Fall 2014 Joint Meeting of the Texas Section of the APS, Texas Section of the AAPT, and Zone 13 of the Society of Physics Students
College Station, Texas
http://www.aps.org/meetings/meeting.cfm?name=TSF14
Saturday, October 18, 2014 10:35AM - 12:35PM – Session 1A Workshop: When Pigs Fly and Various Other Characters   MPHY 211 - Beverly Trina Cannon, Gilliam Collegiate Academy

10:35AM 1A.00001 AAPT Workshop 1 –

Saturday, October 18, 2014 10:35AM - 12:35PM – Session 1B Workshop: Bulk It Up   MPHY 212 - Thomas O’Kuma, Lee College

10:35AM 1B.00001 AAPT Workshop 2 –

Saturday, October 18, 2014 3:35PM - 5:35PM – Session 2A Workshop: The Pendulum and Periodic Motion   MPHY 211 - Beverly Trina Cannon, Gilliam Collegiate Academy

3:35PM 2A.00001 AAPT Workshop 3 –


3:35PM 2B.00001 AAPT Workshop 4 –

Saturday, October 18, 2014 4:45PM - 6:45PM – Session 3A Workshop: Teaching Physics with no Budget   MPHY 211 - Janie Head, Foster High School

4:45PM 3A.00001 AAPT Workshop 5 –

Saturday, October 18, 2014 8:00AM - 8:15AM – Session AA1 Opening Remarks   MPHY 203-205 -

8:00AM AA1.00001 Opening Remarks –

Saturday, October 18, 2014 8:15AM - 10:03AM – Session A1 Plenary I   MPHY 203-205 -

8:15AM A1.00001 Measuring Dark Energy in the Universe DARREN DEPOY, Texas A&M University — Dark Energy is the major component of the Universe and the one we understand least. Parameters that characterize dark energy can be determined by measuring the distribution of matter in the Universe and I will describe how those measurements are made. I will also describe on-going and future projects to constrain the nature of dark energy.

8:51AM A1.00002 Wave-particle dualism and complementarity unraveled by a different mode, WOLFGANG SCHLEICH, University of Ulm —

Saturday, October 18, 2014 10:35AM - 12:35PM — Session B2 Atomic, Molecular and Optical Physics I — MIST 102 - Alexei Sokolov, Texas A&M University

10:35AM B2.00001 Toward Magneto-optical Cooling of $^7$Li, KARL A. BURKHARDT, ALINA BLINOVA, ISAAC CHAVEZ, KEVIN MELIN, MARK G. RAIZEN, Department of Physics, University of Texas at Austin — Laser cooling, the standard approach for producing ultra-cold atoms for the past thirty years, has reached saturation in the number of ultra-cold atoms produced per second and atomic density. We report the development of an alternative method for producing ultra-cold atoms and predict that it will far-surpass laser cooling. Our approach is based on magnetic deceleration of supersonic beams. Once the atoms are brought to rest in the lab frame, we will use internal-state optical pumping and magnetic field gradients to further cool and compress the atomic cloud. This talk will discuss progress toward the physical implementation of these methods with $^7$Li atoms.

10:47AM B2.00002 Neutral Atom Lithography Using a Pulsed Magnetic Lens, ERIK ANCIAXU, RODRIGO CASTILLO-GARZA, JAMIE GARDNER, MARK RAIZEN, University of Texas at Austin — We present the status of a method of neutral atom lithography that achieves sub-10nm resolution. This method is based on the nanoscale imaging of a beam of metastable atoms with an aberration-corrected hexapole lens. The lens creates a magnetic field gradient that increases with the distance from the center of the lens so as to focus divergent low field seeking atoms toward a single focal spot past the lens. The scheme takes advantage of the narrow velocity distribution of a pulsed supersonic beam as well as an optical pumping and cooling scheme that selects the magnetic state of the atoms and further reduces its velocity dispersion. This method can be used not only to pattern but to spectroscopically probe surfaces with spatial resolution below 10nm.

1M. G. R. acknowledges support from the U.S. National Science Foundation, the R. A. Welch Foundation (grant F-1258), and the Sid W. Richardson Foundation.

