2012 Annual Fall Meeting of the APS Prairie Section
Lawrence, Kansas
http://www.aps.org/meetings/meeting.cfm?name=PSF12
The peculiar band structure of graphene is responsible for a variety of unusual many-body effects, e.g., a logarithmic divergence of the group velocity of electron quasiparticles near the Dirac point. Interesting many-body effects have also been predicted for doped graphene sheets. Due to the lack of Galilean invariance in this system, both the plasmon frequency and the Drude weight in the optical conductivity are enhanced relative to the standard RPA values. The orbital magnetic susceptibility, which vanishes in the free-electron approximation, is found to be positive, i.e., paramagnetic, and its value is completely controlled by the electron-electron interaction. I review these theoretical predictions vis-a-vis the current state of the experiment.

Footnote:

1Work supported by NSF Grant DMR-1104788.
9:05AM A2.00002 Third harmonic generation in graphene, NARDEEP KUMAR, JATINDER KUMAR, CHRIS GERSTENKORN, University of Kansas, RUI WANG, University of Kansas and University of Iowa, HSIN-YING CHIU, University of Kansas, ARTHUR SMIRL, University of Iowa, HUI ZHAO, University of Kansas — Third-harmonic generation (THG) is a third-order nonlinear optical process. In this process, the electric field of incident light generates a third-order polarization at triple frequency in matter, in addition to the linear and second-order polarizations. Radiation of this polarization gives rise to light at third-harmonic frequency. Here we report the first experimental observations of THG in graphene and few layer graphene. The samples were fabricated by mechanically exfoliating graphene flakes from a bulk graphite crystal with adhesive tapes. The flakes were deposited on Si/SiO$_2$ substrates. The thickness of the flakes was determined by using their optical contrasts and atomic force microscopy measurements. These flakes were irradiated by femtosecond near-infrared laser pulses. The third harmonic generated in these flakes was detected by using a spectrometer. We verified that the wavelength of the emitted light is one third of the incident light, and its intensity increases with the incident light intensity to the third power. We also studied the dependence on the third harmonic generation on the thickness of the flakes.

9:17AM A2.00003 Heat generation based on graphene with plasmonic nanostructures under illumination, HUI-CHUN CHIEN, GUOWEI XU, JUDY WU, HSIN-YING CHIU, University of Kansas — We study the heat generation based on the graphene decorated with self-assembly silver nanoparticles under uniform illumination. Photoreponse from our devices was observed in high vacuum, which possibly was attributed to the change of interfacial properties between silver nanoparticles and graphene due to the heat generation by plasmonic-enhanced light trapping. Based on this heat generation mechanism, in this talk, we also present a novel scheme of photodetection with high photoresponsivity by employing liquid electrolyte in our system. Moreover, the photo-thermoelectric device will be proposed for solar energy applications.

9:29AM A2.00004 High-Performance Lithium-ion Battery Anode Based on Core-Shell Heterostructure of Silicon-Coated Vertically Aligned Carbon Nanofibers, JUN LI, Kansas State University — This study reports a high-performance hybrid lithium-ion anode material using coaxially coated Si shells on vertically aligned carbon nanofiber (VACNF) cores. The unique “cup-stacking” graphitic microstructure makes VACNFs a good Li$^+$ intercalation medium and, more importantly, a robust brush-like conductive core to effectively connect high-capacity Si shells for Li$^+$ storage. The vertical core-shell nanostructures remain well separated from each other even after coating with bulk quantities of Si (equivalent to over 1.5 μm thick solid films). This open structure allows the Si shells to freely expand/contract in the maximum radial direction during Li$^+$ insertion/extraction. A high specific capacity of 3000-3650 mAh/(g$_{Si}$)$^{-1}$, comparable to the maximum value of amorphous Si, has been achieved. About 89% of capacity is retained after 100 charge-discharge cycles at C/1 rate. After long cycling, the electrode material becomes even more stable, showing invariant Li$^+$ storage capacity as the charge-discharge rate is increased by 20 times from C/10 to C/0.5 (or 2C). Surprisingly, the measured Li$^+$ insertion/extraction capacity increases as the rate is further increased to ~8C. The short diffusion path length for Li$^+$ across the thin Si shell is the key to facilitate the fast electrochemical reaction. The ability to obtain high capacity at significantly improved power rates while maintaining the extraordinary cycle stability demonstrates that this novel structure could be a promising anode material for high-performance Li-ion batteries.

Friday, November 9, 2012 10:40AM - 12:03PM –
Session B1 High Energy and Nuclear Physics I Oread Hotel Hancock Room - Chair: Michael Murray, University of Kansas

10:40AM B1.00001 Investigating the Quark Gluon Plasma with Heavy Ion Collisions, SCOTT PRATT, Michigan State University — By colliding heavy ion collisions at high energies, mesoscopic regions are created with temperatures near 4 x 10$^{12}$ Kelvin. At these temperatures, protons and other hadrons melt and the quark-gluon plasma (QGP) is created. The transient state exists for less than 10$^{-22}$ seconds before cooling and disassociating. Experiments at the Relativistic Heavy Ion Collider and at the LHC record the tracks of the thousands of outgoing hadrons and electromagnetic particles in a single event. I will provide a few examples of how chemical and bulk properties of the QGP can be extracted by comparing sophisticated models of the collision to data.

1Support was provided by the U.S. Department of Energy, Grant No. DE-FG02-03ER41259, and by the U.S. National Science Foundation, Grant No. PHY-0653432.

11:15AM B1.00002 Where and How to Find Strong Parity and CP Violation, JOHN RALSTON, University of Kansas — Testing strong CP symmetry in usually considered a task of low energy, high precision experiments. Meanwhile strong parity and CP symmetry at collider energies has not been adequately questioned, or tested. By constructing numerous new observables and a novel approach to high energy collider physics, we argue that strong CP violation can be discovered at existing facilities. Multiparticle data, when properly processed, can provide superb discovery tools.

11:27AM B1.00003 Photoproduction of J/Psi in ultra-peripheral PbPb collisions at center-of-mass energy of 2.76 TeV in CMS, RAYMOND PATRICK KENNY III, The University of Kansas, CMS COLLABORATION — Ultra-peripheral collisions (UPCs) of heavy ions involve long range electromagnetic interactions at impact parameters larger than twice the nuclear radius. At TeV energies, the strong electromagnetic field due to the coherent action of the Z=82 proton charges generates a large flux of photons, which can be used for high-energy photoproduction studies. Heavy vector mesons (for example J/psi, Psi’, Upsilon) produced in electromagnetic interactions provide direct information on the parton distribution functions in the nucleus at very low values of Bjorken-x. These events are characterized by a very low hadron multiplicity. The wide pseudorapidity coverage of the CMS detectors is used to separate such events from very peripheral nuclear interactions. The CMS experiment has excellent capabilities for the measurement of the heavy vector mesons in the di-muon decay channel using the tracker and the muon chambers. This analysis demonstrates CMS’s capabilities for measuring J/Psi in ultra-peripheral collisions.

11:39AM B1.00004 Derivation of the Geometry of PbPb Collisions at 2.76 TeV Using Correlations between the Zero Degree Calorimeter Signal and Pixel Multiplicity, JEFF WOOD, Compact Muon Solenoid — The geometry of PbPb collisions is derived using correlations from the zero degree calorimeter (ZDC) signal and pixel multiplicity at the Compact Muon Solenoid (CMS) Experiment using data from the heavy ion run in 2010. The method to derive the geometry takes the two-dimensional correlation between the ZDC and pixels and linearizes it for sorting events. A comparison to the current derivation of this geometry from the energy deposit in the forward hadronic calorimeter (HF) to the correlations in the ZDC versus pixels is made. This comparison highlights the similarities between the results of both methods in collisions with large nuclear overlap, as expected, and deviations in the results in collisions with smaller nuclear overlap.
Friday, November 9, 2012 10:40AM - 12:03PM —
Session B2 Atomic, Molecular and Optical Physics Oread Hotel Griffith Room - Chair: Hui Zhao, University of Kansas

10:40AM B2.00001 From cosmology to cold atoms: observation of Sakharov oscillations in quenched atomic superfluids\(^1\), CHENG CHIN, University of Chicago — Sakharov oscillations, conventionally discussed in the context of early universe evolution and the anisotropy of cosmic microwave background radiation, is the manifestation of interfering acoustic waves synchronously generated in an ideal fluid. In atomic superfluids, the ease to induce acoustic excitations makes them a convenient test ground to study and understand this intriguing phenomenon in the laboratory setting. In recent years, many ideas have been proposed to associate cosmological and gravitational phenomena to the non-equilibrium dynamics of quantum gases. Here we report the laboratory observation of Sakharov oscillations in a quenched atomic superfluid. We quench the sample by Feshbach tuning and monitor the subsequent density fluctuations at different time and length scales by in situ imaging. Sakharov oscillations are identified as the multi-peak structure in the density power spectrum, resembling that of the cosmic microwave background radiation. We also observe Sakharov oscillations in the time domain, from which we extract the energy dispersion of the superfluid, and determine the sonic horizon of the excitations. Our work opens up new perspectives to investigate non-equilibrium dynamics of quantum fluids and its analogues in cosmology and astrophysics.

\(^1\)This work is supported in part by the U.S. Department of Energy.

