atoms as well. I will conclude with some comments about the role of large-scale calculations for nanostructures. Some references:

11:00AM A1.00003 Quantum Matters, CHETAN NAYAK, UCSB and Microsoft Station Q — Physicists have discovered states of matter where there are particles with properties not possessed by any particles seen in the vacuum. These particles are collective excitations of the electrons in these materials. Their exotic properties are a consequence of quantum mechanics and have no analog in the familiar classical world. They can be manifested when, for instance, a particle simultaneously takes two different paths from point A to point B and they interfere. Remarkably, these particles might be harnessed for a quantum computer, a hypothetical computer that could solve problems far beyond the reach of today’s computers.

Friday, November 2, 2012 11:45AM - 12:45PM –
Session B1 Business Meeting Chumash Auditorium 065-0

11:45AM B1.00001 Business Meeting –

Friday, November 2, 2012 2:00PM - 3:24PM –
Session C1 Education, Energy, and Medical Physics Business 003 0205 - Chair: Kenneth Ganezer, CSU Dominguez Hills

2:00PM C1.00001 STAR: Preparing future science and math teachers through authentic research experiences at national laboratories1. JOHN KELLER, BRYAN REBAR, Cal Poly San Luis Obispo — The STEM Teacher and Researcher (STAR) Program provides 9-week paid summer research experiences at national research laboratories for future science and math teachers. The program, run by the Cal Poly Center for Excellence in Science and Mathematics Education (CESaME) on behalf of the entire California State University (CSU) System, has arranged 290 research internships for 230 STEM undergraduates and credential candidates from 43 campuses over the past 6 years. The program has partnered with seven Department of Energy labs, four NASA centers, three NOAA facilities, and the National Optical Astronomy Observatory (NOAO). Primary components of the summer experience include a) conducting research with a mentor or mentor team, b) participating in weekly 2-3 hour workshops focused on translating lessons learned from summer research into classroom practice, and c) presenting a research poster or oral presentation and providing a lesson plan linked to the summer research experience. The central premise behind the STAR Program is that future science and math teachers can more effectively prepare the next generation of science, math, and engineering students if they themselves have authentic experiences as researchers.

1This material is based upon work supported by the S.D. Bechtel, Jr. Foundation, the National Marine Sanctuary Foundation, and the National Science Foundation (DUE 0952013)

2:12PM C1.00002 Improving the Efficiency of Homologous Gene Replacement by Disrupting the NHEJ Pathway for Gene KusA in the Oleaginous Fungus Mortierella alpina1. KATHLEEN KRUEGER, Cal Poly State University SLO, ZIYU DAI, Pacific Northwest National Laboratory, UGER UZUNER, Texas A&M, PNLL COLLABORATION — Mortierella alpina, a oleaginous filamentous fungus, is one of industrial fungal strains known for the production of arachidonic acid. It is also of particular interest for hydrocarbon biofuel production since it is able to produce up to 50% of its mass in rich, long-chain polyunsaturated fatty acids [PUFA’s]. In addition to high fatty acid production, M. alpina like many other oleaginous fungi, already have mechanisms for accumulating significant concentrations of hydrophobic compounds making it a naturally equipped candidate to handle potential toxic concentrations of hydrocarbons. The goal of this study was to develop an efficient transformation method for this strain, hence allowing researchers to further manipulate these fungi for further improvement of lipid production. Included was optimization of best culture medium for growth and maintenance, optimal conditions for protoplast generation, and replacement of the homologous KusA gene. A successful deletion of KusA gene within biotechnologically important M. alpina could enable homologous recombination of other genes of interest in a higher frequency. This capacity may also improve the production of microbial oils for bioenergy and arachidonic acid human health applications.

1Thanks to Cesame/Star for support and funding.
2:24PM C1.00003 The Implementation of the Shear Correlation Function and the Matter Power Spectrum in R\(^1\), ALLISON SCHEPPELMANN, California Polytechnic State University, San Luis Obispo, DEBORAH BARD, SLAC National Accelerator Laboratory — Weak gravitational lensing is an important tool in understanding the large-scale structure of the universe. One component in understanding the effect of weak gravitational lensing is the shear correlation function and matter power spectrum. The calculation of these values is often complicated and time consuming. In order to decrease the cost of these calculations the implementation uses parallel computing in the language R. This results in the calculations completing faster and a process that is easily changed in order to fit the need of each researcher using the algorithms created in R.

\(^1\)Made Possible by the CESaME STAR Program. Funding provided by the S.D. Bechtel, Jr. Foundation and by the National Science Foundation under Grant No. 0952013.

2:36PM C1.00004 Small Satellites for Secondary Students\(^1\), KEVIN ZACK, LYNN COMINSKY, NASA E/PO SSU — Small Satellites for Secondary Students is a program funded by a three-year grant from NASA to bridge the gap in STEM education for secondary-school students. This is accomplished by creating the educational resources that are needed to support the development of a small scientific payload in alignment with scientific and technological education standards. The prototype payloads are flexible multi-experiment platforms designed to accommodate a wide range of student abilities with minimal resource requirements. The heart of each payload is an Arduino microcontroller which communicates with components that provide sensor data, Global Positioning System information, and which offer on-board data storage. The payload is built with off-the-shelf components and a pre-etched, custom-designed connector board. The platform also supports real-time telemetry updates through the use of Wi-Fi. To date, the prototype payloads have been tested on both high-powered rockets reaching over 3km and weather balloons tethered at 300m. Multiple successful rocket test runs reaching 1km have been conducted in partnership with amateur rocket clubs including the Association of Experimental Rocketry of the Pacific. From these flights, we are continuing to improve the payload design in order to increase the likelihood of student success.

\(^1\)This work has been supported by NASA Grant NNX12AB97G.

2:48PM C1.00005 Solar Concentration for Electricity and Cooking, MIKE KIM, CONNOR FOURT, PETE SCHWARTZ, MICHAEL LEE, TAYLOR FROSTHOLM, JOSH FERNANDES, JARED TOWER, Cal Poly San Luis Obispo — Over 8000 Schefflers exist worldwide, mostly in Africa and Asia. Having constructed the first Scheffler reflector in North America 2 years ago, the next goal was to make it less expensive. The original model took 4 students 2 months and about $1000. In order to lower the cost and construction time the design was minimized, less expensive materials were used, and the construction process was automated. The original complex frame took 1000 people-hours and it was minimized to a day. Instead of using aluminum for the reflective dish, we turned to using aluminized Mylar, which cut the cost by over 90%. A thermal storage unit was added to extend cooking time well into the evening. Finally, a concentrated solar module of High Efficiency Photo Voltaics (HEPV) is to be placed at the focus of the concentrator to generate electricity and water as a byproduct. The final cost is estimated to be about $200 ($0.10 per thermal watt) including the HEPV, an 80% cost reduction. Such technology is practical in the U.S. as well as developing nations.

3:00PM C1.00006 A Characterization of Pleistocene Climate as Revealed by Empirical Mode Decomposition, MATTHEW RODRIGUES, CHARLES CAMP, California Polytechnic State University San Luis Obispo, PAMELA MARTIN, Indiana University — Purdue University Indianapolis, ALEX GERBER, California Polytechnic State University San Luis Obispo — A consensus as to the characterization of the Pleistocene’s climate with respect to Milankovich theory (the forcing of climate by orbital dynamics) has remained elusive. In part, this is due to the shortcomings of classical techniques such as Fourier analysis in the study of nonlinear, nonstationary data. Confounding this problem, the age-depth relationship used to produce reconstructed time series of proxy data for past climate derived from ocean sediments often are “tuned” by assuming that the records have some component of climate change associated to one of the orbital parameters. Recently, a new time-series of proxy data for the waxing and waning of the ice ages has been constructed devoid of orbital assumptions—thereby allowing for clearer testing of the validity of Milankovich theory and related hypothesis for the timing and amplitude of the Pleistocene ice ages. We analyze this newly constructed record using a relatively new data-adaptive technique known as empirical mode decomposition (EMD), which is well suited for the study of nonlinear and nonstationary time data. Our EMD analysis clearly isolates the various components of this complicated time series and provides new insight into the behavior of the climate during the Pleistocene.

3:12PM C1.00007 Designing high specificity anti-cancer nanocarriers by exploiting non-equilibrium effects, KONSTANTINOS TSEKOURAS, Cal Poly, IGOR GONCHARENKO, New Economic School, MICHAEL COLVIN, UC Merced, KERWYN HUANG, Stanford University, AJAY GOPINATHAN, UC Merced — Although targeting of cancer cells using drug-delivering nanocarriers holds promise for improving therapeutic agent specificity, the strategy of maximizing ligand affinity for receptors overexpressed on cancer cells is suboptimal. To determine design principles that maximize nanocarrier specificity for cancer cells, we studied a generalized kinetics-based theoretical model of nanocarriers with one or more ligands that specifically bind these overexpressed receptors. We show that kinetics inherent to the system play an important role in determining specificity and can in fact be exploited to attain orders of magnitude improvement in specificity. In contrast to the current trend of therapeutic design, we show that these specificity increases can generally be achieved by a combination of low rates of endocytosis and nanocarriers with multiple low-affinity ligands. These results are broadly robust across endocytosis mechanisms and drug-delivery protocols, suggesting the need for a paradigm shift in receptor-targeted drug-delivery design.