10:59AM B2.00003 High resolution neutral atom microscope, GEORGIOS STRATIS, IGAL BUCAY, RODRIGO CASTILLO-GARZA, MARK RAIZEN, University of Texas-Austin — We are developing a high resolution neutral atom microscope based on the technique of metastable impact electron emission (MIEES). When an incoming metastable noble gas atom approaches the surface of our sample, the noble gas atom falls to the ground state and an electron is emitted. The emitted electrons carry information regarding the density of states of the surface without any information from the underlying layers. Furthermore, using a chromatic aberration corrected magnetic hexapole lens we expect to image our atomic beam to a spot with a diameter less than 10nm. Our primary goal is to investigate how local phenomena can give rise to macroscopic effects in materials that cannot be probed using a scanning tunneling microscope.

11:11AM B2.00004 Microscopic theory of Bose-Einstein condensation in an interacting gas, VITALY KOCHAROVSKY1, Department of Physics and Astronomy, Texas A&M University, VLADIMIR KOCHAROVSKY2, Institute of Applied Physics, Russian Academy of Science — We find, for the first time, a microscopic theory of Bose-Einstein condensation in an interacting gas, which is valid both inside and outside a critical region. The derived exact fundamental equations for the condensate wave function and the Green’s functions allow one to describe critical fluctuations and formation of an ordered condensate phase from a disordered phase across the entire critical region continuously. These equations asymptotically turn into the usual Gross-Pitaevskii and Beliaev-Popov equations in a low-temperature limit outside the critical region. The theory is readily extendable to other phase transitions.

1College Station, TX 77843-4242
2603950, 46 Ulyanova street, Nizhny Novgorod, Russia

11:23AM B2.00005 Theoretical Analysis of Noise Induced Quantum Coherence, YIYU ZHOU, DIMITRI VORONINE, MARLAN SCULLY, Texas A&M Univ, IQSE TEAM — Quantum coherence has recently been studied in quantum heat engines such as lasers, solar cells, and photosynthetic complexes. Noise-Induced Coherence (NIC) can be spontaneously generated and does not require external laser sources. We investigate perform theoretical analysis of the effects of NIC under various conditions and the dependence on various parameters such as sample geometry and dynamics. Our work may lead to better understanding of photosynthesis and to development of more efficient solar cells.
11:35AM B2.00006 Formation of trains of attosecond pulses via ionization switching of the resonant interaction between XUV radiation and IR-field-dressed atoms, TIMUR AKHMEDZHANOV, Department of Physics and Astronomy, Texas A&M University and Institute for Quantum Studies and Engineering, College Station, TX 77843-4242, USA, VLADIMIR ANTONOV, Institute of Applied Physics of the Russian Academy of Sciences, 46 Ulyanov street, Nizhny Novgorod 603950, Russia, OLGA KOCHAROVSKAYA, Department of Physics and Astronomy, Texas A&M University and Institute for Quantum Studies and Engineering, College Station, TX 77843-4242, USA — Investigating processes unfolding on the attosecond time scale is one of the key aims of modern physics. Attosecond light pulses with carrier frequency in the vicinity of atomic resonances present themselves the major tool for study of such processes in atoms and molecules. Recently, we presented an analytical model describing formation of attosecond pulses from quasi-resonant quasi-monochromatic vacuum-ultraviolet (VUV) radiation in an atomic gas simultaneously irradiated by a moderately strong infrared (IR) laser field. Subcycle time-dependence of ionization rate of excited states of atoms is used to form attosecond pulses from VUV field. In this contribution we present the results of numerical solution of time-dependent Schrödinger equation for IR-dressed He atoms interacting with quasi-resonant XUV radiation. Our results demonstrate the possibility to form trains of pulses with pulse duration in the range of hundreds of attoseconds in atomic helium dressed by IR field. The results are in a rather good agreement with the analytical solution. Required parameters of IR dressing laser are achievable experimentally.

11:47AM B2.00007 Photoionization and photocurrents at sub-field-cycle temporal scale, PETER ZHOKHOV, ALEKSEI ZHELTIKOV, Physics & Astronomy Dept., Texas A&M University — The Keldysh theory of photoionization in solids is generalized to the case of arbitrarily short driving pulses of arbitrary shape and polarization. We derive a closed-form solution for the nonadiabatic ionization rate and field-driven currents in the solid-state electron-hole plasma. Our results indicate important role of ultrafast photoionization dynamics within the field cycle and link the ultrafast photoionization dynamics with experimentally accessible quantities.