11:15AM B2.00002 Resonant enhancement of single attosecond pulses by time-delayed control field\(^1\), WEI-CHUN CHU, CHII-DONG LIN, Kansas State University — An attosecond coherent control scheme is theoretically investigated. An XUV single attosecond pulse propagates through a dense helium gas medium dressed by a time-delayed laser pulse. The laser pulse in the intensity range \(10^{12}-10^{13}\) W/cm\(^2\) couples the \(2s2p^1\,P\) and \(2s^2\,1S\) resonances while the weak XUV pulse excites the former from the ground state. By tuning the dressing field specifically, we demonstrate an enhancement of the XUV pulse at the resonance energy up to 50% of the input intensity, which exemplifies the reshaping of a broadband attosecond pulse controlled by an ultrashort laser for the first time.

\(^1\)The work is supported by NSF Award PHY-1206095, ARO Grant W911NF0710576 with funds from the DARPA OLE Program, and the Packard Foundation.

11:27AM B2.00003 Equations of state of strongly interacting two-dimensional Bose gases\(^1\), LI-CHUNG HA, The University of Chicago, CHEN-LUNG HUNG, California Institute of Technology, ULRICH EISMANN, SHIH-KUANG TUNG, CHENG CHIN, The University of Chicago — We study strongly interacting two-dimensional Bose gases based on \textit{in situ} density profiles of the sample in the superfluid and critical fluctuation regimes. We achieve strong interaction between atoms by using a magnetically tuned Feshbach resonance and by confining the atoms into an optical lattice. In the superfluid phase, the measured compressibilities deviate from the mean-field prediction when the interaction is strong, and are in better agreement with the renormalization calculation. Near the critical point of the Berezinskii-Kosterlitz-Thouless transition, we find that the equations of state scale universally with respect to the interaction strength within the range of the probe. We extract the critical chemical potentials, critical densities as well as the renormalized interaction strengths and compare the results to the mean-field and renormalization calculations.

\(^1\)This work is supported by NSF Award PHY-1206095, ARO Grant W911NF0710576 with funds from the DARPA OLE Program, and the Packard Foundation.

11:39AM B2.00004 Identification of collisional resonances and three-body universal- ity based on an ultracold mixture of Li-6 and Cs-133 atoms\(^1\), SHIH-KUANG TUNG, COLIN PARKER, JACOB JOHANSEN, CHENG CHIN, University of Chicago — One unique feature about ultracold atom experiments is that we are able to control how atoms interact. When two atoms move towards each other, their scattering wavefunction can couple to a bound state near the scattering continuum, and the scattering amplitude can develop a resonant enhancement, which we called a Feshbach resonance. Here we report our observations on the Feshbach resonances in an ultracold mixture of fermionic Li-6 and bosonic Cs-133 atoms. Those resonances provide us essential information to control the interactions between the two atomic species, which opens up many exciting research fronts, especially to explore the three-body universality of the mixture.

\(^1\)AFOSR-MURI , DARPA-OLE, Packard Fellowship and NSF-MRESC

11:51AM B2.00005 Quantum Mechanics Without Planck’s Constant, JOHN RALSTON, University of Kansas — Planck’s constant was introduced as a fundamental unit in the early history of quantum mechanics. We find a modern approach where Planck’s constant is absent: It is unobservable except as a constant of human convention. Despite long reference to experiment, review shows that Planck’s constant cannot be obtained from the data of Ryberg, Davison and Germer, Compton, or that used by Planck himself. In the new approach Planck’s constant is tied to macroscopic conventions of Newtonian origin, which are dispensable. The precision of other fundamental constants is substantially improved by eliminating Planck’s constant. The electron mass is determined about 67 times more precisely, and the unit of electric charge determined 139 times more precisely. Improvement in the experimental value of the fine structure constant allows new types of experiment to be compared towards finding “new physics.” The long-standing goal of eliminating reliance on the artifact known as the International Prototype Kilogram can be accomplished to assist progress in fundamental physics.

Friday, November 9, 2012 2:00PM - 3:47PM —
Session C1 High Energy and Nuclear Physics II Oread Hotel Hancock Room - Chair: Graham Wilson, University of Kansas
2:00PM C1.00001 Discovery of a Higgs-like resonance and implications for what’s next, HOWARD BAER, University of Oklahoma — The recent discovery of a Higgs-like resonance at ~ 125 GeV by the Atlas and CMS collaborations— with corroborating evidence from CDF and D0 at Fermilab Tevatron— is an outstanding achievement and suggests the completion of the Standard Model. The 125 GeV mass value also falls in the narrow window predicted by models of weak scale supersymmetry (SUSY), although so far there is no sign of SUSY. At first sight, the new LHC mass limits on SUSY particles seem in discord with the measured value of $M_Z$, exacerbating what is known as the “little hierarchy problem”; how can such large values of SUSY model parameters conspire to yield a Z boson mass of just 91.2 GeV? A new paradigm model of SUSY is emerging, known as natural SUSY, which may be difficult to detect at LHC, but which gives rise to new matter states— light higgsinos— which ought to be detectable at a linear $e^+e^-$ collider operating at 0.3–1 TeV. Such a scenario also requires revision of expectations for dark matter: in natural SUSY, one might expect both an axion and a higgsino-like WIMP to appear.

2:35PM C1.00002 Anti-Neutrino-induced Hyperon Production with ArgoNeuT, SAIMA FAROOQ, Kansas State University, ARGONEUT COLLABORATION, MICROBOONE COLLABORATION — ArgoNeuT is a small scale (170 liter) Liquid Argon Time Projection Chamber (LArTPC) which is located at Fermi National Accelerator Laboratory in Batavia, Illinois. ArgoNeuT is located 330 feet underground, upstream of the MINOS near detector, exposed to the on-axis NUMI neutrino beamline. It is an R&D project paving the way for bigger LArTPCs such as MicroBooNE and kiloton-ton scale devices. ArgoNeuT can provide bubble chamber quality images and excellent background rejection. The detector takes neutrino interactions in the 0.1 to 10 GeV range, providing the first ever low energy neutrino interactions data within a LArTPC. There are very few studies on neutral hyperon production via charge current quasielastic (CCQE) neutrino interactions. LArTPCs, with the ability to see the detached vertex of a neutral hyperon decay, makes it stand out among other experiments. Among other measurements, ArgoNeuT will allow for a study comparing CCQE neutral hyperon production and CCQE neutrino production at low energy.

2:47PM C1.00003 Reactor anti-neutrino disappearance and other exciting physics with Double Chooz1, DEEPAK SHRESTHA, Kansas State University, DOUBLE CHOOZ COLLABORATION — Double Chooz is a reactor anti-neutrino experiment which has shown evidence of electron anti-neutrino disappearance at 1 km distance. It has been able to exclude the no-oscillation hypothesis at 99.8% CL (2.9σ) with only one detector. From a rate plus spectral shape analysis the value of sin$^22\theta_{13}$ was found to be 0.109 $\pm$ 0.030(stat) $\pm$ 0.025(syst). Additionally, Double Chooz has proved to be a pioneer in conducting exciting physics analyses in neutrino sector, such as the search for Lorentz violation with a reactor-based anti-neutrino source, neutrino directional analysis and the background analysis with purely reactor-off data.

1On behalf of the Double Chooz collaboration.

2:59PM C1.00004 Higgs boson Mass in GMSB with Messenger-Matter mixing, ABDELHAMID ALBAID, Wichita State University, KALADI BABU, Oklahoma State University — A Higgs-like particle of order 125 GeV has been observed by both ATLAS and CMS experiments. In simple single version of minimal GMSB models, this Higgs mass causes sparticle masses in the several to multi-TeV range in the simple version of minimal GMSB models. We consider the effects of messenger–matter mixing on the lightest CP–even Higgs boson mass in gauge–mediated supersymmetry breaking models. We find with such mixings a 125 GeV Higgs boson can be naturally obtained even with a sub–TeV SUSY spectrum, and when the gravitino has a cosmologically preferred sub–keV mass. In addition, when these models are embedded into a grand unification framework with a $T(1)$ flavor symmetry they explain the fermion mass hierarchy and generate naturally large neutrino mixing angles accompanied with small quark mixing angles. While SUSY mediated flavor changing processes are sufficiently suppressed in such an embedding, it can resolve the apparent discrepancy in the CP asymmetry parameters $\sin 2\beta$ and $\epsilon_K$, and it predicts an observable $\mu \rightarrow e\gamma$ decay rate.

3:11PM C1.00005 Multianode Photomultiplier Testing for the 2013 CMS Hadronic Forward (HF) Upgrades, JARED CORSO, ZHE JIA, GARRETT FUNK, YASAR ONEL, University of Iowa — The Hadronic Forward (HF) section of the Compact Muon Solenoid, a detector at the Large Hadron Collider at CERN, will undergo various upgrades in 2013. The HF requires photomultiplier tubes (PMTs) to detect the energy signatures of hadronic collisions. The University of Iowa High Energy Physics group is responsible for testing new PMTs for the upgrade. These tests provide seven different operational parameters that will be used for the calibration and quality control before installation. The dark current test checks the noise generated by the PMTs at different voltages for the calibration and quality control before installation. The after pulse test measures the degradation of the vacuum chamber of each PMT as it relates to pulse noise. The linearity test measures the tube’s output under varying energies observed by the PMTs. The surface non-uniformity test checks the active face of the PMTs for signal uniformity and “hot spot” when there is no light source. The timing test observes the PMT’s reading and recovery speed. The linearity test measures the tube’s output under varying energies observed by the PMTs. The double pulse test checks the linearity of the PMT with two signals occurring 25 nanoseconds apart.