Friday, November 2, 2012 2:00PM - 3:36PM – Session C2 Condensed Matter I: Phase Changes and Liquid Crystals — Business 003 0112 -
Chair: Sergey Savrasov, University of California, Davis

2:00PM C2.00001 Analysis of an Unusual Liquid Crystal Phase Transition, LONI FULLER, JOSH FANKHAUSER, California Polytechnic State University, SLO student, JONATHAN FERNSLER, California Polytechnic State University, SLO professor — Liquid crystals are a unique phase of matter that resemble a state between a solid and liquid. Within these properties, liquid crystal molecules have the ability to align and create layers. From this phenomenon, many electro-optical effects can be investigated. Among these effects, analyzing the tilt angle between molecules at different temperatures and applied electric fields and also measuring the birefringence is a unique property of liquid crystals in which the index of refraction of the sample behaves differently along different axes. In order to better understand these electro-optical effects, we designed a more precise protocol of measuring this data. This procedure includes manipulating polarizing filters and measuring the effective light intensities with a camera attached to the microscope. From this, we can more successfully analyze the electroclinic effects of liquid crystal displays. For instance, we analyzed the phase transition of two unusual “de Vries” smectic liquid crystals. The phase transition for both materials was consistent with mean field theory near a tricritical phase transition.
2:12PM C2.00002 Field Control of the Surface Electroclinic Effect in Liquid Crystal Displays I

DANA HIPOLITE, KARA ZAPPITELLI, KARL SAUNDERS, California Polytechnic State University, San Luis Obispo — Liquid crystals (LCs) are a fascinating class of materials exhibiting a range of phases intermediate between liquid and crystalline. Smectic LCs consist of elongated molecules arranged in a periodic stack (along z) of liquid layers. In the smectic-A (Sm-A) phase, the average molecular long axis (director) points along z. In the smectic-C (Sm-C) phase, it is tilted relative to z, thus picking out a special direction within the layers. Typically, the Sm-A* to Sm-C* transition will occur as temperature is decreased. In chiral smectics (Sm-A* or Sm-C*) it is possible to induce director tilting (i.e., the Sm-C* phase) from the Sm-A* phase via the application of an electric field. This is known as the “bulk electroclinic effect” (BEC). Often, e.g., in a LCD, the Sm-A* phase is in contact with a surface. The surface acts as a localized electric field, and induces a local tilt, i.e., a local Sm-C* phase. This “surface electroclinic effect” (SECE) leads to a distortion of the smectic layers, which reduces LCD quality. We present a model of the Sm-A*-Sm-C* transition, including both BEC and SECE. Analysis of this model shows that the SECE can be controlled, and even eliminated, by a bulk electric field.

Funding provided by the National Science Foundation, Division of Materials Research-1005834

2:24PM C2.00003 Field Control of the Surface Electroclinic Effect in Liquid Crystal Displays II

KARA ZAPPITELLI, DANA HIPOLITE, KARL SAUNDERS, Cal Poly- San Luis Obispo — As previously introduced in the presentation by Dana Hipolite, chiral, smectic liquid crystal molecules aligned in layers can be controlled by the application of an electric field, which has a variety of implications for the quality of LCD displays. Both the bulk electroclinic effect (BEC) and surface electroclinic effect (SECE) impact the angle at which the molecules tilt with respect to the director in different areas of the cell. Certain LC’s exhibit a continuous Sm-A* to Sm-C* transition, where the angle of the surface and bulk molecules change continually with the electric field. Other LC’s exhibit first order transitions where the molecules are aligned at different values of the applied electric field for the bulk and surface molecules respectively. The difference in angle of the bulk and surface molecules in both of these situations causes discrepancies in the layer spacing within the LC cell. These discrepancies lead to frustrations within the cell, which can be quantified by the strain (?). These frustrations can be relieved in multiple ways, however the method of relief may lead to negative impacts on the alignment quality of the display itself.

National Science Foundation, Division of Materials Research-1005834

2:36PM C2.00004 Ordering Quantum Dot Clusters via Nematic Liquid Crystal Defects

ANDREA RODARTE, R. PANDOLFI, L.S. HIRST, S. GHOSH, University of California Merced — Nematic liquid crystal (LC) materials can be used to create ordered clusters of CdSe/ZnS core/shell quantum dots (QDs) from a homogeneous isotropic dispersion. At the phase transition, the ordered domains of nematic LC expel the majority of dispersed QDs into the isotropic domains. The final LC phase produces a series of QC clusters that are situated at the defect points of the liquid crystal texture. Lower concentrations of QDs are organized in a network throughout the LC matrix that originates from the LC phase transition. Inside the QD clusters the inter-particle distance enables efficient energy transfer from high energy dots to lower energy dots. Because the QD clusters form at defect sites, the location of the clusters can be preselected by seeding the LC cell with defect nucleation points.

Support from NSF, UC MERI and UC MEXUS.

2:48PM C2.00005 New experimental techniques to measure the electroclinic effect in smectic liquid crystals

JOSHUA FANKHAUSER, LONI FULLER, Student Researcher, JONATHAN FERNSLER, Advisor — Liquid crystals have very unique properties that allow them to alter light in ways that many materials cannot. The smectic liquid crystal phases are fluid, layered arrangements of molecules. We are using a technique to measure both the tilt of molecules away from the direction normal to the layer plane and birefringence as a function of temperature as well as electric field. This is done by projecting light through two polarizers and observing the effect that the sample has on the polarization of the light. The system used to gather data for the sample is a newly automated Matlab program along with a standard temperature logging program. The Matlab program was developed this year to gather accurate intensity readings at a rapid rate and export them for further analyzing. The program is also interfaced with a Labjack so that we will be able to observe and collect data on the unusually large electroclinic effect, the coupling between molecular tilt and applied electric field, in our deVries liquid crystals.

3:00PM C2.00006 Dielectric Spectroscopy in Liquid Crystals:

ZACHARY SAILER, CROSBY SPERLING, Student - Cal Poly State University San Luis Obispo, JONATHAN FERNSLER, Professor - Cal Poly State University San Luis Obispo — We use the technique of dielectric spectroscopy (or impedance spectroscopy) to measure the frequency response of common electronic elements and liquid crystal samples. Using the HP 4192A LF impedance analyzer, an alternating electric field is applied across the sample while the impedance is measured. Applying these fields over a range of frequencies allows us to observe the resonant frequency at which a circuit resists or responds to the field. In a liquid crystal sample, this peak describes the frequency at which the molecules are susceptible to rotating around their tilt cone in the Smectic A and Smectic C phases. This technique also allows us to measure other dielectric properties such as the real and imaginary components of the impedance and the phase angle at which the impedance is projected into the imaginary plane.

3:12PM C2.00007 X-ray scattering measurements of ionization in shock-compressed deuterium

PAUL DAVIS, University of California, Berkeley — The physical properties of hydrogen at extreme conditions play an important role in our understanding of high-pressure phase transitions, the structure of giant planets and the dynamics of inertial fusion. We report the first microscopic measurements of ionization in dynamically compressed hydrogen. Cryogenic targets were shock-compressed to several times liquid density using a high power laser. An intense burst of 2 keV x-rays was generated using a second laser pulse, probing the dense shock-front. By collecting and spectrally dispersing scattered radiation in both forward and backward directions, we measured collective plasmon oscillations and the Fermi distribution of the electrons freed in the compression process. Combined with velocity interferometry to diagnose shock velocity, we infer a sharp onset of ionization at 3 times compression. These results offer an important new basis for comparison with the many competing theories of high-pressure hydrogen. In particular, comparison with finite temperature quantum molecular dynamics simulations suggests a close relationship between ionization and molecular dissociation.
Localized surface plasmon resonance (LSPR) from gold nanoparticles (AuNPs) has on the director of the nematic liquid crystal 4-Cyano-4'-pentylbiphenyl (5CB). The presence of LSPR of the AuNPs was confirmed using metal enhanced fluorescence of a red dye. Using two light sources, a white light with crossed polarizers to observe the birefringence of the liquid crystal and a 510-550nm light to excite the LSPR, we observe re-orientation of the director of aligned liquid crystal molecules when the AuNPs are excited with light matching the LSPR absorption band. This response is observed to be temperature dependent and only seen to occur within 1 degree Celsius of the phase transition from nematic to isotropic phase.

Friday, November 2, 2012 2:00PM - 3:36PM

Session C3 High Energy and Accelerator Physics
Business 003 0209 - Chair: Nan Pinney, SLAC National Accelerator Laboratory

2:00PM C3.00001 New Simulations of ATLAS Data for the 8TeV Upgrade, ARYA AFSHARI, California State University Fresno — The recent Large Hadron Collider (LHC) beam upgrade in center-of-mass energy from s = 7TeV to s = 8TeV required upgrades to the existing event generators for simulation of data. Data simulation using known theory is compared to processed data from the ATLAS detector in order to ensure the calibration of the detector. The upgrade in the Pythia6 to Pythia8 event generator was validated, as well as the various parton distribution functions (PDF's) CT10, MRST, and MSTW. A Monte Carlo (MC) simulation for the excited boson W* was created at various resonant energies using Pythia6 with the CT10 PDF and one for each PDF in Pythia8. Various dijet parameters were compared within the PDF's as well as the Fchi variable against the QCD background. Also, two different methods were employed in finding the mass of the excited boson W*. This work is from the authors' summer 2012 research at CERN.

2:12PM C3.00002 Improved cross section calculations in ATLAS simulation packages, APPLgrid and NLOjet, NAVID RAD, California State University Fresno — ATLAS experiment at the Large Hadron Collider (LHC) of CERN is designed to make new discoveries in particle physics. Some of the possible discoveries, in addition to the promising observation of a new particle with Higgs-like properties, include supersymmetry (SUPSY), extra spatial dimensions, and a whole zoo of exotic particles. Looking for these new possibilities can be extremely CPU-intensive and time consuming and therefore it is essential for the data analysis and simulations to be done as efficiently as possible. In order to analyze the data one would like to vary the different parameters such as the Parton Distribution Functions (PDF's). However, currently, the most common tools for calculating cross sections are Monte Carlo event generators such as Pythia which make data analysis very time consuming due to the fact that the entire calculation has to be repeated for every time the parameters are varied. The purpose of this research project is to utilize and develop additional software tools in order to decrease the time and computing power required for cross section calculations done at ATLAS. The APPLgrid software package allows for quick calculations with any PDF in less than a second whereas the same calculation could take Pythia a few hours. The results that will be shown in this talk are sample calculations done by NLOjet and APPLgrid in comparison with Pythia for QCD and a Contact Interaction Model. This research project was done by the author at CERN and DESY during the summers of 2011 and 2012 and the progress has been presented thrice to the ATLAS jet Cross Section Group.

2:24PM C3.00003 Experimental Analysis of Gaseous Chambers for the ATLAS Muon sub-detector Upgrade R&D, EMMANUEL ANGULO, CSU Fresno — CERN, the world’s largest particle accelerator facility, has begun its ambitious Large Hadron Collider (LHC) program which is and will remain as the world energy frontier until at least 2030. ATLAS, one of the LHC experiments, has been taking data for two years. ATLAS has been investigating the necessary changes to its sub-detectors to withstand much higher instantaneous luminosity and to operate after 3000 fb⁻¹ of integrated data. The goal is to achieve the same or better performance (spatial resolution, etc.) despite the large increase in event rate and final integrated dose. The current ATLAS Muon sub-detector will not be able to handle the increased luminosity of a factor of ten. This makes it necessary to replace the current muon sub-detector by possible new gaseous chambers that push their performance to limits never tested before. This talk will focus on the different lab experiments performed at CERN during the summers of 2011 and 2012, including functional and uniformity results of a new “T-series” chamber design developed by the ATLAS Muon detector upgrade R&D team. As a result, a new visual mapping design was developed by the author that enabled an easier way to find anomalies in the chambers. This work has been presented to ATLAS Weekly Micromegas Meeting’s 6 times during the summers of 2011 and 2012.