11:59AM B2.00008 Beam shaping and production of vortex beams in coherent Raman generation, ALEXANDRA ZHDANOVA, Texas A&M University, MIAOCHAN ZHI, NIST, KAI WANG, JILA, HUA XIA, ALEXEI SOKOLOV, Texas A&M University — Broadened coherence one-dimensional vortex fields is obtained analytically (using Mathematica) and is confirmed by numerical calculations. Dimensional Potential Energy Surface of 2-Cyclopenten-1-one Ethylene Ketal, HONG-LI SHEU, Dept. of Chemistry, Texas A&M University 77843-3255, NIKLAS MENVANDER, Dept. of Military Technology, Finnish National Defence University, Helsinki Finland, JAAN LAAANE, Dept. of Chemistry, Texas A&M University 77843-3255 — The bicyclic spiro molecule 2-cyclopenten-1-one ethylene ketal (CEK) was studied by infrared and Raman spectroscopy. Density functional theory (DFT) calculations were utilized to compute the theoretical spectra and excellent agreement with the experimental spectra was observed. The structures and conformational energies for the two pairs of conformational minima, which can be defined in terms of ring-bending (x) and ring-twisting (τ) vibrational coordinates, were also calculated. The results from the ab initio MP2/cc-PVTZ computations, a two-dimensional potential energy surface (PES) was established. The energy levels and wavefunctions of the PES were then calculated and their characteristics were analyzed. At lower energies all of the quantum states are doubly degenerate and correspond to either the lower energy conformation L or to conformation H which is 154 cm⁻¹ higher in energy. At energies above the 264 cm⁻¹ barrier, the wavefunctions show that the quantum levels have significant probabilities for both conformations.


12:11PM B2.00009 Maximizing the response of a specific vibrational mode to a laser pulse, CHARLES SHANNON, ROLAND ALLEN, Texas A&M University — In previous publications [1,2] our group predicted the following for molecules and materials responding to femtosecond-scale optical laser pulses: The maximum relative excitation of a Raman-active vibrational mode with period T will be attained when the pulse has a full-width-at-half-maximum duration τ \approx 0.42T. The analytical model used for this prediction involved averaging over the oscillations of the field within the pulse, and the absolute (rather than relative) response is maximized as τ \to 0. Here we generalize the model to include the oscillations of the field, and we find that the absolute maximum is shifted to a nonzero value of the duration which depends on the other parameters of the laser pulse, as well as the period of the vibrational mode. This result is obtained analytically (using Mathematica) and is confirmed by numerical calculations.

12:23PM B2.00010 Vibrational Spectra, Theoretical Calculations, and the Two-Dimensional Potential Energy Surface of 2-Cyclopenten-1-one Ethylene Ketal, HONG-LI SHEU, Dept. of Chemistry, Texas A&M University 77843-3255, NIKLAS MENVANDER, Dept. of Military Technology, Finnish National Defence University, Helsinki Finland, JAAN LAAANE, Dept. of Chemistry, Texas A&M University 77843-3255 — The bicyclic spiro molecule 2-cyclopenten-1-one ethylene ketal (CEK) was studied by infrared and Raman spectroscopy. Density functional theory (DFT) calculations were utilized to compute the theoretical spectra and excellent agreement with the experimental spectra was observed. The structures and conformational energies for the two pairs of conformational minima, which can be defined in terms of ring-bending (x) and ring-twisting (τ) vibrational coordinates, were also calculated. Utilizing the results from ab initio MP2/cc-PVTZ computations, a two-dimensional potential energy surface (PES) was established. The energy levels and wavefunctions of the PES were then calculated and their characteristics were analyzed. At lower energies all of the quantum states are doubly degenerate and correspond to either the lower energy conformation L or to conformation H which is 154 cm⁻¹ higher in energy. At energies above the 264 cm⁻¹ barrier, the wavefunctions show that the quantum levels have significant probabilities for both conformations.