3:23PM C1.00006 Evidence for associated production of a single top quark and W boson from CMS, DANIEL NOONAN, University of Kansas, CMS COLLABORATION — Evidence is presented for the associated production of a single top quark and W boson in pp collisions at $\sqrt{s} = 7$ TeV with the CMS experiment at the LHC. The analyzed data corresponds to an integrated luminosity of 4.9 fb$^{-1}$. The measurement is performed using events with two leptons and a jet originated from a b quark. A multivariate analysis based on kinematic properties is utilized to separate the tt background from the signal. The observed signal has a significance of 4.0 $\sigma$ and corresponds to a cross section of $16^{+5}_{-4}$ pb, in agreement with the standard model expectation of $15.6 \pm 0.4^{+1.0}_{-1.2}$ pb.

3:35PM C1.00007 Study of $Z\gamma$ Helicity Distributions at CMS1, IRAKLI CHAKABERIA, Kansas State University — Measurement of the production of electroweak gauge bosons ($\gamma, W, Z$) provides important tests of the standard model. The production of a diboson final state at the Large Hadron Collider (LHC) can occur by quark-antiquark annihilation (t-channel) or by boson self-interaction (s-channel). The s-channel production provides a unique probe of triple gauge boson couplings (TGCG) and the effects of new physics on these couplings. CMS detector provides a very high resolution measurement of kinematic properties of the final state particles. Multivariate analysis using full kinematic picture may increase the sensitivity to anomalous TGCG. I present a study of the helicity angle distributions in the $Z\gamma$ production process at the CMS experiment at the CERN LHC.

1CMS Collaboration
2:00PM C2.00001 Theory of single-spin dynamics for transition-metal dopants in diamond¹. MICHAEL FLATTÉ, Department of Physics and Astronomy, University of Iowa — Spin centers in diamond, especially the well-studied nitrogen-vacancy center, exhibit exceptionally favorable properties for quantum control, including remarkably long room temperature spin coherence times, optical excitation, manipulation by RF fields and optical readout. Although transition-metal dopants in diamond have not been as extensively studied, they offer novel opportunities for external control of single-spin dynamics by comparison, which originate from the symmetry of the dopant’s d shell in a tetrahedral lattice and the presence of strong spin-orbit coupling. The d-shell states of a substitutional transition-metal dopant can be either strongly hybridized with the diamond host electronic structure (t²2 symmetry states) or very weakly hybridized (e symmetry states) due to a mismatch of the symmetry of the states of the dopant and host. Thus the electronic wave function of the spin-1 ground state of a dopant like Cr is atomic-like and unresponsive to external perturbations of the lattice or an applied electric field. Ni, which also has a spin-1 ground state, has strongly hybridized electronic wave functions and is sensitive to local strain and electric fields. The more extended states that produce the Ni ground state spin provide helpful consequences for spin manipulation. The ground state of Ni is found to behave as a spin-1/2 predominately on the Ni site and a ferromagnetically-oriented spin-1/2 predominately on the four nearest-neighbor carbon sites around the Ni. Under compressive hydrostatic strain the overlap between these two wave functions increases and a transition can be reached where the two spins orient antiferromagnetically; a similar effect is seen in double quantum dots where it has been used to perform exchange-only quantum operations on a qubit composed of the two-electron spin singlet and the zero-magnetization two-electron spin triplet. We propose use of the same effect for strain-mediated control of encoded qubits in diamond.

¹This work has been supported by DARPA QUEST and an AFOSR MURI.

2:35PM C2.00002 Evidence for the Collective Nature of the Reentrant Integer Quantum Hall States of the Second Landau Level, ASHWANI KUMAR, Monmouth College, IL, NIANPEI DENG, MICHAEL MANFRA, Purdue University, LOREN PFEIFFER, KEN WEST, Princeton University, GABOR CSATHY, Purdue University — At low temperatures and in the presence of magnetic field, high quality two dimensional electron systems exhibit exotic states of matter such as fractional quantum states and the reentrant integer quantum Hall States (RIQHS). In this presentation we report a systematic study of RIQHS in the second Landau level. We observed an unexpected sharp peak in the temperature dependence of the magnetoresistance of the RIQHS. This peak defines the onset temperature of these states. We find that in different spin branches the onset temperatures of the reentrant states scale with the Coulomb energy. This scaling provides direct evidence that Coulomb interactions play an important role in the formation of these reentrant states evincing their collective nature.

2:47PM C2.00003 The effect of spin fluctuations on scattering rates in diluted magnetic semiconductors¹, MATTHEW MOWER, GIOVANNI VIGNALE, University of Missouri — We study the scattering rate of carriers due to large spin fluctuations in diluted magnetic semiconductors near the ferromagnetic transition. Both the carrier-impurity and carrier-carrier scattering rates are considered. We calculate an enhancement of the carrier resistivity when crossing from the paramagnetic to ferromagnetic regimes. The enhanced resistivity has a noticeable impact on spin lifetimes from the Dyakonov-Perel and Elliott-Yafet spin relaxation mechanisms.

¹Work supported by NSF-DMR 1104788.

2:59PM C2.00004 Protein folding intermediates probed by ensemble of their transient stiffnesses in single-molecule force-quenched AFM¹, ROBERT SZOSZKIEWICZ, KATARZYNA MALEK, Kansas State University — By using force-quench AFM (FQ-AFM) spectroscopy molecular structures with transient stiffnesses are detected during folding of a recombinant protein with four I27 molecules linked in tandem. The intermediate stiffnesses are detected from shape and peaks of the autocorrelation of fluctuations in end-to-end lengths of the folding molecules, as well as by applying the equipartition theorem to the FQ-AFM experimental results. In the light of the relevant molecular dynamics simulations these intermediates are likely to probe the ensemble of random-coiled collapsed states present both in the force-quench and thermal-quench folding pathways.

¹This work was supported by the Thierry Johnson Cancer Research Center at KSU, as well as NSF EPS-0903806 and matching support from the State of Kansas through Kansas Technology Enterprise Corporation.

3:11PM C2.00005 Substrate effect on few-layer MoS2 transistors, JATINDER KUMAR, HUICHUN CHIEN, HSIN-YING CHIU, Department of Physics and Astronomy, University of Kansas, KS 66045 — Due to the realization of graphene transistors but without applicable bandgap, the similar two-dimensional MoS2 and MoSe2 field effect transistors with nonzero bandgap have been demonstrated and reveal promising potential. Previous experiments showed that carrier mobility could be enhanced by depositing hafnium dioxide (HfO2) on top of MoS2 devices, which was possibly attribute to the suppression of Coulomb scattering by high-k environment and surface polar phonon scattering. In our talk, we will present the electrical transport experiments in few layers of MoS2 on HfO2 dielectrics, including the carrier mobility improvement and electrical transport phenomena in high bias region.

3:33PM C2.00006 Using Atomic Layer Deposition for Josephson Junction Quantum Bits, ALAN ELLIOTT, GARY MALEK, RONGTAO LU, SIYUAN HAN, JUDY WU, University of Kansas Dept. of Physics & Astronomy, H.F. YU, G.M. XUE, S.P. ZHAO, Beijing National Laboratory for Condensed Matter Physics, Chinese Academy of Sciences — Ultrathin dielectric tunneling barriers are critical to Josephson junction (JJ) based superconducting quantum bits (qubits). However, the prevailing technique of thermally oxidizing aluminum via oxygen diffusion produces problematic point defects, such as oxygen vacancies, which are believed to be a primary source of the two-level fluctuators that contribute to decoherence of the qubits. Atomic Layer Deposition (ALD) of aluminum oxide (Al₂O₃) is a promising alternative to resolve the issue of oxygen vacancies in the Al₂O₃ tunneling barrier, and its self-limiting growth mechanism provides atomic-scale precision in tunneling barrier thickness control. ALD has been implemented in a high-vacuum magnetron sputtering system for in situ deposition of Al₂O₃ tunneling barriers in superconductor-insulator-superconductor (SIS) JJs. The modifications made to the Al surface during ALD were explored with ellipsometry and atomic force microscopy, and ALD-Al₂O₃ barriers were grown on Nb to form Nb/Al₂O₃/Nb JJs. Preliminary low temperature measurements of current-voltage characteristics of the Josephson junctions made from these trilayers confirmed the integrity of the ALD-Al₂O₃ barrier layer.
4:15PM D1.00001 Measuring the Red Sequence Slope in a Distant Galaxy Cluster , ERIN SCHULTZ, GREGORY RUDNICK, University of Kansas — Our project goal is to constrain the possible stellar mass dependence of galaxy ages for red sequence galaxies. We use the Y, J, and K-band data collected from the Very Large Telescope in Chile of the $z = 1.62$ galaxy cluster XMM-LSS J02182-051020. This spectroscopically confirmed galaxy cluster is one of the only known massive clusters at an epoch close to the time when stars stopped forming within red sequence galaxies. For red sequence galaxies, which have little recent star formation and little dust, the color is an indicator of the luminosity weighted age of the stars. This is in turn correlated to the last epoch of significant star formation. At the same time, the mass of such a galaxy is correlated to its magnitude. The more stars a galaxy contains, the more massive and brighter the galaxy. The slope of the red sequence in color-magnitude space, therefore, gives an indication of the dependence of galaxy age on stellar mass. We use the age-sensitive Y-J color and measure a slope of zero for the red sequence in Y-J vs. J. We interpret this to mean that the age does not depend strongly on the mass of the galaxy. If time allows, we will present the limits on the slope of the color-magnitude relation and will discuss what limits this corresponds to on the age dependence with mass.