2:36PM C3.00004 Simulating the Response of the High-Intensity Luminosity Monitor at the LHC, SAMUEL HEDGES¹, HOWARD MATIS, ALESSANDRO RATTI, MASSIMO PLACIDI, WILLIAM TURNER, LBNL, LARP COLLABORATION, NERSC COLLABORATION — To achieve the recent discovery of a Higgs-like object at the LHC, the machine operators needed detectors to optimize the number of collisions in the machine. One of these detectors is called the Beam Rate of Neutrals (BRAN). The BRAN is a gas ionization chamber detector developed at LBNL and used to measure relative luminosity of collisions on both sides of the ATLAS and CMS interaction regions. We have used the Monte Carlo simulation software FLUKA to simulate the detector’s response to p-p, p-Pb, and Pb-Pb collisions at both current and future colliding conditions. In this talk, we will describe the detector and the results from the simulations. The simulations can be used to explain differences between the energy deposited in the BRAN at ATLAS and CMS. We will compare these measurements with data taken with the detector.

¹Current graduate student at CSU Long Beach

2:48PM C3.00005 Solar Neutrino Measurements in Super-Kamiokande-IV, ANDREW RENSHAW, University of California, Irvine, SUPER-KAMIOKANDE COLLABORATION — Super-Kamiokande-IV begins taking data in September of 2008, and with upgraded electronics and many improvements to water system dynamics, calibration, and analysis techniques the solar neutrino energy threshold was pushed down to 3.5MeV (recoil electron energy). The observed recoil electron spectrum flavors a flat suppression over distortions predicted by standard neutrino flavor oscillation parameters by 1.1 to 1.9. Using a maximum likelihood fit of the amplitude of the expected zenith variation, the observed day/night asymmetry of -2.8±1.1(stat)+0.5(syst)% is consistent with zero at the 2.3σ level. This significance is increase to 2.9σ when combined with SNO’s day/night measurement, giving a slight hint for the regeneration of electron type solar neutrinos as they travel through Earth’s matter.
3:00PM C3.00006 Recent results from Super-Kamiokande on searches for baryon number violation and on neutrino oscillations, neutrino astrophysics and plans for the future of Super-Kamiokande including Hyper-K. DYLAN NICHOLAS, California State University, Dominguez Hills — In this talk we will describe results obtained during the last two years at Super-Kamiokande on searches for Baryon Number violation including nucleon decay and neutron oscillations as well as studies of neutrino oscillations including the mixing parameters and neutrino astrophysics. We will also discuss future plans for Super-Kamiokande including Hyper-K.

3:12PM C3.00007 The planned search for free neutron-antineutron transformation using the mbarX experiment at Fermilab and how it relates to bound neutron oscillations at Super-Kamiokande and elsewhere. OMAR MORENO, Santa Cruz Institute for Particle Physics, HEAVY PHOTON SEARCH COLLABORATION — The Heavy Photon Search (HPS) is a new experiment at Jefferson Lab (JLab), which will search for massive vector gauge bosons in the mass range of 20-1000 MeV/c^2. These dark photons are expected on very general theoretical grounds and are motivated by recent astrophysical evidence suggesting that they may mediate dark matter annihilation and/or interactions with ordinary matter. The dark photon couples to the ordinary photon through kinetic mixing which induces their weak coupling to electrons. This allows for dark photon production through a process analogous to bremsstrahlung radiation. If the coupling is small enough, then the dark photons will travel detectable distances before decaying, providing a second signature. Using JLab’s high luminosity electron beam along with a compact large acceptance forward spectrometer, silicon vertex tracker, PbWO_4 electromagnetic calorimeter and a muon detector, HPS will explore a large domain in the mass/coupling plane with extraordinary sensitivity. In this talk, I will discuss the status of the HPS experiment.

Friday, November 2, 2012 4:12PM - 5:48PM — Session D1 Gravitation and Quantum Mechanics Business 003 0205 - Chair: Andreas Bill, California State University, Long Beach

4:12PM D1.00001 Rapid Bayesian Triangulation of Gravitational Wave Inspirals for Advanced LIGO. LEO SINGER, LARRY PRICE, LIGO Laboratory, California Institute of Technology — Potential electromagnetic counterparts of compact binary mergers detectable by ground-based gravitational wave detectors fade rapidly. In the last joint LIGO–Virgo science run, a coincidence-based triangulation code produced sky maps for rapid telescope pointing. We are improving upon it with a more accurate Bayesian sky localization algorithm that takes as input the matched-filter amplitude and time-of-arrival. We review the parameter estimation accuracy of matched filters, comparing the often-used Cramér-Rao bound with the tighter, but less well known, Barankin bound. We then describe our new sky localization algorithm and its performance.

4:24PM D1.00002 Comparing Numerical Relativity and Black Hole Perturbation Waveforms for Intermediate Mass Ratio Black Hole Binaries. DEREK NELSON, Cal Poly, San Luis Obispo, STEVE DRASCO, Grinnell College — Advanced gravitational-wave observatories with broadened frequency windows will soon be online. Intermediate Mass Ratio Inspirals are source candidates in the newly exposed low frequencies. These are a class of compact binary coalescences containing stellar-mass compact objects and black holes with masses on the order of hundreds to perhaps thousands of solar masses. Waves from these systems must be accurately and efficiently modeled in order to enable observations. A possible substitute for the current waveform model that assumes slow motion are waveforms calculated with a perturbative technique based on the mass ratio, a more stable small parameter. We implement an inexpensive version of this model and compare the corresponding waveforms with impractically expensive waveforms from full Numerical Relativity simulations. I discuss the somewhat surprising success of the comparisons for systems with simple motion and nearly equal-mass binaries. I will also discuss similar comparisons currently underway for more complex motion and mass distributions.

4:36PM D1.00003 Aspects of General Relativity in 1+1 Dimensions. RICHARD MELLINGER, SCOTT FRASER, THOMAS GUTIERREZ, Cal Poly San Luis Obispo — What would be the properties of a universe with only one spatial dimension and one time dimension? General relativity in 1+1 dimensions is unique since the two curvature terms in the Einstein field equations cancel. This makes the Einstein field equations algebraic rather than differential equations. This special feature can make 1+1 dimensionality attractive as an instructional tool to simplify the mathematics that many beginners find opaque. We explore the implications and features of the Einstein field equations in 1+1 dimensions and find they provide a surprisingly rich and interesting model.

4:48PM D1.00004 Binding of Small Black Holes to a Brane in Asymptotically Randall-Sundrum Spacetimes. SCOTT FRASER, Cal Poly San Luis Obispo, DOUGLAS EARLDLEY, Kavli Institute for Theoretical Physics, UC Santa Barbara — General relativity in five spacetime dimensions can be used to model our universe as a surface (brane) in an extra-dimensional bulk space. We study the binding of small black holes to a brane with positive brane tension and a mirror (orbifold) symmetry, in asymptotically Randall-Sundrum spacetimes. We find that a small black hole that is on the brane has a substantial gravitational binding energy, hence it is stable against escaping from the brane into the bulk. We also find that a new kind of static black hole can exist at a certain location in the bulk; this new black hole is unstable to falling either towards or away from the brane. These results are obtained from a variational principle based on a version of the first law of black hole mechanics.

This research was partially funded by the College of Science and Mathematics, Cal Poly San Luis Obispo.
5:00PM D1.00005 Precision Optical Systems for Short-range Tests of Gravity

HOLLY LEOPARDI, Humboldt State University — Due to the incompatibility of the Standard Model and General Relativity (GR), tests of gravity remain at the forefront of experimental physics. At Humboldt State University, undergraduates and faculty are developing an experiment that will test gravitational interactions below the 50-micron distance scale. The experiment will measure the twist of a torsion pendulum as an attractor mass is oscillated nearby in a parallel-plate configuration, providing a time varying torque on the pendulum. The size and distance dependence of the torque variation will provide means to determine deviations from accepted models of gravity on untested distance scales. To observe the twist of the pendulum inside the vacuum chamber, an optical system with nano-radian precision is required. This talk will focus on the improvements made to the optical system such that it is expected to achieve the required sensitivity, as well as recent data taken with the updated optical system. A future improved optical system under development that will implement a small-angle interferometer to measure the twist of the pendulum will also be presented.

1Supported by NSF grant PHY-1065697
2Undergraduate
3Undergraduate

5:12PM D1.00006 Tests of Gravity Below the 50-micron Distance Scale

C.D. HOYLE, HUMBERTO LEOPARDI, Humboldt State University — Though it is the oldest recognized of the fundamental forces, tests of gravity remain at the forefront of experimental physics research. Due to the incompatibility of the Standard Model and General Relativity, there is no accepted Unified Field Theory, though some attempts to construct such a model via String Theory predict more than three spatial dimensions that could alter the gravitational Inverse-Square Law at short distances. Certain scenarios also predict unobserved subatomic particles that may cause short-range violations of the Weak Equivalence Principle. The Gravitational Research Laboratory at Humboldt State University, a collaboration of undergraduate students and faculty, is developing an experiment that will test gravitational interactions below the 50-micron distance scale. The experiment will measure the torque applied to a torsion pendulum as an attractor mass is oscillated nearby. The size and distance dependence of the torque variation will provide means to determine any deviations from Newtonian gravity at heretofore untested distance scales. The major components of the experiment have been designed and fabricated including a novel stepped parallel-plate torsion pendulum and a high-precision optical angle detection system. This talk will provide a general overview of the experiment and focus primarily on current status and expected outcomes.

1Supported by NSF grant PHY-1065697
2Undergraduate
3Undergraduate

5:24PM D1.00007 Foucault’s Pendulum, Analog for an Electron Spin State

REBECCA LINCK, University of San Jose State University — The classical Lagrangian that describes the coupled oscillations of Foucault’s pendulum presents an interesting analog to an electron’s spin state in an external magnetic field. With a simple modification, this classical Lagrangian yields equations of motion that directly map onto the Schrodinger-Pauli Equation. This analog goes well beyond the geometric phase, reproducing a broad range of behavior from Zeeman-like frequency splitting to precession of the spin state. By demonstrating that unmeasured spin states can be fully described in classical terms, this research opens the door to using the tools of classical physics to examine an inherently quantum phenomenon.