Saturday, October 18, 2014 10:35AM - 11:59AM – Session B3 Computational Physics

10:35AM B3.00001 Computer Simulations of Protein Interactions with Lipid Domains, RONALD DAVENPORT-DENDY, KWAN CHENG, Trinity University — Protein interactions with multi-component lipid bilayers are major molecular events in cell membranes. Using coarse-grained (CG) molecular dynamics simulations, we have studied the binding behavior and membrane disruption mechanics of a protein dimer on phase separated lipid rafts consisting of cholesterol, saturated and unsaturated lipids. Large size (50,000 CG-atoms) and long (3000 ns) simulations have been performed. We observed that the protein prefers to bind to the interface of liquid-ordered (Lo) and liquid-disordered (Ld) coexisting phases. When the polarity of cholesterol is increased, this interface becomes more hydrophilic and the protein prefers to bind at the interface. Using coarse-grained (CG) molecular dynamics simulations, we have studied the binding behavior and membrane disruption mechanics of a protein dimer on phase separated lipid rafts consisting of cholesterol, saturated and unsaturated lipids. Large size (50,000 CG-atoms) and long (3000 ns) simulations have been performed. We observed that the protein prefers to bind to the interface of liquid-ordered (Lo) and liquid-disordered (Ld) coexisting phases. When the polarity of cholesterol is increased, this interface becomes more hydrophilic and the protein prefers to bind at the interface. Using coarse-grained (CG) molecular dynamics simulations, we have studied the binding behavior and membrane disruption mechanics of a protein dimer on phase separated lipid rafts consisting of cholesterol, saturated and unsaturated lipids. Large size (50,000 CG-atoms) and long (3000 ns) simulations have been performed. We observed that the protein prefers to bind to the interface of liquid-ordered (Lo) and liquid-disordered (Ld) coexisting phases. When the polarity of cholesterol is increased, this interface becomes more hydrophilic and the protein prefers to bind at the interface.

10:47AM B3.00002 Continuing Studies of Hydrogenic Quantum Systems Using the Feynman-Kac Path Integral Method, JAMES REJECK, Univ of Texas, Arlington — The Feynman-Kac path integral method is applied to the atomic hydrogen quantum system for the purpose of evaluating eigenvalues. These are computed by random walk simulations on a discrete grid. The study provides the latest simulation analysis and includes the use of symmetry that allows higher order eigenstates to be computed. The method provides exact values in the limit of infinitesimal step size and infinite time for the lowest eigenstates.
10:59AM B3.00003 Dynamics of a Piecewise Linear Bouncer, CAMERON LANGER, BRUCE MILLER, Texas Christian University — The dynamical properties of a particle in a gravitational field colliding with a rigid wall moving with piecewise constant velocity are studied. We consider three distinct approaches to modeling the collision: elastic, inelastic with constant restitution coefficient and inelastic with a velocity-dependent restitution function. We confirm the existence of Fermi acceleration in the elastic model, and find periodic, quasi-periodic, and chaotic behavior in both inelastic models. We also examine the phenomenon of inelastic collapse. We address the related “sticking solutions” and their connection to both the overall dynamics and the phenomenon of self-reanimating chaos. Additionally we investigate the long-term behavior of the system as a function of both initial conditions and parameter values. The analytical and numerical investigations reveal that our model captures the essential features of the well-studied sinusoidally driven version and also exhibits behavior unique to the discontinuous dynamics.

11:11AM B3.00004 Charged Particle Motion in the Vicinity of a Magnetic Null Curve1, RYAN LANE, CARLOS ORDONEZ, University of North Texas — A magnetic null curve is a 1D region of 3D space where the magnetic field is zero and is otherwise non-zero. Two geometries that produce null curves have been studied with classical trajectory Monte Carlo simulations to understand the properties of charged particle motion near the null curve. One system consists of two infinite, straight, parallel wires carrying identical current. In another system the null curve is generated by coaxial coils carrying identical current and separated axially by a small distance. The null curve is directly between the wires or coils, respectively. The motion of charged particles near the null curve and the conditions that produce charged particle confinement are discussed. Possible applications of systems containing magnetic null curves are given and specific experimental challenges are outlined.

1This material is based upon work supported by the Department of Energy under Grant No. DE-FG02-06ER54883 and by the National Science Foundation under Grant No. PHY-1202428.