4:27PM D1.00002 The Role of Clusters and Groups in Stopping Gas Accretion onto Galaxies , GREGORY RUDNICK, University of Kansas, PASCALE JABLONKA, École Polytechnique Fédérale de Lausanne, Switzerland, JOHN MOUSTAKAS, Siena College — Despite decades of work, it is still unclear whether a galaxy’s properties are affected by environment or whether they are determined solely by the galaxy’s mass. We will present the new results they shed light on the key question of how properties of galaxies may be altered by dense environments. We use a stellar mass selected sample consisting of hundreds of cluster, group, and field galaxies at $0.4 < z < 0.8$ with multi-wavelength imaging and deep spectroscopy. We identify galaxies whose light is dominated by old stellar populations and, contrary to expectations, we find that these “old” galaxies at intermediate redshift have a high likelihood of hosting weak [OII] emission. In contrast, analogously old galaxies in clusters and groups are significantly less likely to have activity. Our results imply that the cluster and group environments are effective at either stripping out gas from deep in the potential wells of galaxies or at cutting off their fuel supply of fresh new gas. Our work is possible because we probe a large number of clusters (not available in DEEP2 or COSMOS) as well as coeval group and field galaxies, and use deep Spitzer observations to search for dust-obscured star formation.

4:39PM D1.00003 Constraining dark energy models using Hubble parameter, Supernova, and BAO Data 1, MUHAMMAD FAROOQ, Kansas State University — We use Hubble parameter versus redshift data, Baryon Acoustic Oscillation (BAO) data and Supernova Type Ia (SNeIa) data to place constraints on model parameters of one constant two one time-evolving dark energy cosmological models. These constraints are we got are pretty much consistent with (through not as restrictive as) those derived by Yun & Ratra (2011). The reason for that is the systematic errors in new BAO and SNeIa data are more as compared to the old data Yun & Ratra (2011). A joint analysis of the Hubble parameter data with more restrictive baryon acoustic oscillation peak length scale and supernova Type Ia apparent magnitude data favors a spatially-flat cosmological model currently dominated by a time-independent cosmological constant but does not exclude slow time-varying dark energy.

1Supported by DOE grant DEFG03-99ER41093 and NSF grant AST-1109275.

4:51PM D1.00004 Forecasting cosmological parameter constraints from near-future space-based galaxy surveys, ANATOLY PAVLOV, Kansas State University, LADO SAMUSHIA, University of Portsmouth, BHARAT RATRA, Kansas State University — The next generation of space-based galaxy surveys are expected to measure the growth rate of structure to about a percent level over a range of redshifts. The rate of growth of structure as a function of redshift depends on the behavior of dark energy and so can be used to constrain parameters of dark energy models. In this work we investigate how well these future data will be able to constrain the time dependence of the dark energy density. We consider parameterizations of the dark energy equation of state, such as $\Lambda$CDM, as well as a consistent physical model of time-evolving scalar field dark energy, $\omega$CDM. We show that if the standard, specially-flat cosmological model is taken as a fiducial model of the Universe, these near-future measurements of structure growth will be able to constrain the time dependence of scalar field dark energy density to a precision of about 10%, which is almost an order of magnitude better than what can be achieved from a compilation of currently available data sets.

5:03PM D1.00005 A Correlation of Magnitudes, Color and Redshift in Cosmologically Distant Type 1a Supernovae , GOPOLANG MOHLABENG, JOHN RALSTON, University of Kansas — We independently explore the Union 2.1 data set (Supernova Cosmology Project) of 580 type Ia supernovae. We find a correlation of very high statistical significance between supernova color × redshift and distance modulus residuals relative to the standard cosmological model. We find a Pearson correlation coefficient $r_{\text{col}} = -0.521$, which is more than 13 standard deviations ($\sigma$) away from the mean obtained by Monte-Carlo simulations with random data shuffling. We find that adding one parameter to the standard magnitude vs redshift relation improves the value of $\chi^2$ by more than 50 units. The updated Dark Energy and matter density parameters, assuming a flat universe $\Omega_m = 0.260 \pm 0.013$ and $\Omega_m = 0.74 \pm 0.013$ and $\Omega_m = 0.260 \pm 0.013$. The trend of the correlation is that distant supernovae become redder as a function of redshift by a rule which cannot be fit by the standard Cosmology.

5:15PM D1.00006 Formation and Origin of Rotation Equations for Planetary and Stellar Bodies , STEWART BREKKER, Northeastern Illinois University (former grad student) — Planets began with a planetary core, slowly rotating, with rings of molten material orbiting it. The gravitational attraction of the core caused the orbits of the rings of material to decay and the rings tangentially collided with the planetary core attaching to the core and transferring the orbital momentum of each of the rings to the planetary core thereby increasing the rotational speed of the newly formed planet. The equation for this phenomenon is as follows: $(1/2)\omega_{\text{core}}^2 + (1/2)\omega_{\text{ring}}^2 + ... = (1/2)\omega_{\text{planet}}^2$. Stars began with a slowly rotating stellar core orbited by rings and partial rings of primarily hydrogen in motion. As the gravitational attraction of the stellar core caused the orbits of the rings and partial rings to decay the rings and partial rings of hydrogen tangentially collided with the rotating stellar core attaching and transferring their orbital momentum to the stellar core thereby causing a speeded up rotation of the newly formed star. The equation for this stellar formation and origin of rotation is as follows: $(1/2)\omega_{\text{stellar core}}^2 + (1/2)\omega_{\text{ring}}^2 + ... + (1/2)\omega_{\text{ring}}^2 = (1/2)\omega_{\text{star}}^2$. 
Friday, November 9, 2012 4:15PM - 5:27PM

Session D2 Condensed Matter Physics III  Oread Hotel Griffith Room - Chair: Siyuan Han, University of Kansas

4:15PM D2.00001 Effect of Oxygen on the Stability of Ag islands on Si(111)-(7x7)  
DAHAI SHAO, Ames Laboratory. Department of Chemistry, Iowa State University, XIAOJIE LIU, NING LIU, C.Z. WANG, KAI-MING HU, MICHAEL TRINGIDES, Ames Laboratory. Department of Physics and Astronomy, Iowa State University, PATRICIA THIEL, Ames Laboratory. Department of Chemistry, and Department of Materials Science and Engineering, Iowa State University, THIEL RESEARCH GROUP TEAM — We are working to determine whether an electronic effect known as the quantum size effect can influence chemisorption on Ag islands of different height. We have used scanning tunneling microscopy to probe the effect of oxygen exposure on an ensemble of Ag islands separated by an Ag wetting layer on Si(111)-(7x7). Starting from a distribution dominated by islands that are 1 layer high (measured with respect to the wetting layer), coarsening in ultrahigh vacuum at room temperature leads to growth of 2-layer islands at the expense of 1-layer islands, which is expected. If, however, the sample is exposed to oxygen, coarsening leads to growth of 3-layer islands. There is no evidence for oxygen adsorption on top of Ag islands, but there is clear evidence for adsorption in the wetting layer. Density functional theory supports a model in which traces of oxygen on top of Ag islands can change the height-dependent relative stabilities of the islands. Dahai Shao, et al. Surf. Sci. 606, 1871 (2012).

4:27PM D2.00002 Characterizing the Superconducting Properties of NbSe2 Using Point Contact Spectroscopy  
JAMES HANSEN, Missouri State University, LAURA GREENE, University of Illinois at Urbana Champaign — Superconductivity has applications from MRI machines in hospitals to high energy particle accelerators like those at CERN. However to find more applications in medicine, research, and industry we must better understand superconductivity and discover higher temperature superconductors. Point Contact Spectroscopy (PCS) is an important tool for studying the electron interactions inside a material. Using PCS I studied the electronic properties of niobium diselenide (NbSe2) which exhibits a charge density wave (CDW) below 33.5 K and superconductors below 7.2 K. The superconducting energy gap was determined by the spectroscopic data obtained being fitted to the Blonder-Tinkham-Klapwijk theory of conductance. Several temperature evolutions of the PCS conductance reveal no signatures of the CDW. The data obtained was also an important diagnostic of PCS junction quality.

4:39PM D2.00003 Optical Properties of Lead Borate Glasses Containing Ag Nanoparticles  
P.K. BABU, AKINLOLUWA OLUIMOROTI, SAISSUDA MALLUR, Western Illinois University — We prepared a series of lead borate glasses containing Ag nanoparticles. Ag nanoparticles were derived from silver nitrate that was added as a precursor during glass preparation. Thermochromic reduction of silver nitrate to silver atom was achieved by controlled annealing near the glass transition temperature. Transmission electron microscope (TEM) images confirm the formation of Ag nanoparticles and the variation of their sizes with the duration of annealing. Optical absorption experiments show that a well-defined surface plasmon resonance (SPR) peak can be observed only for samples that were annealed for 36 hrs. We also investigated the effect of Ag nanoparticles on the fluorescence of Pb2+ ions. The excitation spectra obtained at two different emission wavelengths clearly show that Ag nanoparticles create new Pb2+ emission centers by altering the chemical environment of lead ions. Comparing our results with earlier investigations on Pb2+ fluorescence reveals that the new emission centers represent lead dimers and lead aggregates. Detailed analysis of the emission spectra show that in lead borate glasses containing Ag nanoparticles, the fraction of lead aggregates increases systematically with heat treatment.

4:51PM D2.00004 Optical techniques to study electronic transport in solids  
HUI ZHAO, University of Kansas — In most transport studies, currents are generated and detected by electrical techniques. Although these techniques can have superior sensitivities and high spatial resolution, most of them require contacts and device fabrications, can only study steady-state transport that is sensitive to spin. Using ultrashort pump optical techniques provides additional time-resolution complementary to these traditional techniques, and can overcome some of the limitations. First, a coherent control technique by utilizing quantum interference between multiple interband transitions can be used to generate ballistic charge and spin currents. Second, by incorporating a differential detection scheme in transient absorption microscopy, we can monitor transport of electrons with sub-nanometer spatial resolution and femtosecond time resolution, even with micrometer-sized laser spots. Third, we use nonlinear optical effects induced by currents to achieve non-invasive and non-destructive detection of charge and spin currents in real time. By combining these techniques, we have recently studied intrinsic spin Hall effect, plasma oscillation, optical effects of spin currents in GaAs, and charge carrier diffusion in several nanoscale materials.