5:36PM D1.00008 A Metric on the Space of Quantum Fields

MICHAEL MAROUN, University of California, Riverside — Over the past 60 years, there have been many attempts at giving a precise mathematical definition of a quantum field. A space of quantum fields is proposed as the space of operator-valued generalized functions and arguments are given justifying the need for such general objects. A metric is then constructed on this space in such a way that it is dynamically defined through the Hamiltonian. This then allows one to keep track of differences between ideal states in interacting theories by comparing them to the corresponding ideal states in asymptotically free theories. For simplicity, an emphasis is placed on scalar $\phi^4$ theory. The metric then allows one to construct geometric and topological attributes in order to find differences that characterize changes between asymptotically free theories to that of interacting ones.

Friday, November 2, 2012 4:12PM - 6:00PM
Session D2 Condensed Matter II: Nanotechnology and Materials
Business 003 0112 - Chair: Ben Wang, Svaya Nanotechnologies

4:12PM D2.00001 Single Layer Multipolymer Photovoltaics

GRANT OLSON, RYAN BLUMENTHAL, SPENCER HERRICK, DANIEL SPAIZMÁN, ROBERT ECHELIS, Cal Poly San Luis Obispo — Polymer (Plastic) solar cells are an exciting and quickly developing area of study in photovoltaics. Our research group uses a blend of high and low bandgap polymers to create solar cells with broad spectral response, while maintaining a simple single active layer. Devices created have power conversion efficiencies as high as 2.0%, with a spectral response that spans from 400 to 900nm, the portion of the solar spectrum with the highest photon flux.

4:24PM D2.00002 Defects as qubits in SiC

LUKE GORDON, ANDERSON JANOTTI, C.G. VAN DE WALLÉ, University of California, Santa Barbara — The NV- center in diamond has been extensively studied as a promising qubit for quantum computing applications. However, technological limitations of the NV center in diamond impel a search for alternative defects in other materials which possess NV-like characteristics. Using first-principles calculations based on hybrid density functional theory, we explore possible defects in 4H- and 3C-SiC that hold potential as new solid-state qubits. Specifically, the divacancy in 4H and 3C-SiC and N-V centers in 3C-SiC are investigated. The calculated excitation and emission energies of the divacancy in 4H-SiC can explain the experimental data. In addition, our results indicate that the neutral divacancy and the negatively-charged N-V center in 3C-SiC are promising candidates as qubits; both defects are stable in n-type 3C-SiC, opening a pathway for possible coupling with charge carriers.

4:36PM D2.00003 First-principles lineshapes of defect luminescence bands

AUDRIUS ALKAUSKAS, DANIEL STEIAUF, JOHN L. LYNDS, CHRIS G. VAN DE WALLÉ, University of California Santa Barbara — We present a theoretical study of broadening of defect luminescence bands due to vibronic coupling. Numerical proof is provided for the commonly used assumption that a multi-dimensional vibrational problem can be mapped onto an effective one-dimensional configuration coordinate diagram. Our approach is implemented based on density functional theory with a hybrid functional, resulting in luminescence lineshapes for important defects in GaN and ZnO that show unprecedented agreement with experiment. We find clear trends concerning effective parameters that characterize luminescence bands of donor- and acceptor-type defects, thus facilitating their identification.
4:48PM D2.00004 Absolute surface energies of polar and non-polar planes in GaN
, CYRUS DREYER, ANDREWER JANOTTI, CHRIS G. VAN DE WALLE, University of California, Santa Barbara Materials Department — Growth of high quality single crystals and epitaxial layers of GaN is very important for producing optoelectronic devices. Ab initio calculations can help in determining absolute surface energies, which are key quantities that control crystal-growth rates and fracture toughens. By means of hybrid functional calculations, we have determined absolute surface energies for the non-polar {1120} and {1010} and polar (0001) planes in wurtzite GaN. Low energy reconstructions of the bare and hydrogenated surfaces were considered under various conditions chosen to respond to growth by molecular beam epitaxy (MBE) or metal-organic chemical vapor deposition (MOCVD). We find that the non-polar planes are close in energy, and lower in energy than the reconstructed (0001) polar plane under all conditions considered. The reconstructed (0001) plane is lower in energy than the (0001) plane over the whole range of conditions, and lower in energy than the non-polar reconstructions for Ga-rich chemical potential conditions. From these surface energies, lower bounds on the anisotropic fracture toughness of GaN are determined. Surface energies of polar planes for other III-nitrides will be compared to those of GaN.

5:00PM D2.00005 Electromagnetic Interaction in Plasmonic Artificial Molecules , SARAH GREFE, YOHANNE ABATE, California State University Long Beach, NANOOPTICS GROUP TEAM — Plasmonic hotspots located in the nanogaps of infrared optical antennas are mapped in the near-field. The enhanced evanescent fields are imaged as a function of excitation wavelength, polarization, particle length, gap size, and tip material. The near-field resonance behavior of antennas composed of rods, "bowtie" and "fourie" infrared antenna structures reveals that field enhancement strongly depends on the particle length and interparticle gaps. In rod antenna-field imaging using scattering probes, the probe tip can be considered as a load in the gap of the antenna, and the antenna response to tips can be directly understood by using nanocircuit theory. Experimental results are in agreement with finite-difference time-domain (FDTD) simulations.

5:12PM D2.00006 LAMMPS Simulations of Ternary CuTiZr Metallic Glasses, SARA CHENG, University of California Berkeley, LEV GELB, University of Texas Dallas — Metallic glasses are a family of amorphous solids which display highly desirable material properties. These include high magnetic permeability, high hardness, and absence of micro structures such as grains and phase boundaries (Miller 2011). In this computational study we apply a three-step heating treatment to a ternary mixture of copper, titanium, and zirconium to study glass formation and recrystallization. We empirically apply a Second Moment Approximation Tight Binding Potential with adjustable parameters, outlined in Dalgic et al. (2011), Qin et al. (2011), and Rosato et al. (1993). We calculate the temperature, volume, pressure, and total energy of the system as functions of time. We also calculate the radial distribution function for the entire system as well as grouped atom constituents. We employ common neighbor analysis to qualify the structure of clusters of atoms in terms of either face-centered-cubic, hexagonal close packed, icosahedral, or unknown configurations.

5:24PM D2.00007 Copper Phthalocyanine Thin Film Morphology Impact on Impedance Spectrum 1, KYLE ROBINSON, THOMAS GREDIG, California State University - Long Beach — Copper phthalocyanine thin films play an important role as the active layer in gas sensors, organic solar cells, and organic field-effect transistors. The surface morphology of such thin films can be controlled via modification of thermal deposition parameters. Thin films were deposited onto platinum interdigitated electrodes for impedance measurements to study the effect of structure on charge transport. The average grain size increases and changes from α- and β-phase for samples deposited in the temperature range of 295-534 K. AC measurements in the temperature range of 295-385 K reveal relaxation peaks in the impedance spectra. From this spectrum, essential properties are retrieved, such as relaxation times and effective capacitances, and correlated with the film morphology. Subject to both photo- and 5-day-dark current trials, photodecay rates are extracted via effective impedance circuit analysis using a phenomenological model that includes contributions from the grain boundary and the bulk part of the grain. Results indicate that the resistance contribution of low frequency relaxation peaks decrease while approaching the phase transition temperature, and vice versa for capacitance. We attribute the low-frequency peaks to grain boundaries, which are reduced in high temperature deposited samples. Hyper β-phase deposition temperatures show a sudden rise in resistance and lower capacitance due to increased roughness of samples.

5:36PM D2.00008 Synthesis of Gadolinium and Neodymium Nanoparticles through the Reverse Micelle Method 1, RYAN FUKUDA, MAYA CASTRO DE LA TORRE, PEI-CHUN HO, Physics/California State University Fresno, SAEED ATTAR, MELISSA GOLDEN, Chemistry/California State University Fresno, DENNIS MARGOSAN, United States Department of Agriculture-Agriculture Research Service — Nanotechnology is a growing field that can be applied to several technologies such as electronics and medicine. Due to micro-scale materials reaching their limit, nano-scale development of materials is becoming the new focus. In reaction to this trend, our lab has aimed to synthesize Gd and Nd nanoparticles through the reverse micelle method. This method uses a molecule with a polar head and nonpolar tail, known as a surfactant, to form and contain nanoparticles. In this study, we used the surfactant Aerosol OT (AOT) with polar methanol and nonpolar hexane. The geometry of AOT’s two nonpolar tails favors the formation of reverse micelles in a hexane solution containing small “pools” of methanol. The “pools” contain the rare earth compounds that are reduced by using sodium borohydride as a reduction agent. Samples have been examined using scanning electron microscopy, energy dispersive x-ray analysis, and a Leica microscope. The reduction of gadolinium chloride has been confirmed, but is not seen in spherical particles. The same procedure was used for neodymium chloride and neodymium nitrate, but further testing is required. Future work will be done to improve the purity of our sample, generate spherical reverse micelles, and develop smaller particles.

5:48PM D2.00009 Electronic Properties of Graphene Multilayers 1, HAMED SADEGHI, Department of Physics & Astronomy, California State University Long Beach, Long Beach 90840, JULIUS DE ROJAS, Department of Physics, University of California at Davis, Davis 95616, ANDREAS BILL, Department of Physics & Astronomy, California State University Long Beach, Long Beach 90840 — We determine numerically the tight-binding band structure, the density of states and the plasmon spectrum of N stacked graphene layers beyond the Dirac cone approximation. We calculate the polarizability in the random phase approximation and determine the dielectric function ε(q,ω). This allows to determine the acoustic and optical modes of the plasmon spectrum. Because we do not limit ourselves to the Dirac cone approximation we cannot use the semi-analytic approach usually proposed for graphene in the literature. Instead we use a combination of numerical procedures to determine the collective modes of graphene multilayer.

---

1 This research was generously supported by NSF grant DMR-0847552
2 We gratefully acknowledge the support of the National Science Foundation (DMR-0907242), the Army Research Laboratory, and the RSCA grant at CSU Long Beach.
High-Threshold Čerenkov Counter (HTCC) is being built to allow measurements of the cross section ratio for U-238 to U-235 and Pu-239 to U-235. The HTCC is designed to resolve the magnetic field requirements for the detection of Čerenkov photons, which are produced by charged particles traveling faster than the speed of light in a medium. The mirror assembly directs the Čerenkov photons into a region of the detector with a low magnetic field, allowing for improved resolution. This new detector will utilize a mirror reflectivity test stand to assess the performance of the HTCC.