11:23AM B3.00005 Asynchrony-tolerant finite difference method for partial differential equations at extreme scales1, ADITYA KONDURI, DIEGO DONZIS, Texas A&M University — Computer simulations have been an important tool in understanding a wide variety of multiscale problems in sciences: from molecular to geophysical phenomena. Many of these phenomena are modeled with partial differential equations that are often complex and nonlinear in nature, and thus demand massive computations. With increasing degree of parallelism in today’s supercomputers, simulations are routinely performed on hundreds of thousands of processing elements (PEs) on Petascale machines. At this scale, communication between PEs take substantial amount of time during which PEs remain idle, leading to unused compute cycles and poor scalability. In this work, we propose a novel asynchronus method based on commonly used finite-difference schemes, where computations are carried out independent of the status of communication between PEs. We show that, while current schemes are stable and consistent under asynchrony, their accuracy is significantly affected. We derive new schemes that are tolerant to asynchrony due to slow communications relative to computations and maintain accuracy. We will also show results from numerical experiments to demonstrate the scalability of the method. These numerical schemes may provide a viable path towards true Exascale simulations.

1We acknowledge support from NSF, NERSC and XSEDE.

11:35AM B3.00006 Calculating Relativistic Transition Matrix Elements for Hydrogenic Atoms Using Monte Carlo Methods, S.A. ALEXANDER, Southwestern University, R.L. COLDWELL, University of Florida — The nonrelativistic transition matrix elements for hydrogen atoms can be computed exactly and their expressions are given in a number of classic textbooks. The relativistic counterparts of these equations can also be computed exactly but these expressions have been described in only a few places in the literature. In part, this is because the relativistic equations lack the elegant simplicity of the nonrelativistic equations. In this talk I will describe how variational Monte Carlo methods can be used to calculate the energy and properties of relativistic hydrogen atoms and how the wavefunctions for these systems can be used to calculate transition matrix elements.

11:47AM B3.00007 Experimental Study of Short Time Scale Brownian Motion, JIANYONG MO, AKARSH SIMHA, MARK RAIZEN, Center for Nonlinear Dynamics and Department of Physics, The University of Texas at Austin — We report our progress on the study of optically-trapped microspheres. In earlier work, we observed the instantaneous velocity of microspheres in gas and in liquid, verifying a prediction by Albert Einstein from 1907. We now report a more accurate test of the energy equipartition theorem for a particle in liquid. We also observe boundary effects on Brownian motion in liquid by setting a wall near the trapped particle, which changes the dynamics of the motion. We find that the velocity autocorrelation of the particle decreases faster as the particle gets closer to the wall.

Session B4 High Energy Physics

Saturday, October 18, 2014 10:35AM - 12:23PM - MPH 336 - Lois Strigari, Texas A&M University

10:35AM B4.00001 SiPM Simulation Study with GosSiP, RONALD MUSSER, AMIT BASHYAL, JOSHUA MEDFORD, YING WUN YVO NG, TIMOTHY WATSON, ANDREW WHITE, JAEHOON YU, University of Texas at Arlington — Silicon Photomultipliers (SiPMs) are photon detection devices that can detect down to single photon events. SiPMs can be an important advancement on typical Photomultiplier Tubes (PMTs) that are used in PET imaging in the medical field and have been used in detectors in high energy particle physics experiments. However, these devices are still relatively new and there is still much to learn about their behavior, in particular under high cryogenic temperature such as that in Liquid Argon Time Projection Chamber. In order to understand SiPMs in detail, this study used simulation software called GosSiP. With GosSiP, the behaviors of various types of SiPMs were examined with variations in multiple characteristic parameters such as photo-detection efficiency (PDE), device gain, crosstalk probability and many others. The information from this study will then be used in future experiments, in particular, the Long Baseline Neutrino Experiment at Fermi National Accelerator Laboratory to examine the optimal coupling of SiPMs with a scintillator inside the Liquid Argon Time Projection Chamber.