5:03PM D2.00005 Development of doped and plasmonic graphene for transparent conductive electrodes and photodetector  
JIANWEI LIU, GUOWEI XU, RONGTAO LU, RONGQING HUI, JUDY WU, University of Kansas Dept. of Physics & Astronomy — Graphene nanohole arrays (GNAs) were fabricated using nanoimprint lithography. The improved optical transmittance of GNAs is primarily due to the reduced surface coverage of graphene from the nanohole fabrication. The exposed edges of the nanoholes provided effective sites for chemical doping using thionyl chloride was shown to enhance the conductance by a factor of 15-18 in contrast to only 2-4 for unpatterned graphene. We fabricated plasmonic graphene using thermally assisted self-assembly of silver nanoparticles on graphene. The localized-surface-plasmonic effect is demonstrated with the resonance frequency shifting from 446 nm to 495 nm when the lateral dimension of the Ag nanoparticles increases from about 50 nm to 150 nm. The plasmonic graphene shows much improved electrical conductance by a factor of 2-4 as compared to the original graphene, making the plasmonic graphene a promising advanced transparent conductor with enhanced light scattering for thin-film optoelectronic devices. Along this direction, we developed a scheme of photodetection based on ionic liquid grafted graphene with plasmonic metal nanostructures.

5:15PM D2.00006 Micromechanical Model for Structural Transition of Secondary Phase Oxide Nanorods in Epitaxial YBa2Cu3O7 Films  
JACK SHI, JUDY WU, University of Kansas Dept. of Physics & Astronomy — A micromechanical model based on the theory of elasticity has been developed to study the configuration of self-assembled secondary phase oxide nanostructures in high temperature superconducting YBa2Cu3O7−x (YBCO) films. With the calculated equilibrium strain and elastic energy of the impurity doped film, a phase diagram of lattice mismatches vs. elastic constants of the dopant was obtained that predicts the energetically-preferred orientation of secondary phase nanorods. The structural transition of the nanorods orientation was studied with impurity doped YBCO films on vicinal SrTiO3 substrates. It was found that the increase of the vicinal angle of the substrate leads to a substantial change of the strain field in the film, resulting in a transition of the nanorod orientation from the normal to in-plane direction of the film. The calculated threshold vicinal angle for the onset of the transition and lattice deformation of the YBCO film due to the inclusion of the nanorods are in very good agreement with experimental observations. This result sheds lights on understanding of the role of the film/substrate lattice mismatch in controlling self-assembly of dopant nanostructures in matrix films.
E1.00001 Data throughput testing for the CMS pixel upgrade, DAVID GIER, University of Kansas/CMS Collaboration — The Optical Hybrid converts a differential signal to an optical signal as part of the data readout chain for the CMS detector at the Large Hadron Collider at CERN. The current Analog Optical Hybrid must be updated to a Pixel Optical Hybrid which can run at the 400Mbps rate of the upcoming Pixel Detector upgrade. This project tests the optical hybrids by examining eye diagrams, simulating data streams from the detector and constructing bit error rate test firmware.

E1.00002 X-ray studies of the pixel readout for the CMS detector, JACKSON YOUNG, University of Kansas, CMS COLLABORATION — X-ray tests have been conducted on the silicon pixel detectors which are being used in the Compact Muon Solenoid experiment at the Large Hadron Collider. Using an X-ray box setup at the University of Kansas, a broad scope of tests from simple parameter effects to more complex multi stage tests have been performed. A fluorescence setup was made to allow the adjustment of incoming particle energy which allows one to calibrate the energy in the detectors. The trimming algorithm used to adjust the readout threshold for each pixel is also studied using X-rays.

E1.00003 ABSTRACT WITHDRAWN —

E1.00004 Astrophysical magnetic micro-turbulence: relation of diffusion of relativistic electrons to the emitted radiation spectra, B. KEENAN, M.V. MEDVEDEV, U. Kansas — Kinetic (Weibel-type) instabilities are ubiquitous in astrophysical high-energy density environments, e.g., in relativistic collisionless shocks, reconnection regions of relativistic winds from neutron stars with the interstellar medium, and so on. Such instabilities generate strong (sub-equilibrium) magnetic fields which reside at small, sub-Larmor scales. Efficient electron acceleration to relativistic energies is not uncommon in such environments. Spectra of radiation emitted by these relativistic electrons, called jitter radiation, can deliver wealth of information about the internal structure of such “Weibel turbulence.” The small-scale fields simulate the particle transport via pitch-angle diffusion. Both effect are related and can be used to diagnose the astrophysical plasmas. Indeed, the radiation pattern is intimately related to the particle orbits and, thus, to the transport properties of the turbulence. We study such a relation between transport in and radiation from micro-scale turbulence via numerical simulations and analysis.

E1.00005 Revisiting the Carrington Event: Updated modeling of atmospheric effects, BRIAN THOMAS, KEITH ARKENBERG, BROCK SNYDER, Washburn University — The terrestrial effects of major solar events such as the Carrington white-light flare and subsequent geomagnetic storm of August-September 1859 are of considerable interest, especially in light of recent predictions that such extreme events will be more likely over the coming decades. Here we present results of modeling the atmospheric effects, especially production of odd nitrogen compounds and subsequent depletion of ozone, by solar protons associated with the Carrington event. This study combines approaches from two previous studies of the atmospheric effect of this event. We investigate changes in NOx compounds as well as depletion of O3 using a two-dimensional atmospheric chemistry and dynamics model. Atmospheric ionization is computed using a range-energy relation with four different proxy proton spectra associated with more recent well-known solar proton events. We find that changes in atmospheric constituents are in reasonable agreement with previous studies, but effects of the four proxy spectra used vary more widely than found by one of those studies. In particular, we find greater impact for harder proton spectra, given a constant total fluence. We report computed nitrate deposition values and compare to measured values in ice cores.

E1.00006 Mass-Eigenstate Scattering and Conversion of Non-Relativistic Self-Interacting Flavor-Mixed Dark Matter Particles, A. FORD, M.V. MEDVEDEV, U. Kansas — Some Cold Dark Matter candidates are flavor-mixed particles. Recently, it has been shown that a collision (scattering) of two non-relativistic flavor-mixed particles, as in a self-interacting dark matter model, can cause the particles to experience mass eigenstate conversions, which in turn can ultimately lead to their escape from a trapping gravitational potential of a dark matter halo. Such a process has an important effect on the large scale structure formation and provides an elegant solution to several outstanding cosmological problems. Here we study elementary processes involving flavor-mixed particles – elastic scatterings and conversions – and calculate cross-sections of these processes under various conditions. Our results are of great importance for fundamental theory of the interaction of mixed particles and for understanding of the cosmological structure formation.

E1.00007 Sub-nanoscale Resolution for Microscopy via Coherent Population Trapping and Coherent Population Oscillations, KISHOR KAPALE, Western Illinois University, GIRESH AGARWAL, Oklahoma State University — We present microscopy schemes to attain sub-nanoscale resolution based on two phenomena—coherent population trapping (CPT) and coherent population oscillation (CPO). The CPT-based method uses three-level atoms coupled to amplitude modulated probe field and a spatially dependent drive field. Whereas, the CPO based schemes involve two-level atoms coupled to two optical fields slightly different in frequency. The modulation of the probe field (in CPT-based scheme) allows us to tap into the steep dispersion normally associated with electromagnetically induced transparency and offers an avenue to attain sub-nanometer resolution using just the optical fields. CPO-based schemes offer similar resolution as the CPT-based schemes but they are attainable in a larger class of materials. It is known that group velocity manipulations with the CPO effect have been observed in room temperature solids and biological samples as opposed to in atomic vapors and cold atomic gases in the case of CPT. This parallel allows us to extend our CPT-based work to CPO-based microscopy schemes and makes them attainable in much larger class of materials including solids and biological samples.
E1.00008 Local Thermomechanical Analysis of a Microphase-Separated Thin Lamellar PS-b-PEO Film, REGINALD RICE, Kansas State University — We use atomic force microscopy (AFM) and hot tip AFM (HT-AFM) to thermophysi- cally characterize a 30 nm thick film of polystyrene-block-ethylene oxide, PS-b-PEO, and to modify its lamellar pattern having spacing of 39 ± 3 nm. AFM tip scans of the polymer film induce either abrasive surface patterns or nanoscale ripples, which depend upon the tip force, temperature, and number of scans. The evolution of the lamellar pattern is explained by the polymer film molecular structure and mode I crack propagation in the polymer combined with the stick-and-slip behavior of the AFM tip. The HT-AFM measurements at various tip-sample temperatures and scanning speeds yield several thermophysical quantities.