As a result of this, the existing CLAS Čerenkov counter is not sufficient to distinguish electrons from pions. To alleviate this situation, a new, higher energy Čerenkov counter is being built. The CEBAF accelerator at the Thomas Jefferson National Accelerator Facility is currently undergoing an energy upgrade from 6 to 12 GeV. This in turn provides a means of searching for the possible critical point to quantify the nature of the phase transition between hadronic and partonic matter. In this talk, fixed target acceptances for tracking will be discussed. Pion ratios extracted from these fixed-target collisions will be presented and compared to earlier published results from the AGS, SPS, and RHIC.

The new HTCC is designed to allow measurements of the cross section ratio for U-238 to U-235 and Pu-239 to U-235. The detection of neutrinoless double beta decay ($\nu_{\beta\beta}$) in $^{130}$Te. The detection of $\nu_{\beta\beta}$ indicates the neutrino is a Majorana fermion and also sets the absolute mass scale of the electron neutrino. The experiment is currently being built in stages at the Gran Sasso National Laboratory in Assergi, Italy. CUORE-0 is a detector array expected to go online this year consisting of 52 bolometric crystals in a single tower, which is equivalent to 1/19th of the full mass of CUORE. We will describe our recent contributions to activities associated with CUORE-0 deployment, background reduction efforts, and the CUORE crystal verification runs as the collaboration works towards bringing CUORE online in 2014.

Contract DE-AC52-07NA27344 and funded by the LLNL LDRD program (10-ERD-044).
At higher energies, detectors using radio Cherenkov techniques have produced aggressive limits on the neutrino flux. In this talk, we summarize current efforts to search for sources of high energy neutrinos and describe a novel concept for the next generation of astrophysical neutrino detection, called ARIANNA, which takes advantage of unique geophysical features of the Ross Ice Shelf in Antarctica. ARIANNA, based on the radio Cherenkov technique, is designed to improve the sensitivity to neutrinos with energies in excess of \(10^{19}\) W/cm\(^2\) ultra-short (~picosecond scale) pulsed laser experiments, the main irradiating pulses are usually preceded by nanosecond scale of pre-pulses, due to amplified stimulus emission (ASE). The ASE generates pre-plasma, which is often characterized by its scale-length, the spatial decay length of the plasma density. These preformed plasmas are believed to play an important role in laser-plasma interactions and in accelerating charged particles, such as electrons. To better understand their role in producing charged particle beams in laser-solid target interactions, we have investigated, using optical interferometry, pre-plasmas produced by a controlled nanosecond-long pulse laser and also ones created by the ASE of the short-pulse Titan laser at Lawrence Livermore National Laboratory. I will present the optical interferometry data and compare the characteristics of pre-plasmas from both the LP and ASE cases.

\[^{1}\]This work was performed under the auspices of the U.S. DOE by LLNL under Contract DE-AC52-07NA27344, LDRD-10-ERD-044.

5:36PM D3.00008 Cold Plasma Characterization and Interaction with Materials\(^{1}\), JUDE ROWE, Sonoma State University — The nature of cold plasma and the interaction it has on other surfaces and microbial organism is of great scientific and applied potential. Using a “starting from scratch” approach, a plasma chamber equipped with AC pick-up coils was designed and built to investigate interactions with the plasma state and other materials. Three main experiments were conducted, first plasma interacting with material within the chamber, second frequency change due to change in ionized gas, and finally methods of pumping energy into plasma were examined. AC Plasma was created using 60Hz power with voltage up to 1.5kV and 36mA in Helium and in air. Temperatures inside the chamber did not significantly increase and plasma temperature was derived from theory. Chamber pressure was measured down to 200 mtorr and averaged around 350 mtorr during measurements. The distance between electrodes controlled main plasma confinement for measurement within coil range. Fourier spectrum analysis was utilized in identifying and characterizing plasma internal characteristics. External macroscopic changes and wave form behaviors were observed and these behaviors will be discussed in context of current theories.

\[^{1}\]Thank you Dr. Qualls and the SSU Physics department.

Saturday, November 3, 2012 9:00AM - 10:30AM — Session F1 Plenary Session II Phillips Hall 006-0124

9:00AM F1.00001 Energy, Sustainability, Collaboration: Learning it, Teaching it, and Living it — At Cal Poly, in Guatemala, and at Home, PETE SCHWARTZ, Cal Poly — Three questions have become important to me:

1. “What is the future of our energy dilemma, and how can I participate toward a solution?” Since 2007, I have been teaching “Energy, Society, and the Environment” at Cal Poly as well as developing and analyzing renewable energy technologies. In the process I have learned as much as my students. This interest was initially sparked by making “sustainable” changes to my home and lifestyle, and has since fueled constant domestic experimentation.

2. The above question extends to “Environmental Justice”, which is essentially a question of “who benefits and who suffers as a result of our societal choices?” For the past three years, I’ve developed and directed a collaborative (Guatemalan/Cal Poly) appropriate technology field school. Students from both countries learn together during the two-month summer program in a small mountain village in Guatemala (www.guateca.com).

3. “What happens to learning efficacy when students become friends?” For the past three years, I’ve been actively engaged with a group of Cal Poly instructors in a quest to create community in the learning environment (www.sustain sno.org). Additionally, I’ve begun to teach all my classes “inside out”, consistent with the advice of Physics Nobel Prize Laureate Carl Weiman (Science, 13 May 2011, VOL 332 862 – 864). Students learn the material at home by reading or watching videos available on the web. This opens up class time for guided discussion, experimentation, and calculations. The Guateca field school provides an extreme example of this principle, as all the students do become friends. . . . with very interesting results.

9:45AM F1.00002 Search for Extremely High Energy Neutrinos\(^{1}\), STEVEN BARWICK, UC Irvine — Dedicated high-energy neutrino telescopes based on optical Cherenkov techniques have been scanning the cosmos for about a decade. Consequently, neutrino flux limits have improved by several orders of magnitude in the TeV-PeV energy interval. At higher energies, detectors using radio Cherenkov techniques have produced aggressive limits on the neutrino flux. In this talk, we summarize current efforts to search for sources of high energy neutrinos and describe a novel concept for the next generation of astrophysical neutrino detection, called ARIANNA, which takes advantage of unique geophysical features of the Ross Ice Shelf in Antarctica. ARIANNA, based on the radio Cherenkov technique, is designed to improve the sensitivity to neutrinos with energies in excess of \(10^{19}\) W/cm\(^2\) ultra-short (~picosecond scale) pulsed laser experiments, the main irradiating pulses are usually preceded by nanosecond scale of pre-pulses, due to amplified stimulus emission (ASE). The ASE generates pre-plasma, which is often characterized by its scale-length, the spatial decay length of the plasma density. These preformed plasmas are believed to play an important role in laser-plasma interactions and in accelerating charged particles, such as electrons. To better understand their role in producing charged particle beams in laser-solid target interactions, we have investigated, using optical interferometry, pre-plasmas produced by a controlled nanosecond-long pulse laser and also ones created by the ASE of the short-pulse Titan laser at Lawrence Livermore National Laboratory. I will present the optical interferometry data and compare the characteristics of pre-plasmas from both the LP and ASE cases.

\[^{1}\]The author acknowledges support from NSF grants 0970175, 1126072 and 0970168
region follows the gravitational potential of the bulge. While the \([\text{OIII}]\) line has the great advantage of being easily measurable in AGNs out to alternative way to estimate \(\sigma\). This is all in preparation for the construction of the final system, Prime. Building the final system is set to begin in intensity and optical throughput of the system, researching improvements to the WFS component of the instrument, as well as improving the on characterization of on-sky closed loop performance of the prototype system, Alpha. Special attention has been given to investigating the a tip-tilt mirror, a 140 actuator microelectromechanical deformable mirror (MEMS DM) and a 1kHz wavefront sensor (WFS) camera. The Optics instrument, is currently in its third and final year of development. This dual-band (optical/IR) AO instrument is based on custom optics, technology used on ground based telescopes to correct for atmospheric aberration in astronomical images. KAPAO, a Pomona College Adaptive technology used on ground based telescopes to correct for atmospheric aberration in astronomical images. KAPAO, a Pomona College Adaptive

\[\sigma(\text{AGNs}), \text{measuring } \beta \text{ origin. While the mass of the BH can be easily estimated using the Doppler broadening of the } H_\alpha \text{ line in type-1 active galactic nuclei (AGNs), measuring } \sigma \text{ simultaneously is challenging, since the nuclear emission outshines the host galaxy. Thus, it is highly desirable to find an alternative way to estimate } \sigma. \text{ In the literature, the width of the [OIII] emission line has been used as a surrogate, assuming that the narrow-line region follows the gravitational potential of the bulge. While the [OIII] line has the great advantage of being easily measurable in AGNs out to large redshifts, it is also known to be affected by outflows and jets. For a sample of about 100 nearby active galaxies, we determine the width of the [OIII] line using two Gaussians to exclude any outflowing component. The resulting width is compared to } \sigma \text{ measurements previously compiled from Keck spectroscopy for the entire sample to determine the method’s viability.}\]

\[2:24\text{PM H1.00003 The Outbursts of the Cataclysmic Variable V425 Cassiopeiae}\]

DILLON TRELAWNY, FRED RINGWALD, California State University, Fresno — We report time-resolved photometry of the cataclysmic variable V425 Cassiopeiae, taken in 2010, 2011, and 2012 at Fresno State’s station at Sierra Remote Observatories. We measure a long-term period of 4.24 ± 0.71 days and a 1.0 magnitude amplitude. This is separate from the orbital period of 0.1496 days (Shafter 1983). Our period value is in direct contrast with that measured by Kato et al. (2001) of 2.65 days for the same system. As a result of this long-term variability, Kato et al. proposed that V425 Cas is a VY Scl-type system, characterized by standstills, between dwarf nova outbursts that recur rapidly. Observations from Kato et al. (2001) are included for comparison. Further evidence of near-infrared magnitudes of V425 Cas from the 2MASS survey and its absolute magnitudes at outburst maximum, standstill, and minimum are included to support our argument.

\[2:36\text{PM H1.00004 Searching for Q-Balls with the High Altitude Water Cherenkov Observatory}\]