10:47AM B4.00002 Magnetic Moment of Neutrino at Finite Temperature and Density, SAMINA MASOOD, University of Houston Clear Lake — We recalculate the magnetic moment of neutrinos in the light of observational data and other available information. We show that the magnetic dipole moment of a flavor of neutrinos may be more significant for a particular astronomical system than others, based on the statistical conditions. Interaction of neutrino with the magnetic field is a higher order effect due to the induced magnetic moment of massive neutrino in an astrophysical body with a strong magnetic field. However, the higher order radiative correction contributions may be more than the vacuum values at extremely high temperatures and densities. We show that the neutrinos were not polarized at any time in the early universe but they may be polarized inside the superdense stars with high magnetic field. Polarization component of the form factors always vanishes in electron-positron symmetric background at extremely high temperatures.
10:59AM B4.00003 Probing the nature of neutrinos under the supersymmetric U(1) B-L Model, YU GAO, University of Texas A&M, ROUZBEH ALLAHVERDI, University of New Mexico, SHELDON CAMPBELL, Ohio State University, BHASKAR DUTTA, Texas A&M University — This talk presents the prospects for determining the nature of neutrinos in the context of a supersymmetric $B - L$ extension of the standard model by using dark matter indirect detection signals and bounds on $N_{\text{eff}}$ from the cosmic microwave background data. The model contains two new dark matter candidates whose dominant annihilation channels produce more neutrinos than neutralino dark matter in the minimal supersymmetric standard model. The photon and neutrino counts may then be used to discriminate between the two models. If the dark matter comes from the B-L sector, its indirect signals and impact on the cosmic microwave background can shed light on the nature of the neutrinos. When the light neutrinos are of Majorana type, the indirect neutrino signal from the Sun and the galactic center may show a prompt neutrino box-feature, as well as an earlier cut-off in both neutrino and gamma ray energy spectra. When the light neutrinos are of Dirac type, their contribution to the effective number of neutrinos $N_{\text{eff}}$ is at a detectable level.

11:11AM B4.00004 Helical Phase Inflation, ZHIJIN LI, Texas A&M University, TIANJUN LI, Institute of Theoretical Physics, Chinese Academy of Sciences, DIMITRI NANOPOULOS, Texas A&M University — We show that quadratic inflation can be realized by the phase of a complex field with helicoid potential. Remarkably, this helicoid potential can be simply realized in minimal supergravity. The global U(1) symmetry of the Kähler potential introduces a flat direction in the F-term potential and evades the ? problem automatically. So such inflation is technically natural. During inflation the norm of the complex field is strongly stabilized and the phase evolves along a flat helix trajectory. The phase excursion is super-Planckian as required by the Lyth bound, while the norm of the complex field can be suppressed in the sub-Planckian region. This model resolves the contradiction between the strict flat condition for inflation and the dangerous corrections from quantum gravity effects.

11:23AM B4.00005 SuperCDMS Detector R&D: SNOLAB and Beyond, ANDREW JASTRAM, Texas A&M University — SuperCDMS (Cryogenic Dark Matter Search) is an experiment designed to directly detect dark matter particles in the form of WIMPs (Weakly Interacting Massive Particles). Germanium and silicon detectors, cooled to <30mK, are instrumented to simultaneously measure phonon and ionization energy deposited by incident particles, allowing event-by-event discrimination, to identify and study possible WIMP interactions. Using phonon amplification via the Neganov-Luke effect, recent studies utilizing a modified version of these detectors (called CDMSLite) have demonstrated the energy resolution necessary to search for WIMPs of mass ∼ 1 GeV/c². A recent design, inspired by these studies, has led to a world record ionization resolution of 8eV.

11:35AM B4.00006 Aerogel Cherenkov Detector For The LArIAT Experiment, BRANDON SOUBASIS, Texas State University, WILL FLANAGAN, JOHN CESAR, KAROL LANG, RAMON SALAZAR, The University of Texas at Austin, LARIAT COLLABORATION — The Liquid Argon In A Testbeam (LArIAT) experiment at the Fermilab Test Beam Facility (FTBF) will allow for critical measurements of interest to all current and proposed liquid argon detectors. Our group has designed and constructed prototypes of an aerogel Cherenkov detector to be placed along the beamline. This detector will allow us to separate incoming muons and pions in the momentum range of most interest to the LArIAT experiment. This talk will focus on the detector design, PMT calibration, prototype construction, and preliminary measurements using cosmic muons.