E1.00009 Mechanical Unfolding of the NRR Domain from Human Notch 1, ASHIM DEY, KATARZYNA MALEK, NICOLETA PLOSCARIU, ROBERT SZOSZKIEWICZ, Kansas State University — Notch signaling in mammals is responsible for cellular processes related to embryonic development and tissue homeostasis. Problems in Notch signaling lead to many diseases, including T-cell acute lymphocytic leukemia and solid tumors in breast cancer. Exposure of the S2 site within an extracellular NRR domain of Notch is the key early event in Notch signaling. In this paper we use single molecule force-extension (FX) AFM force spectroscopy to investigate the role of mechanical force in unfolding the NRR domain from human Notch 1. We provide probability analysis of the NRR unfolding traces, which supports the sequential NRR unfolding model. Our FX AFM measurements provide us also with histogram of the N to C termini lengths related to conformational transitions within the NRR domain. By fitting multiple Gaussians to this histogram we detect four classes of events. Based on the related steered molecular dynamics (SMD) study, we associate the first two classes of events with the S2 site exposure. We obtain that their mean unfolding forces are 77.2 ± 60.4 pN and 82.2 ± 57.67 pN, respectively. These substantial molecular forces constitute a double protection barrier against any accidental S2 site exposure.

E1.00010 Average Energy Approximation of the Ideal Bose-Einstein Gas and Condensate, DON LEMONS, Bethel College of North Newton, Kansas — I introduce and use the average energy approximation according to which the particles of an ideal quantum gas all have the average energy of the system. For instance, if the N bosons that compose an ideal Bose-Einstein gas with energy E and volume V are each assumed to have the average energy E/N, the entropy is easily expressed in terms of the number of bosons N and the number of single-particle microstates n they can occupy. Because the entropy derived is a function of only N and n, and the latter is a function of the extensive variables, E, V, and N, this entropy describes all that can be known of the thermodynamics of this fluid system. In particular, the entropy recovers the Sakur-Tetrode entropy in the classical limit and at sufficiently low temperatures describes an unstable system. A thermodynamic stability analysis recovers the Bose-Einstein condensate and a two-phase region. Apart from numerical factors of order one, results are identical with those derived via standard, probabilistic methods.

E1.00011 The Continuing Development of a Low-Cost Scanning Tunneling Microscope for High School and College Classrooms, BRETT AMEN, Doane College, AXEL ENDERS, University of Nebraska - Lincoln, MARK PLANO CLARK, University of Cincinnati — We have been developing an inexpensive, room-temperature, atmospheric-pressure scanning tunneling microscope (STM) with atomic resolution for use in high school class rooms and undergraduate teaching laboratories. Because of a lack of consistency during coarse approach and withdrawal of the tip head using the inertial slip-stick design, we are developing a “walker” motion consisting of four linear piezo actuators moving independently under microcontroller control. In addition to improving the coarse motion, we also need more robust atomically sharp tips for scanning surfaces at atmospheric pressure. We are in the process of producing sharp carbon fiber tips to make this STM an effective tool for the intended audience.

E1.00012 Neutron scattering studies of glassy solid state Li electrolytes, LEO ZELLA, New Mexico State University and the University of Missouri Research Reactor, ALI ZAIDI, Missouri State University, MUNESH RATHORE, ANHUMAN DALVI, Birla Institute of Technology and Science, SAIBAL MITRA, Missouri State University, TOM HEITMANN, University of Missouri Research Reactor — We present characterizations, performed using two different neutron scattering techniques, on superionic materials that are good candidates for use as solid state electrolytes in next generation Li+ ion batteries. The materials are glassy in nature and composed of a complex network of the following sub-units: Li2O, Li2SO4, and 2NH4H2PO3. This disordered structure is integral to its function in that it promotes Li+ ion conduction while suppressing electron conduction, the necessary qualities of a good Li+ electrolyte. We have implemented neutron diffraction to study the formation of crystallites upon heating of the material above 400° C. The crystallite formation is understood to be detrimental to the Li+ ion mobility and, hence, is identified with a diminished performance in devices that require heating in their fabrication process. We have also used a triple-axis spectrometer to begin to separate out the diffuse scattering that results from the disordered structure of the material from the diffuse scattering that results from dynamic processes that occur in it. This is done by a comparative study of the energy resolved versus energy integrated scattering over the full available q-range.

E1.00013 Seedling Detection in a Flatbed Scanner Image Acquisition System for Plant Growth Studies, BRAD R. HIGGINS, TESSA DURHAM BROOKS, CHRISTOPHER D. WENTWORTH, Doane College, Crete, NE — Recent plant genome studies have made use of a low cost flatbed scanner image acquisition system to obtain a large number of image sequences showing growth of seedlings. This system has generated a significant database of images for growth studies of the model plant Arabidopsis thaliana with varying genetic and environmental conditions. Analysis of image sequences must be automated due to the very large number of images that need to be studied. We have developed a processing algorithm and code that can identify individual seedlings and track them over time in a scanner image sequence. Our code can also remove unused parts of the image thereby saving hard drive storage requirements for the image database. The code was developed in Python using functions from the open source image processing library OpenCV. The code is available under an open source license.

1Department of Physics, Kansas State University, Manhattan, Kansas 66506

2Department of Physics

3Department of Biology

4Department of Physics

1This work was supported in part by NSF Award #0621702 and by the Doane College Summer Undergraduate Research Program.
includes integration over the internal phases describing the oscillations. For $N$ physics.

I will give some examples from astrophysics, but these problems appear in almost all areas of contemporary experimental

settled on a framework for big data analysis that will not satisfy the needs of physics; we are going to have to create new methods if we are

of models we might want to use grow, and the precision requirements and expectations for experimental results grow. The dot-com world has

York University — The problem of big data is not really a problem of data volume and data management per se; it is a problem of inference

American Rooms

This project was an ideal activity for students to learn about measurement and analysis of data and an introduction to atmospheric physics.

recording GPS position, temperature, atmospheric pressure and relative humidity during the three hour flight. The payload also carried a digital

students designed and constructed a helium balloon that lofted a 3.0 kg payload to 26500 m. An Arduino Mega acted as flight computer,

High altitude ballooning is a popular scientific activity for colleges and high schools. In this three week summer project, four undergraduate

E1.00014 An Empirical Study of the Velocity Field for Arabidopsis Root Cells¹, AMY E. CRAIG², TRACY GUY², BRAD HIGGINS⁴, TESSA DURHAM BROOKS⁵, CHRISTOPHER D. WENTWORTH⁶, Doane College — The velocity field of a plant’s primary root describes the velocity of cells as a function of position measured with respect to the root apex. This field has a characteristic sigmoidal shape in many plants that can be described empirically by a modified logistics function. In this study we measured the velocity field for root cells in Arabidopsis thaliana for several different genotypes and environmental conditions using an inexpensive computer-based image acquisition and analysis system. Image analysis was done using open source software. We fit our data to the modified logistics function and determined whether there were statistically significant changes in model parameters depending on growing conditions.

¹This work was supported in part by NSF Award #0621702 and by the Nebraska EPSCoR Undergraduate Research Experience in Small Colleges and Universities Program.

²Dept. of Physics
³Dept. of Biology
⁴Dept. of Physics
⁵Dept. of Biology
⁶Dept. of Physics

E1.00015 Excluded-volume effects of molecular vibrations in a one-dimensional gas , JAMES H. TAYLOR, Univ. of Central Missouri — Some common thermodynamic properties are found for $N$ rod-like, vibrating molecules in 1D, where the length of each molecule oscillates with an amplitude determined by the molecule’s internal vibrational energy. Properties are found via exact evaluation of the partition function, $Z$; to account for the different possible lengths of individual molecules, calculation of $Z$ includes integration over the internal phases describing the oscillations. For $N$ greater than 1 and large system length $L$, there is an increase in the average energy of the system at a given temperature—compared to that for molecules with fixed lengths—as well as in the entropy and isothermal compressibility; the pressure decreases, though, and there is a variable effect on the heat capacity. These alterations can be traced directly to an effective increase in the 1D volume available to the molecules, the changes being larger for higher energy states than for lower ones. The oscillations have minimal influence when $L$ is large compared to the combined length of all molecules, but dominate the behavior when the two lengths become comparable.

E1.00016 High Altitude Ballooning: A Physics Experience For Undergraduate Students , TIMOTHY STILES, CORBIN PETERSON, GAGE DECOOK, PATRICK CRAWFORD, ANDREW SELEP, Monmouth College — High altitude ballooning is a popular scientific activity for colleges and high schools. In this three week summer project, four undergraduate students designed and constructed a helium balloon that lofted a 3.0 kg payload to 26500 m. An Arduino Mega acted as flight computer, recording GPS position, temperature, atmospheric pressure and relative humidity during the three hour flight. The payload also carried a digital camera and GPS receiver/satellite phone to transmit locations. The payload was successfully recovered and the data analyzed by the students. This project was an ideal activity for students to learn about measurement and analysis of data and an introduction to atmospheric physics.

Friday, November 9, 2012 7:00PM - 9:30PM –
Session F1 Banquet and After-Dinner Speaker Adams Alumni Center Bruckmiller/McGee/All-American Rooms

7:00PM F1.00001 SOCIAL/GATHERING TIME –

7:30PM F1.00002 DINNER –

8:30PM F1.00003 Big data challenges for physics in the next decades . DAVID HOGG, New York University — The problem of big data is not really a problem of data volume and data management per se; it is a problem of inference or learning. As data sets grow, the numbers of and subtleties of questions we might want to ask grow, the required or supported complexities of models we might want to use grow, and the precision requirements and expectations for experimental results grow. The dot-com world has settled on a framework for big data analysis that will not satisfy the needs of physics; we are going to have to create new methods if we are going to succeed. I will give some examples from astrophysics, but these problems appear in almost all areas of contemporary experimental physics.