PETER KARN, University of California, Irvine, HIGH ALTITUDE WATER CHERENKOV (HAWC) COLLABORATION — The High Altitude Water Cherenkov (HAWC) experiment is a gamma-ray observatory currently under construction at Sierra Negra in Mexico. When complete it will consist of 29,000 square meter array of 300 water Cherenkov detectors, each with 50,000 gallons of water and four photomultiplier tubes. Although HAWC is designed to study gamma rays from galactic and extra-galactic sources, the large volume of instrumented water gives the opportunity to search for more exotic species. One such target, predicted by several varieties of supersymmetric theory, is the Q-ball. Q-balls are large, subrelativistic particles that can have a large baryon number and can be stable since their creation in the early universe. They are also a very appealing candidate for the dark matter of the universe, but their large masses must mean the flux is very low. HAWC has a flexible data acquisition system which, with a specialized trigger algorithm for non-relativistic species, allows a search for Q-balls traversing the detector.

\[2:48\text{PM H1.00005 KAPAO: Implementing a Camera for Atmospheric Correction on the Table Mountain 1-meter Telescope}\]

DANIEL CONTRERAS, Pomona College — Adaptive optics (AO) is a technology used on ground based telescopes to correct for atmospheric aberration in astronomical images. KAPAO, a Pomona College Adaptive Optics instrument, is currently in its third and final year of development. This dual-band (optical/IR) AO instrument is based on custom optics, a tip-tilt mirror, a 140 actuator microelectromechanical deformable mirror (MEMS DM) and a 1kHz wavefront sensor (WFS) camera. The system will be integrated onto the remote access Table Mountain Observatory (TMO) 1-meter telescope Recent work on KAPAO has focused on characterization of on-sky closed loop performance of the prototype system, Alpha. Special attention has been given to investigating the intensity and optical throughput of the system, researching improvements to the WFS component of the instrument, as well as improving the software control loop. This is all in preparation for the construction of the final system, Prime. Building the final system is set to begin in winter 2012-2013.

---

1This project is funded by the National Science Foundation under award #0960343.
measuring heat capacity. will report on the progress of the specific heat measurement of the doped compound Pr$_{1-x}$Nd$_x$Os$_4$Sb$_{12}$. Any findings in this direction will contribute to the selection of superconductors that are reproducible and suitable for commercial use. Previous studies have shown that Pb doping, within a certain range, can increase a superconductor’s critical current density without altering the structure of the material. In order to better understand what the exact optimal lead doping range is, various ranges of Pb in superconducting Bi$_{2-x}$Pb$_x$Sr$_2$Cu$_2$O$_y$ (x ranging from 0.1-0.6). HTS within this optimal lead doping range have a more stabilized crystal structure, which reduces annealing time and improves their magnetic properties, and as a result, improves their manufacturability for commercial applications. When the Pb doping process through µ currents. By means of Maximum Entropy analysis, we investigate transverse field Jose State University — For the pseudogap phase, an important feature of cuprate superconductivity, Varma et al. predict the existence of loop currents. To search for precursor effects, and for predicted pseudogap loop currents, our focus is on a temperature interval between T = 1.85 and T*. An extra drop in normal-state frequency indicates demagnetization effects, possibly caused by short-living Cooper-pairs in the Cu-O planes. In sum, our results suggest magnetic roots of cuprate superconductivity. 

3:12PM H1.00007 The protection of shock wave for Interstellar travel, YONGFENG WU, UMaine — Interstellar travel is definitely an important step for mankind in the future space exploration. Relativistic time dilation is then necessary to cover galaxy-scale distance in a reasonable amount of personal time. Consequently, interstellar hydrogen H, although only presents at a density of approximately 1.8 atoms/cm$^3$, will be a disaster for spaceships and passengers as it will turn to be a surprisingly high density flow with the effect of relativistic time dilation. Limiting the speed of spaceships may avoid severe H irradiation sets but this is inadequate for long distance trip in the universe. However, shock wave, automatically produced by high speed spaceships, will protect the spaceships and passengers from the radiation of H atoms.

3:24PM H1.00008 MEST- avoid next extinction$^1$. DAVYONG CAO, Avoid Earth Extinction Association — Asteroid 2011 AG5 will impact on Earth in 2040. (See Donald K. Yeomans, “Asteroid 2011 AG5 - A Reality Check.” NASA-JPL, 2012) In 2011, the author say: the dark hole will take the dark comet to impact our solar system in 20 years, and give a systemic model between the sun and its companion-dark hole to explain why were there periodicity mass extinction on earth. (see Dayong Cao, BAPS.2011.CAL.C1.7, BAPS.2011.DFD.LA.24, BAPS.2012.APR.K1.78 and BAPS.2011.APR.K1.17) The dark Asteroid 2011 AG5 (as a dark comet) is made of the dark matter which has a space-time (as frequency-amplitude square) center- a different systemic model from solar systemic model. It can absorb the space-time and wave. So it is “dark.” When many dark matters hit on our earth, they can break our atom structure and our genetic code to trigger the Mass Extinction. In our experiments, consciousness can change the systematic model and code by a life-informational technology. So it can change the output signals of the solar cell. (see Dayong Cao, BAPS.2011.MAR.CL.296 and BAPS.2012.MAR.P33.14) So we will develop the genetic code of lives to evolution and sublimation, will use the dark matter to change the systemic model between dark hole and sun and will avoid next extinction.

$^1$AEEA
2:36PM H2.00004 A real time, continuously operating, fluxlocked superfluid interferometer1. ADITYA JOSHI, RICHARD PACKARD, University of California, Berkeley — Interferometers are widely used in basic and applied sciences. These instruments using sound, light or de Broglie matter waves, have an output amplitude (e.g., the Josephson critical current in a dc SQUID), which is a sinusoidally varying function of some variable of interest (magnetic flux in the case of the SQUID). To achieve widespread practical utility, it is very useful to have a method to linearize the instrument’s response. We report here a real-time flux locking technique using thermal counter flow to linearize the output of a superfluid He-4 quantum interference device (SHeQUID), an analogue of the superconducting dc SQUID. A continuously changing rotation flux through the interferometer sense loop of the SHeQUID produces a phase-difference in the sense loop. This change is canceled via continuous negative feedback using the phase shift caused by a thermally driven superflow. The feedback signal (injected heater power) is then a linear measure of rotation flux and is used to track the rotation signal in real time.

1Supported by the National Science Foundation.

2:48PM H2.00005 Measurements of the Critical Casimir Effect and Superfluid Density in 4He Films , JOHN ABRAHAM, GARY WILLIAMS, UCLA Department of Physics and Astronomy, KONSTANTIN PENANEN, Jet Propulsion Laboratory, NASA — We report the results of experiments on 4He films in the vicinity of the bulk superfluid transition temperature $T_\lambda$. A novel experimental apparatus allows measurements of film thinning due to the critical Casimir effect as well as the superfluid density of the film via third sound measurements. The temperature where the the Casimir film thinning begins to occur is found to be very close to the Kosterlitz-Thouless superfluid transition temperature in the film. Additionally, a new thinning effect is observed at $T_\lambda$ when the temperature is swept extremely slowly.

3:00PM H2.00006 Odd-Frequency Triplet Josephson Current Through an Exchange Spring1, ADAM MOKE, THOMAS BAKER, ADAM RICHIE-HALFORD, ANDREAS BILL, CSU Long Beach — The existence of an odd-frequency long range triplet component in the order parameter of a proximity system with singlet superconductors is a recent prediction that has garnered great interest. The experimental fingerprint of this phenomenon is difficult to establish. We investigate a hybrid structure in which the emergence of the long range triplet component may be measured and identified. We consider a superconductor - exchange spring - superconductor Josephson junction as a function of increasing twist of the magnetic domain wall in the exchange spring. We show that as the domain wall is generated the long range triplet component emerges and modifies the current flowing through the Josephson junction. The critical temperature is also affected by the increased twist of the domain wall. The calculations lead us to propose an experiment where the long range triplet component can unequivocally be identified.

1We gratefully acknowledge the support of the National Science Foundation (DMR-0907242), the Army Research Laboratory, the Research Corporation, the Graduate Research Fellowship and block grant at CSU Long Beach.

3:12PM H2.00007 Phase separation instabilities and modulated coherent pairing states in Bi-based cuprates , ARMEN KOCHARIAN, California State University, Los Angeles, KUN FANG, GAYANATH FERNANDO, University of Connecticut, Storrs, ALEXANDER BALATSKY, Los Alamos National Laboratory, KALUM PALANDAGE, Trinity College, Hartford — There is growing evidence that the unconventional spatial inhomogeneities and structural changes in the doped high-Tc superconductors are accompanied by the pairing of electrons, subsequent quantum phase transitions (QPTs), and condensation in coherent states. We show that these superconducting coherent pairing with mediated opposite spin coupling are driven by phase separation instabilities near the quantum critical points. We examine electron coherent and incoherent pairing instabilities using our results on exact diagonalization in pyramidal and octahedron Hubbard-like clusters under variation of chemical potential (or doping), interaction strength, temperature and magnetic field. We also evaluate the behavior of the energy gap in the vicinity of its sign change in a real space as a function of out-of-plane position of the apical oxygen atom, due to vibration of apical atom and variation of inter-site coupling. Our results show direct correlation between the size of the energy gap characterizing the coherent superconducting state and a modulation of the structural positions of apical atom. These results provide a transparent microscopic explanation of (electron correlation induced) supermodulation of the coherent pairing gap observed recently in tunneling microscopy.

3:24PM H2.00008 Investigation of Fermi & Luttinger surfaces in Ca$_{2-x}$Na$_x$CuO$_2$Cl$_2$ using ARPES , SIMON BELL, San Jose State University, GEY-HONG GWEON, JIANQIAO MENG, UC Santa Cruz, K.H. KIM, H.G. LEE, Pohang University of Science & Technology, S.I. LEE, Seogang University — The electronic structure & occupancy of doped cuprate superconductors Ca$_{2-x}$Na$_x$CuO$_2$Cl$_2$ of various doping levels is probed using angle-resolved photoemission spectroscopy (ARPES). The Fermi surface investigated shows that the Luttinger sum rule involving only the Fermi surface fails to account for the particles sum rule. Instead, the Luttinger rule that involves both the Fermi surface and the Luttinger surface seems the Fermi surface rule. We argue that such a generalized sum rule indicates the importance of very strong electron correlations.