11:47AM B4.00007 Neutron Detection with Cadmium Tungstate Crystal Scintillators, WILLIAM BAKER, Texas A&M University — Neutrons of MeV scale energy can be produced by a number of nuclear reactions, yet traditional detectors have a hard time seeing these free neutrons due to their lack of charge. Their detection has relevance to dark matter experiments and radiation monitoring for security. The most common means of detecting neutrons is through scintillating materials which typically create a signal by converting the energy of the neutron into light. We present a neutron detection system utilizing a high density polyethylene for energy moderation, Gadolinium (Gd) and Cadmium Tungstate (CdWO₄), an inorganic crystal scintillator. Gadolinium is used for its high neutron capture cross-section which produces several high energy gammas in a single n + Gd_{157} reaction. CdWO₄ converts this gamma production into a burst of light in the ultraviolet range, which can be detected with photo-sensitive electronics such as Avalanche Photo-Diodes (APDs). We produce a monenergetic collimated beam of neutrons for use in calibration by using a pelletron-driven proton accelerator. Moving forward from preliminary results with a polyvinyltoluene scintillator, we explore the detection efficiency for ∼ 120 keV neutrons with CdWO₄.

11:59AM B4.00008 Geant4 Simulations of the Beam Hadron Monitor for the Long Baseline Neutrino Experiment at Fermilab, TIMOTHY WATSON, AMIT BASHYAL, JAEHOON YU, Univ of Texas, Arlington, LONG BASELINE NEUTRINO EXPERIMENT COLLABORATION¹ — Modern research into new physics on the scale of the fundamental constituents of nature often requires multimillion-dollar machines capable of producing high-energy particles and equally expensive detectors sensitive enough to make the desired measurements. Such constructions are necessarily intricate endeavors, complicated by the fact that often the desired experiment demands a very high level of precision. For these reasons, it is prudent to perform computational simulations in order to ensure proper performance of the experiment as well as to anticipate possible sensitive tolerances in construction. To these ends, the de facto standard for the simulation of particle physics remains Geant4. Presented here are the results of simulations for the beamline of the Long Baseline Neutrino Experiment. Specifically outlined are the results of simulations of the beam hadron monitor and the interpretation and application of these simulations for the design considerations of the detector.

¹Beam Simulation Group

12:11PM B4.00009 10 TeV Hadron Collider: an Opportunity for Texas, PETER MCFIN-TYRE, Texas A&M University — There is a growing enthusiasm for the importance of building a 10 TeV hadron collider as the basis for a next generation of discovery in high energy physics. A cable-in-conduit NbTi dipole technology is being developed at Texas A&M University as an affordable basis for this purpose. It requires a 270 km circumference tunnel, and an optimum site for this purpose lies in the favorable rock strata that underlie the city of Dallas.
scintillators have low density and hence poor energy resolution which limits their use in gamma spectroscopy. Ceramic scintillator can be a cost effective alternative to inorganic single crystal. Here we have studied the luminescence of La$_{0.2}$Y$_{1.8}$O$_3$ ceramic scintillator. We have fabricated La$_{0.2}$Y$_{1.8}$O$_3$ ceramic and characterized structurally using XRD and TEM. Photoluminescence and radioluminescence studies were done using UV and X-ray as an excitation source. We have used gamma isotopes with different energy to studies the scintillation properties of La$_{0.2}$Y$_{1.8}$O$_3$ scintillator. Preliminary studies of La$_{0.2}$Y$_{1.8}$O$_3$ scintillator shows promising result with energy resolution comparable to that of NaI and CsI.

### Correlation Between Optical Properties and Charge Carrier Mobility in Regioregular Poly (3-hexylthiophene) Thin Films

RASOOL KENARANGUI, Univ of Texas, Arlington — Inorganic single crystals and organic (plastic and liquid) scintillators are the two important types of scintillators. Both of these scintillators have their own drawbacks. Inorganic single crystals are expensive and difficult to grow in desire shape and size. Also, some efficient inorganic scintillator such as NaI and CsI are not environmental friendly. But on the other hand, organic scintillators have low density and hence poor energy resolution which limits their use in gamma spectroscopy. Ceramic scintillator can be a cost effective alternative to inorganic single crystal. Here we have studied the luminescence of La$_{0.2}$Y$_{1.8}$O$_3$ ceramic scintillator. We have fabricated La$_{0.2}$Y$_{1.8}$O$_3$ ceramic and characterized structurally using XRD and TEM. Photoluminescence and radioluminescence studies were done using UV and X-ray as an excitation source. We have used gamma isotopes with different energy to studies the scintillation properties of La$_{0.2}$Y$_{1.8}$O$_3$ scintillator. Preliminary studies of La$_{0.2}$Y$_{1.8}$O$_3$ scintillator shows promising result with energy resolution comparable to that of NaI and CsI.