Saturday, November 10, 2012 8:30AM - 9:30AM –
Session G1 Astrophysics, Cosmology and Space Science III Oread Hotel Hancock Room -
Chair: Hume Feldman, University of Kansas

8:30AM G1.00001 Ions in the Plume of Enceladus and the Role of Grain Interactions , SRIHARSHA POTHAPRAGADA, THOMAS CRAVENS, University of Kansas, NATALY OZAK, Weizmann Institute of Science, Rehovot, Israel, MIHALY HORÁNYI, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, United States, SASCHA KEMPFF, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, United States, GERAINT JONES, Mullard Space Science Laboratory, University College of London, Holmbury St. Mary, United Kingdom — Data from instruments aboard the Cassini Orbiter indicate plumes of neutral gas and ice from the southern polar region on the Saturn’s moon, Enceladus. Flyby missions through the plumes have measured plasma (both electron and ion) conditions and composition in addition to the magnetic field. INMS measurements point to H$_2$O$^+$ as the dominant ion species through rapid reaction of H$_2$O$^+$, OH$^+$, and O$^+$ species with neutral H$_2$O. CAPS has reported presence of both positive and negative ions along with measured water cluster ions. We present results from Monte Carlo/test particle simulations to model the ion distribution for different species in the Enceladus plumes. We have incorporated previously proposed models of the plume / atmosphere density and plasma flow around the satellite. Effects of charge exchange, photo-ionization and dust-grain collisional ionizations by the electron and ion distributions are included in the models. We aim to interpret Cassini data by understanding the contributions of each of these effects on the observed ion, neutral and electron fluxes.
Science & Engineering, Sichuan University, China, JUDY WU, University of Kansas Dept. of Physics & Astronomy — This work explores MEETH, JIANWEI LIU, RONGTAO LU, PAUL HARRISON, University of Kansas Dept. of Physics & Astronomy, BING LI, College of Materials University of Kansas the search for a suitable location, and the process of muon detection and how it can be used to determine characteristics of the primary cosmic much higher energy cosmic rays. Mini-Tunka is on-going and I will be discussing the process of setting up the experiment, from hardware to in the process, hopefully resolve some anomalies in the Tunka data. Ultimately the study of Cherenkov radiation will aid in the study of other neutral line model has a more complex final state structure, which does indicate self-similarity, with a fractal structure to be determined.

MARTIN, DANIEL HOLLAND, CONNOR BRENNAN, JAMIE SVETICH, Illinois State University — In this paper we examine chaotic scattering to detect particle showers and measure Cherenkov light. Mini-Tunka is an attempt to re-create the Tunka experiment locally and on a smaller scale for the detection of cosmic ray muons. From the measurements I will attempt to determine the nature of the primary cosmic rays and, in the process, hopefully resolve some anomalies in the Tunka data. Ultimately the study of Cherenkov radiation will aid in the study of other much higher energy cosmic rays. Mini-Tunka is on-going and I will be discussing the process of setting up the experiment, from hardware to the search for a suitable location, and the process of muon detection and how it can be used to determine characteristics of the primary cosmic rays, such as direction and approach and energy.

9:06AM G1.00004 Mini-Tunka . KATE ORR, University of Kansas — Tunka is a 133-antenna array whose purpose is to detect particle showers and measure Cherenkov light. Mini-Tunka is an attempt to re-create the Tunka experiment locally and on a smaller scale for the detection of cosmic ray muons. From the measurements I will attempt to determine the nature of the primary cosmic rays and, in the process, hopefully resolve some anomalies in the Tunka data. Ultimately the study of Cherenkov radiation will aid in the study of other much higher energy cosmic rays. Mini-Tunka is on-going and I will be discussing the process of setting up the experiment, from hardware to the search for a suitable location, and the process of muon detection and how it can be used to determine characteristics of the primary cosmic rays, such as direction and approach and energy.

9:18AM G1.00005 Preliminary work for developing a Method for Surface Wave Detection1. ANDREW JOHANNESEN, AMY ZHENG, University of Kansas — It is theoretically possible to improve current methods of ultra-high energy neutrino detection by observing askaryan radiation via dielectric-dielectric surface waves rather than bulk waves. The purpose of our research was to observe properties of these surface waves within the paradigm of neutrino detection. Observations were made of waves propagating through various dense dielectric media including granulated fused silica, polystyrene foam, deionized water, and granulated sodium chloride at preliminary frequencies of 1500, 1000, and 750 MHz. Larger scale granulated fused silica measurements were taken at the frequencies of 600 and 300 MHz. Limited experimental result would indicate a qualitative increase in attenuation length for radio frequency waves propagating along a dielectric-dielectric surface rather than exclusively in either dielectric substance. Further investigation should be in the far-field, substantially lower frequency, and in the context of the surface layer between ice and air.

1Thank you to Dave Besson and Marie Piasecki

Saturday, November 10, 2012 8:30AM - 9:30AM
Session G2 Condensed Matter Physics IV Oread Hotel Griffith Room - Chair: Matthew Antonik, University of Kansas

8:30AM G2.00001 PLD Fabrication of CdTe-based Thin Film Solar Cells, D. JAKE MEETH, JIANWEI LIU, RONGTAO LU, PAUL HARRISON, University of Kansas Dept. of Physics & Astronomy, BING LI, College of Materials Science & Engineering, Sichuan University, China, JUDY WU, University of Kansas Dept. of Physics & Astronomy — This work explores in situ fabrication of thin film solar cells using pulsed laser deposition (PLD). Optimization of the PLD processing conditions, including laser energy density, substrate temperature, and the PLD chamber pressure, was achieved with respect to pinhole-free CdS and CdTe layers and solar power conversion efficiency. By introducing a novel quantum based structure called Single Offset Superlattice (SOS) to the thin film cell, further increases to the efficiency have been made. SOS allows for tuning of the charge carrier density of the semiconductor. The efficiency of a thin film solar cell can be improved, relatively easily, by pairing the SOS structure with the complicated structure of SOS. High efficiency up to 6.8% has been demonstrated with a CdS (100nm)/CdTe (1500nm) cell and 8.8% efficiency has been achieved with the introduction of SOS structure. Improved performance is expected with optimized PLD conditions and SOS dimensions.

8:42AM G2.00002 Al2O3 Conformal Coating of High-Aspect-Ratio Vertically Aligned Carbon Nanofiber Array Using Atomic Layer Deposition . GARY MALEK, JUDY WU, RONGTAO LU, JIANWEI LIU, ALAN ELLIOT, LOGAN WILLE, University of Kansas Dept. of Physics & Astronomy, JUN LI, STEVEN KLANKOWSKI, Kansas State University, Department of Chemistry — A vertically aligned carbon nanofiber array (VACNFA) was used as a high-aspect-ratio substrate for atomic layer deposition (ALD) coating of aluminum oxide (Al2O3). Al2O3 was deposited on the VACNFA using alternating pulses of trimethylalumimium and distilled water for each cycle. The VACNFA was chosen as the substrate because of its large surface area as a result of the three dimensional structure and its surface reactivity due to outside dangling bonds. This reactive nature eliminated the need for functionalization of the VACNFA before ALD deposition. Transmission electron microscopy (TEM) was used to verify the Al2O3 layer conformally coated the VACNFA despite its high-aspect ratio. TEM images also revealed an approximate growth rate of the Al2O3 layer to be 0.85 Å/cycle. Therefore, we can control the thickness of the Al2O3 layer on the VACNFA by tuning the number of ALD cycles.
present the use of non-equilibrium response spectroscopy (NRS) technique where the randomly generated pulses constantly drive the channel. Markov models for the same ion channel. It is argued that by using stepped potentials, the channel is always being observed at equilibrium. We parameters between states of the models are empirically determined. Using this current technique, researchers have proposed more than one number of possible states with one or more of these states corresponding to the channel being open. Using the patch clamp technique and data from single channel recordings with stepped potential protocols, Markov models are proposed for different ion channels. The transition rate in the turnoff, coincident with an apparent main sequence gap. The junctions is much smaller than the value expected from the Ambegaokar-Baratoff formula suggesting a significant pair-breaking mechanism at the interfaces. The Use of NRS Pulses to Select Among Competing Markov Models for the Same Ion Channel. NICK MARTINEZ, AZIDA WALKER, Department of Physics and Astronomy, University of Central Arkansas — Markov models are used to describe the probability of a system being in a certain state and is completely independent of the previous states. If the correct parameters are applied, these models have the ability to predict the random occurrence of protein unfolding to form ion channels. The Markov models of ion channels are used to determine the probability of the channel being in a number of possible states with one or more of these states corresponding to the channel being open. Using the patch clamp technique and data from single channel recordings with stepped potential protocols, Markov models are proposed for different ion channels. The transition rate parameters between states of the models are empirically determined. Using this current technique, researchers have proposed more than one Markov models for the same ion channel. It is argued that by using stepped potentials, the channel is always being observed at equilibrium. We present the use of non-equilibrium response spectroscopy (NRS) technique where the randomly generated pulses constantly drive the channel far from equilibrium where the channel is observed. The NRS pulses selected will yield different expectations from competing models for an L-type voltage gated calcium channel.

Minimum entropy coding of hierarchical mixture data. NATHANIEL MADDUX, JOHN RALSTON, University of Kansas — Many types of data consist of hierarchical mixtures of signals. For example, a fetal electrocardiogram is a linear combination of the maternal and fetal cardiac signals, each of which is composed of signals originating in different muscles and nerves. Linear combinations of the signals are sensed by several electrodes, yet the hierarchy of the component signals is hidden. In this talk, an intuitive geometric picture of hierarchical mixture data is developed by use of synthetic data. Results are shown of minimizing, through gradient descent, the entropy of a code for a synthetic hierarchical mixture dataset. The use of invariant subspaces of a linear operator to express a code for a hierarchical mixture is discussed. The approach is applied to the classification of multi-domain proteins by their essential dynamics. Nine teacup shaped "proteins" are constructed by combining 3 differently shaped bodies with 3 differently shaped handles. The impulse response function of each teacup is treated as a vector, the set of vectors is decomposed as a hierarchical mixture, and results are discussed.