3:36PM H2.00009 High resolution ARPES spectroscopy on topological insulators , AHRAM KIM, Physics Department, San Jose State University, San Jose, CA, 95112; Physics Department, University of California, Santa Cruz, CA, 95064, JIAN-QIAO MENG, Physics Department, University of California, Santa Cruz, CA, 95064, GENDA GU, Condensed Matter Physics and Materials Science Department, Brookhaven National Laboratory, Upton, New York 11973, GEY-HONG GWEON, Physics Department, University of California, Santa Cruz, CA, 95064 — We report new angle resolved photoelectron ARPES spectroscopy (ARPES) results on topological insulators, Bi$_2$Se$_3$ and Bi$_2$Te$_3$. Our data are characterized by unprecedentedly small Dirac point binding energy and the near absence of bulk conduction band near the Fermi energy, therefore, implying that our samples are closer to the ideal topological state than previously known samples. We also discuss the self energy extracted from the ARPES data and the line shapes, and compare them with those known for strongly correlated electron materials such as high temperature superconductors, with emphasis on high temperature. While our results agree with previous results known for topological insulators, in that they signify very weakly correlated and conventional electronic structure, thereby proving a nice reference case, we also point out some intriguing feature in the data.

Saturday, November 3, 2012 2:00PM - 3:36PM —
Session H3 Atomic and Molecular Physics Business 003 0209 - Chair: Peter Beiersdorfer, Lawrence Livermore National Laboratory
2:00PM H3.00001 Search for an anomalous spin-mass coupling with a dual isotope rubidium comagnetometer1, 2. CESAR RIOS, JULIAN VALDEZ, JERLYN SWIATLOWSKI, JACKIE KREMER, DEREK KIMBALL, California State University - East Bay — We discuss progress in our search for a hypothetical long-range coupling between rubidium (Rb) nuclear spins and the mass of the Earth. The experiment employs a dual-isotope Rb comagnetometer: the valence electron dominates magnetic interactions and serves as a precise magnetic field monitor for the nuclei in a simultaneous measurement of Rb-85 and Rb-87 spin precession frequencies, enabling accurate subtraction of magnetic perturbations. The nuclear structure of Rb makes the experiment particularly sensitive to non-magnetic, spin-dependent interactions of the proton. The majority of recent searches for similar effects limit anomalous couplings of either the neutron or electron spin, so the proposed experiment searches a parameter space to some degree, depending on the theoretical model, orthogonal to that constrained by previous experiments. We have begun to collect data and carry out in-depth analysis of systematic effects. The optimized dual-isotope Rb magnetometer has the sensitivity to improve experimental limits on long-range spin-mass couplings by an order of magnitude in general and by three orders of magnitude for the proton spin in particular.

1Supported by NSF grant #PHY-0969666.

2:12PM H3.00002 Two-photon direct frequency comb spectroscopy of alkali atoms1, 2. CHRISTOPHER PALM, TRINITY PRADHANANGA, California State University - East Bay, KHOA NGUYEN, San Jose State University, CAITLIN MONTERIEFFE, DEREK KIMBALL, California State University - East Bay — We have studied transition frequencies and excited state hyperfine structure in rubidium using 2-photon transitions excited directly with the frequency-doubled output of a erbium fiber optical frequency comb. The frequency comb output is directed in two counterpropagating directions through a vapor cell containing the rubidium vapor. A pair of optical filters is used to select teeth of the comb in order to identify the transition wavelengths. A photomultiplier tube (PMT) measures fluorescence from a decay channel wavelength selected with another optical filter. Using different combinations of filters, we can accurately determine the frequency of the transition. By scanning the repetition rate, a Doppler-free spectrum can be obtained enabling kHz-resolution spectral measurements. An interesting dependence of the 2-photon spectrum on the energy of the intermediate state of the 2-photon transition is discussed. Our investigations are laying the groundwork for a long-term research program to use direct frequency comb spectroscopy to understand the complex spectra of rare-earth atoms.

1Supported by NSF grant #PHY-0958749.

2:24PM H3.00003 Application of electric fields to alkene-casted cesium vapor cells1, 2. LI WANG, BRANDON GUIDL, CHENG-KAI CHEN, MARYNA LONGNICHEL, DEREK KIMBALL, California State University - East Bay — Recently, a new alkene-based antirelaxation coating coating has been discovered [Balabas et al., Phys. Rev. Lett. 105, 070801 (2010)] which enables spin-polarized alkali atoms to bounce off vapor cell walls more than a million times before the spin polarization relaxes, yielding electron spin relaxation times on the order of minutes. This remarkable new technology may open the possibility of conducting a new search for the parity- and time-reversal violating permanent electric dipole moment (EDM) of the electron using a cesium vapor contained in an alkene-coated cell. Previous antirelaxation coatings have demonstrated dramatic vapor density variations upon application and reversal of the large electric fields required for an EDM experiment [Jackson Kimball et al., Phys. Rev. A 79, 023201 (2009)]. We have found that in the new alkene-coated cells these electric-field-induced vapor density variations can be mitigated for particular choices of cell and alkali metal reservoir temperatures. Future work will involve demonstrating the long spin-relaxation times during application and reversal of electric fields and direct measurement of the electric field using the Stark shift of excited states in Cs.

1Supported by NSF grant #PHY-0969666.

2:36PM H3.00004 On the Non-Pauli Electronic States of Atoms and Molecules1, 2. PETER LANGHOFF, UCSD, JEFFREY MILLS, AFRL — Schrödinger’s equation for atoms and molecules supports solutions that are not totally antisymmetric with respect to coordinate permutations. These non-Pauli eigenstates are generically regarded as unphysical, with interest in them centered largely on their role as possible “contaminants” in physical solutions constructed by methods that provide only approximate antisymmetry, such as exchange perturbation theories, many-body diagrammatic approaches, and variational methods in the absence of precise prior enforcement of basis-state antisymmetry. Here we report atomic and molecular non-Pauli Schrödinger solutions employing largely pedestrian methods as an alternative to the more complicated Wigner-Weyl approach based on theory of the symmetric group. Using the non-relativistic Hamiltonian operator and spin-orbital product representations in variational calculations, we show that every antisymmetric Schrödinger eigenstate of an n electron atom or molecule is accompanied by 2n−1 degenerate non-Pauli “ghost” solutions. As a consequence of this degeneracy, admixtures of non-Pauli states are always present in Pauli solutions having only approximate antisymmetry. These can significantly affect calculated expectation values, even in the face of precise energy predictions.

2:48PM H3.00005 ABSTRACT WITHDRAWN —

3:00PM H3.00006 Thermodynamic description of cellulose chain collapse using coarse grain modeling1, 2. RITANKAR DAS, JIHJ-WEI CHU, UC Berkeley — Biomass contains abundant amounts of cellulose as crystalline microfibers. A limiting step to using cellulose as an alternative energy source, however, is the hydrolysis of the biomass and subsequent transformation into fuels. Cellulose is insoluble in most solvents including organic solvents and water, but it is soluble in some ionic liquids like BMIM-Cl. This project aims to find alternative solvents that are less expensive and are more environmentally benign than the ionic liquids. All-atom molecular dynamics simulations were performed on dissociated glucan chains separated by multiple (4-5) solvation shells, in the presence of several novel solvents and solvent mixtures. The solubility of the chains in each solvent was indicated by contact calculations after the equilibration of the molecular dynamics. It was discovered that pyridine and imidazole acted as the best solvents because perturbation of the solvent interactions in the presence of glucan chains was minimal.

3:12PM H3.00007 Path-Integral Foundations1, 2. KEN WHARTON, San Jose State University — Research in the field of Quantum Foundations often aims to interpret the standard quantum wavefunction (including its dynamics and its probabilistic relationship to observations). However, it is known that all of the predictions of quantum theory can also be recovered using the Feynman Path Integral (FPI), in which the wavefunction need not play any role at all. This raises the possibility of an alternate approach to quantum foundations — “path-integral foundations” — in which it is the FPI that needs an interpretation, not the wavefunction. This talk will summarize the efforts that have already been made in this regard, and will present indications that this is a promising research direction — especially if one is concerned with time-symmetry and/or “realistic” approaches to quantum phenomena.
3:24PM H3.00008 Capillary Action may be used in feeding Particles and as calorimeters in Accelerators, RICHARD KRISKE, University of Minnesota — Capillary Action was first proposed to be a Quantum Mechanical Efffect by this Author. In plain it takes no work for water to travel up a tree, a flow of fluid begins when a thermal photon causes the water at the top of the column to evaporate. When the molecule evaporates a “hole” is transferred down the water column to the roots where apparently the “hole” establishes a “current” of “holes” in the manner of theory which is superior to the theory of “solid-state” physics. The “hole” can also be used in a “path-integral” formulation as is done in particle physics. A particle (a thermal photon) would strike the surface at the top of the column in through some “spring” method cause the whole column to rise which is an interesting variation of the “spring-in-mattress” model used in Quantum Field Theory. Obviously a proper size tube- say a nanotube could be coupled to an Accelerator and the Quantum Field Theory Calculation of the Beam could be used to couple with the “spring” field available in the Tube. For the right sized tube, a Calorimeter would be the result. For other sized tubes, the beam could be fed with molecules and particles that have similar characteristics to water. Capillary Action is an example of Particle Physics seen in directly in the Classical world.

Saturday, November 3, 2012 2:00PM - 3:48PM — Session H4 Condensed Matter IV: Atoms and Molecules — Business 003 0113 — Chair: Michael Peterson, California State University, Long Beach

2:00PM H4.00001 Possible Quantum Transport in (RE)Ba$_2$Cu$_3$O$_{7−y}$ Perovskites, PAUL GRANT, W2AGZ Technologies — For $y \approx 0$, the crystal structure of the “1-2-3” family of rare earth perovskites displays a curious “porosity” feature, namely, along the b-axis direction of a region usually termed the “CuO chains,” one observes a dramatically wide “channel” bounded within a Ba$_2$-CeO$_2$ tube. The cross-sectional area of these channels is roughly that of a single-wall carbon nanotube, suggesting the former may manifest Buettiker-Landauer quantum conductance similar to that observed in the latter. Moreover, by employing various ratios of Pr/Y for the RE component of the host system, the bulk electrical properties of the surrounding host can be tailored from completely insulating to metallic. We test our conjecture predicting ballistic transport down the “Ba-Cu-O channel” using density functional theory and report our initial findings here. We also discuss possible experimental embodiments which could lead to nano-controllable gate structures.