Palladius and Horizontal Sundials - How 36 numbers and astronomy help us understand the ancient world. RAN SIVRON, JOHN RICHARDS, MASON BRUZA, Baker University — Palladius was a Roman aristocrat "gentleman farmer." He wrote the only surviving farmer’s almanac from the Roman period. It includes advice on how to take care of grapes, olives, wheat, and manage a farm. Farming chores need to be done in season and in the right time of the day. For describing when things should be done, he used a sundial. That’s why Palladius left a table of the length of the shadow of a pole - a Gnomon - for 11 hours in the first day of every month for 12 months, hence 36 numbers. Palladius presumed symmetries that cut this to 36 useful numbers, the only useful such table from Roman times. That is a treasure trove for both historians and astronomers! Unfortunately we know little else about Palladius, except that his farm was probably in Sardinia, and his family had property somewhere in Gaul, present day France. Its not clear when and where he wrote this, and that could be one question answered by those numbers. In trying to answer that specific question using spherical trigonometry and (as calibration) recipes for building a sundial from the first century BC, we discovered discrepancies. Those could indicate great error in assembling this table, great progress by assuming that Ptolemi’s greatest “discoveries” were taken into account, or a combination of several minor factors.

High Dispersion Spectroscopic Analyses of the Open Clusters NGC 6819 and NGC 7789. BARBARA ANTHONY-TWAROG, University of Kansas, CONSTANTINE DELIYANNIS, Indiana University, EVAN RICH, BRUCE TWAROG, University of Kansas — We have used the HYdra multi-object spectrophotograph on the WIYN 3.5m telescope to obtain high resolution spectra in the region of Li 6708A for 333 and 377 stars in the open clusters NGC 6819 and NGC 7789, respectively. Radial and rotational velocity measures have been obtained for the stars to identify and eliminate probable binaries and non-members from the sample through internal comparisons and external comparisons with previous work whenever possible. With the ultimate goal of mapping the evolution of Li with temperature, metallicity, and evolutionary phase, the samples cover the luminosity range from the tip of the giant branch to below the cluster turnoff. Reaching to V~16.5 in NGC 6819, we have identified and bracketed the location of the main sequence Li-dip in the turnoff region. A brighter limit to the sample in NGC 7789 at present allows us to just reach the hot side of the Li-dip in the turnoff, coincident with an apparent main sequence gap.

Chair: Bruce Twarog, University of Kansas

We gratefully acknowledge support from the National Science Foundation for E.A.R. as part of the REU program at San Diego State University under grant AST-0850564.
10:24AM H2.00004 In the Blink of an Eye: Seeing Mathematics through High-Speed Imagery, MICHAEL SOSTARECZ, Monmouth College — In this talk, we share how high-speed imagery can be used to illustrate mathematical concepts in the classroom and serve as the inspiration for student projects in mathematical modeling. Through comparisons with analytic solutions or numerical simulations of differential equations, we are able to see when a model is an accurate description of the experiment or if revisions to the model need to take place. Examples will be drawn from experiments in projectile motion, harmonic oscillators, and fluid dynamics.

1We gratefully acknowledge support from the National Science Foundation for S.B. as part of the REU program at San Diego State University under grant AST-0850564.

10:36AM H2.00005 Formation and dynamics of an electromagnetic bubble during the NS binary inspiral: theory and observational signatures¹, MIKHAIL MEDVEDEV, U. Kansas, A. LOEB, Harvard U. — We consider a merging binary system of either two magnetized neutron stars or magnetars, or a neutron star – black hole binary during the last year days of its evolution. Both compact companions possess magnetic moments and hence are sources of low-frequency electromagnetic (EM) waves, whose frequency is the inverse orbital period and, hence, does not exceed a few kHz. Such EM waves are evanescent: they do not propagate in ambient ISM plasmas because the wave frequency is below the plasma frequency. As the EM energy is continuously pumped into the system by the binary, there forms a cavity (or a bubble) filled with EM radiation. The bubble pushes on the surrounding plasma and can drive a shock wave through the ISM. The shock dynamics is different from the Sedov blast wave solution describing a freely expanding shock from a point-like explosion. Instead, the shock in the system at hand is continuously driven by the ever-increasing pressure inside the bubble. Here we explain the dynamics and evolution of the bubble and the driven shock. We predict that such shocks can be observed just before the merger. These sources become brighter and spectroscopically harder as the binary evolves toward the final merger. After the merger, the shock should ultimately settle onto the Sedov solution.

¹Supported by NSF and DOE via grant DE-FG02-07ER54940.

11:00AM H2.00006 Cosmogenic nuclide production within Earth’s atmosphere and long period comets, ANDREW OVERHOLT, MidAmerica Nazarene University — Our atmosphere is continually bombarded by cosmic rays. These high energy particles create showers of secondary particles produced in collisions with the atmosphere. As rare isotopes are produced in these showers they have served as an indicator of cosmic ray climate. Our work simulates these showers both in the Earth’s atmosphere and on long period comets. Long period comets spend a large amount of time outside the protection of the heliosphere where cosmic ray flux is greatly increased. Our work shows that this environment produces an abundance of cosmogenic nuclides on the comet. We find that the amount of $^{14}$C produced on large comets may be sufficient for creating anomalies within the $^{14}$C record.

Saturday, November 10, 2012 10:00AM - 11:00AM –
Session H2 Multidisciplinary Research Oread Hotel Griffith Room - Chair: Chris Fischer, University of Kansas

10:00AM H2.00001 Cooking DNA with muons, MICHAEL MURRAY, University of Kansas, ADRIAN MELOTT, University of Kansas, CHRISTOPHER FISHER, University of Kansas — Given the rate of nearby supernovae, the Earth must have been repeatedly bombarded with intense cosmic ray showers. There are major gaps in understanding the radiation impact of such an event, particularly the effect of several orders of magnitude increase in the muon flux on the ground. As muons are not an important part of the impact of conventional terrestrial radiation sources, almost no work has been done on their effects on biological molecules. This will be remedied by experimental studies of muon flux on accelerators on DNA.

10:12AM H2.00002 Physics-inspired techniques for segmenting human self-reported weight loss time series¹, DAVID MERTENS, JULIA PONCELA CASASNOVAS, Northwestern University Department of Chemical and Biological Engineering, BONNIE SPRING, Northwestern University Department of Preventive Medicine, L.A.N. AMARAL, Northwestern University Department of Chemical and Biological Engineering — Using techniques from statistical physics, physicists have modeled and analyzed human phenoma varying from academic citation rates to disease spreading to vehicular traffic jams. The last decade’s explosion of digital information and the growing ubiquity of smartphones has led to a wealth of human self-reported data. Unfortunately, the medical community has traditionally eschewed self-reported data due to concerns about dishonesty and the complexities of analyzing data that exhibits non-uniform sampling and statistically significant but physically insignificant correlations. How do we move beyond summary statistics? In this talk I present our physically motivated techniques for segmenting and characterizing individual human weight loss time series and contrast them with more traditional statistically and algorithmically motivated techniques.

¹Sponsored by the Howard Hughes Medical Institute.

10:24AM H2.00003 In the Blink of an Eye: Seeing Mathematics through High-Speed Imagery, MICHAEL SOSTARECZ, Monmouth College — In this talk, we share how high-speed imagery can be used to illustrate mathematical concepts in the classroom and serve as the inspiration for student projects in mathematical modeling. Through comparisons with analytic solutions or numerical simulations of differential equations, we are able to see when a model is an accurate description of the experiment or if revisions to the model need to take place. Examples will be drawn from experiments in projectile motion, harmonic oscillators, and fluid dynamics.
Experimental and Numerical Explorations of Water Bottle Rockets, BRANDON KEMERLING 1, TIM STILES 2, MICHAEL SOSTARECZ 3, Monmouth College — The simple setup of a 2-liter soda bottle partially filled with water and pressurized air can produce launches with velocities over 100 m/s in less than one tenth of a second. This project used high-speed imagery and tracking software to experimentally determine the position and velocity versus time profile. This study varies the initial air pressure and the water volume of the bottle rockets across a range of pressures from 2.0 to 8.0 times atmospheric pressure and volumes from only compressed air in the bottle to 1700 mL of water in the bottle. The results are consistent with models that include the use of Euler’s Equation to model the exit velocity of the water relative to the rocket.

1 Senior Physics/Mathematics double major
2 Professor of Physics
3 Professor of Mathematics

Evaluation of the Xbox Kinect Sensor for Three-Dimensional Positional Data Acquisition, JORGE BALLESTER, CHUCK PHEATT, Emporia State University — Microsoft introduced the Kinect sensor in November 2010 as an add-on peripheral for the Xbox 360 video game system. The sensor unit is designed to be positioned above or below a video display and to track player body and hand movements in three-dimensional space, which allows users to interact with the Xbox 360. The device contains a RGB camera, depth sensor, IR light source, three-axis accelerometer and multi-array microphone, as well as supporting hardware that allows the unit to output sensor information to an external device. In this presentation the authors evaluate the capabilities of a stand-alone Kinect sensor as a three-dimensional data acquisition platform for use in physics experimentation. Positional data obtained for a simple pendulum, a spherical pendulum, a projectile and a bouncing basketball will be presented. The expected uncertainty in positional data obtained from the Kinect sensor as well as the authors’ graphical interface will also be discussed. Overall, the Kinect is found to be both qualitatively and quantitatively useful as a motion data acquisition device in the physics lab.