2:12PM H4.00002 Magneto Optical Kerr Effect Measurement of Double Exchange Spring System$^1$, HANMING YUAN, JIYEONG GU, Department of Physics and Astronomy, California State University, Long Beach — Magnetic property of the symmetric Double Exchange Spring System, soft(S)/hard(H)/soft(S) magnetic layers Glass/NiFe (bottom Py)/SmFe/NiFe (top Py), was investigated using Magneto Optical Kerr Effect (MOKE) measurement. In order to produce a symmetric non-collinearity in magnetization, the thicknesses of the two Py layers are controlled to be the same during the deposition. Due to the finite skin depth of the laser used in MOKE measurement magnetic hysteresis loop for each Py layer can be measured separately by adjusting the right thickness of the layers. First of all, we found the magnetic hysteresis loops for the bottom and the top Py layers are not the same. Moreover, we found that the coercivity of the bottom Py measured from MOKE is closer to the coercivity of the first switching measured from Alternating Gradient Magnetometer (AGM) and is much smaller than that of the top Py from MOKE; the coercivity of the top Py from MOKE is closer to that of switching from AGM. These show that the non-collinearity provided by the two soft layers is not symmetric in reality even with a symmetric structure. The experimental observations might be due to the difference in the growing environment between the bottom Py layer and the top Py layer.

$^1$This project is supported by the 2011-2012 Mini Grant from California State University, Long Beach

2:24PM H4.00003 Redesign of an AC Magnetic Susceptometer for smaller samples$^1$, ANDRES VARGAS, RYAN FUKUDA, SMITHA SUNNY, PEI-CHUN HO, California State University, Fresno — A new AC magnetic susceptometer that measures samples of the 10 mg range has been built to improve upon our previous model in design and materials. The AC magnetic susceptometer will be measuring the magnetic susceptibility of our samples. It is made up of a sample holder, a primary coil, and a secondary coil. A current is inputted to the primary coil which provides an applied AC magnetic field. The sample lies at the center of one of the solenoids of the secondary coil and becomes polarized due the applied magnetic field. The polarization will cause an induced voltage on the secondary coil which is directly proportional to the sample’s magnetic susceptibility. The new AC magnetic susceptometer contains roughly 1.30 and 1.32 more windings than the previous primary and secondary coil respectively. The improvements of the new AC magnetic susceptometer will result in a smoother and more accurate data curve. We will be using our AC magnetic susceptometer to determine a polycrystalline sample’s magnetic susceptibility at critical temperature. We will be using our new AC magnetic susceptometer using an 11 mg sample of Gd. The sharp change of Gd’s magnetic susceptibility at the critical temperature qualitatively agrees with our previous AC magnetic susceptometer data.

$^1$This project is funded by the NSF through grant # DMR-1104544.

2:36PM H4.00004 Differences in the Magnetic Susceptibility of UCu$_{3.95}$Ni$_{1.05}$ due to Grinding$^1$, CARLOS SANCHEZ, CARMEN QUEN, EDITH SOTO, California State University of Los Angeles — The effects on the magnetic susceptibility due to grinding a sample of UCu$_{3.95}$Ni$_{1.05}$ are studied using the Vibrating Sample Magnetometry (VSM) technique. Peculiar differences between powder and ingot material of magnetic susceptibility of this sample are found. Magnetic susceptibility of UCu$_{3.95}$Ni$_{1.05}$, measured in a constant magnetic field of 500 Oe. The data shows a magnetic phase transition at around 150K, which appears to affect a polycrystalline sample more than a powder sample. We suspect a relation between the observed effects and a second phase present in the system. We will be using our AC magnetic susceptometer to determine the second phase contribution from the total susceptibility.

$^1$Dr. Oscar O. Bernal, CSULA MORE Program, LSAMP

2:48PM H4.00005 Real Space Rotational Spectroscopy: Measurement of the Rotational Excitation of a Single Molecule by the Scanning Tunneling Microscope, SHAOWEI LI, ARTHUR YU, FREDDY TOLEDO, ZHUMIN HAN, WILSON HO, University of California, Irvine — The power of rotational transition spectroscopy has long been demonstrated in the frequency domain by microwave spectroscopy, but its application in real space is limited. Using a scanning tunneling microscope (STM) and inelastic electron tunneling spectroscopy (IETS), we are able to conduct real-space measurements of rotational transitions of gaseous hydrogen molecules physisorbed on Au(110) surface. By varying the tip-substrate distance, we could precisely investigate how the environmental coupling modifies the structure of a single molecule with sub-Angstrom resolution. Rotational spectroscopy at the single molecule level provides a powerful tool for chemical identification as well as bond length measurement in both frequency and space domains.
3:00PM H4.00006 High Resolution Vibrational Spectroscopy at the Atomic Scale: CO on Au(110) and Cu(100), and C2H2 on Cu(100)\textsuperscript{1,2} CHEN XU\textsuperscript{3}, CHILUN JIANG\textsuperscript{2}, YANNING ZHANG, RUQIAN WU, WILSON HO, Department of Physics and Astronomy, University of California, Irvine — STM-IETS has been regarded as the ultimate tool to identify and characterize single molecules adsorbed on solid surfaces with atomic spatial resolution. With the improvement of the energy resolution obtained at \textasciitilde 600 mK, STM-IETS is able to reveal subtle interactions between the molecule and its environment which was previously not possible at higher temperatures. Here we demonstrate the capability of sub-Kelvin STM on detecting the influence of the tip as well as the anisotropy of the reconstructed Au(110) surface on the low energy hindered vibrational motions of single adsorbed CO molecule. In the case of acetylene, more vibrational modes are resolved due to the enhanced spectral resolution. Single molecule vibrational spectroscopy with atomic scale spatial resolution opens new possibilities to probe molecular interactions with high spectral resolution.

\textsuperscript{1}These authors contributed equally to this work
\textsuperscript{2}These authors contributed equally to this work

3:12PM H4.00007 3-dimensional indexation of the icosahedral diffraction pattern using the techniques of electron microscopy \textsuperscript{1} ANTONY BOURDILLON, UHRL — The following facts about icosahedra need wider attention. 1) The golden section \(\tau\) as fundamental to the icosahedral structure (length /edge) as \(\pi\) is to the sphere (circumference /diameter). 2) The diffraction series are in restricted Fibonacci order because the ratio of adjacent terms \(f_n/f_{n-1}\) does not vary, but is the constant \(\tau\). The series is therefore geometric. 3) Because of the tetragonal subgroup in the icosahedral point group symmetry, many axes in the icosahedral structure have identical orientation to axes in the face centered cubic matrix of Al\(_n\)Mn \cite{Shechtman1984} (e.g. [100] and [111]). On these bases, a three dimensional stereographic projection will be presented. 4) A quasi-Bragg law is derived that correctly represents the diffraction series in powers of \(\tau\) \cite{Bourdillon2009}. Furthermore, by employing the normal conventions of electron microscopy, all diffraction patterns are completely indexed in three dimensions. These are the topic of this presentation. Significant consequences will be presented elsewhere: 1) The diffraction pattern intensities near all main axes are correctly simulated, and all atoms are located on a specimen image. 2) The quasi-Bragg law has a special metric. Atomic locations are consistently calculated for the first time. 3) Whereas the Bragg law transforms a crystal lattice in real space into a reciprocal lattice in diffraction space, the quasi-Bragg law transforms a geometric diffraction pattern into a hierarchic structure. 4) Hyperspatial indexation \cite{Duneau2006} is superceded. \cite{Duneau2006} Shechtman, D.; Blech, I.; Gratias, D.; Cahn, J.W., Metallic phase with long-range orientational order and no translational symmetry, Phys. Rev. Lett., 1984, 53, 1951-3. \cite{Bourdillon2009} Bourdillon, A. J., Nearly free electron band structures in a logarithmically periodic solid, Sol. State Comm. 2009, 149, 1221-1225. \cite{Duneau2006} Duneau, M., and Katz, A., Phys Rev Lett 54, 2689-2691

3:24PM H4.00008 Exact Diagonalization studies of Entanglement Entropy of zig-zag spin chains with Heisenberg and ring-exchange interaction\textsuperscript{1} JON SPALDING, DONG-NING SHENG, California State University, Northridge — In the study of interacting quantum spin chains, the ground state wavefunction carries information about the phases of matter that occur for different interaction parameters. In this case, a spin-1/2 chain with 3 interaction terms in the Hamiltonian—nearest neighbor, next nearest neighbor, and ring exchange, is investigated using entanglement entropy to map out a ground state phase diagram. In addition, further information can be obtained from the entanglement spectrum. Finally, preliminary investigations of the effects of an impurity on this triangular Heisenberg ladder are reported.

\textsuperscript{1}NSF grants DMR-0906816 and DMR-1205734

3:36PM H4.00009 Experimental investigation of the temperature effects on CO\textsubscript{2} permeability of fractured coal rock\textsuperscript{1} YANG JU, State Key Laboratory of Coal Resources and Safe Mining, China University of Mining Technology, Beijing 100083, HUIJIE WANG, School of Mechanics and Civil Engineering, China University of Mining Technology, Beijing 100083, RANJITH PATHEGAMA GAMAGE, Department of Civil Engineering, Monash University, Melbourne, Victoria, 3800, Australia, HUAFeI SUN, School of Mechanics and Civil Engineering, China University of Mining Technology, Beijing 100083 — Accurate prediction of gas permeability is of great significance for coalbed methane production and CO\textsubscript{2} sequestration. The permeability of coal rock plays a key role in determining coalbed methane productivity in the application of simultaneous excavation of coal and gas in deep coal mines. The main objective of this study is to investigate the temperature effects on the permeability of fractured coal rock in deep coal seams. The CO\textsubscript{2} permeability of the fractured coal samples obtained from Ping Ding Shan coalfield, China, was measured using high pressure undrained triaxial apparatus. To probe the temperature effects, four levels of temperatures (25-75\textdegree C) were tested with the injection pressures ranging from 7 to 11MPa and a confining pressure of 15MPa. It is shown that the CO\textsubscript{2} permeability of the fractured coal rock rises apparently with an increasing temperature. The physical mechanism that governs the CO\textsubscript{2} permeability of coal rock is discussed in this study.

\textsuperscript{1}The authors acknowledge the supports of NSFC for Distinguished Young Scholars of China (No.51125017) and Basic Research Development Program of China (Nos.2010CB226804,2011CB201201)