### 10:47AM B5.00002 Correlation Between Optical Properties and Charge Carrier Mobility in Regioregular Poly (3-hexylthiophene) Thin Films

RASOOL KENARANGUI, Univ of Texas, Arlington — Inorganic single crystals and organic (plastic and liquid) scintillators are the two important types of scintillators. Both of these scintillators have their own drawbacks. Inorganic single crystals are expensive and difficult to grow in desire shape and size. Also, some efficient inorganic scintillator such as NaI and CsI are not environmental friendly. But on the other hand, organic scintillators have low density and hence poor energy resolution which limits their use in gamma spectroscopy. Ceramic scintillator can be a cost effective alternative to inorganic single crystal. Here we have studied the luminescence of La$_{0.2}$Y$_{1.8}$O$_3$ ceramic scintillator. We have fabricated La$_{0.2}$Y$_{1.8}$O$_3$ ceramic and characterized structurally using XRD and TEM. Photoluminescence and radioluminescence studies were done using UV and X-ray as an excitation source. We have used gamma isotopes with different energy to studies the scintillation properties of La$_{0.2}$Y$_{1.8}$O$_3$ scintillator. Preliminary studies of La$_{0.2}$Y$_{1.8}$O$_3$ scintillator shows promising result with energy resolution comparable to that of NaI and CsI.

### 10:59AM B5.00003 Photo-Induced Typographic with Vanadium Dioxide Thin Films

SANCHARI SEN, MD NADIM FERDOUS HOQUE, LUIS GRAVE DE PERALTA, ZHAOYANG FAN, AYRTON BERNUSSI, Texas Tech University — We report photo-induced insulator-metal phase transition studies of vanadium dioxide (VO$_2$) thin films to generate rewritable patterns in the NIR using a combination of pump-probe technique, a scanning mirror and an IR camera. The structures consisted of VO$_2$ ~150 nm thick films deposited on both sides of c-plane oriented sapphire substrates which temperature was controlled by a thermoelectric heater/cooler stage. Light from a CW high-power laser was deflected by the scanning mirror towards one of the sides of the sample to produce the desired patterns. An IR probe light source was used to illuminate the VO$_2$ samples and the images were obtained with an IR camera. The high power laser optically triggers the VO$_2$ insulator to metal phase transition and the scanned region becomes opaque to the IR irradiation. Clear and high contrast images with different shapes and sizes were demonstrated with the proposed technique. The characteristics of the generated patterns were controlled by the vibration amplitude of the scanning mirror. We anticipate that the developed approach can be prospectively used to realize reconfigurable Fresnel lenses, spatial light modulators, and optical equalizers operating in the NIR.

### 11:11AM B5.00004 Two Color Fluorescence Enhancement Using Gold Nanogratings

ROBERT HURE, SAMUEL SIMONEAU, JENNIFER STEELE, Trinity University — We demonstrate directional enhanced fluorescence emission from two fluorophores using a gold wire grating with a period of 500 nm. The dominant enhancement mechanism was found to be fluorophores decaying back to the ground state by exciting a surface plasmon mode, which can then radiate via the periodicity of the grating. Gratings were manufactured with soft lithography using silicon master gratings and polydimethylsiloxane (PDMS) molds. Fluorescent enhancement from the gold gratings corresponds to surface plasmons observed by measuring the transmission of white light through the gratings as a function of incident angle. Fluorescent enhancement of two fluorophores on one grating was observed using two different excitation lasers, producing similar enhancements. Fluorescent measurements were recorded by fixing the angle of a laser incident on the grating and varying the detector angle relative to the sample.

### 11:23AM B5.00005 DNA in Nanoscale Electronics

JASON SLINKER, The University of Texas at Dallas — Functional nanowires and nanoelectronics are sought for their use in next generation integrated circuits, but several challenges limit the use of most nanoscale devices on large scales. DNA has great potential for use as a molecular wire due to high yield synthesis, near-unity purification, and nanoscale self-organization. Nonetheless, a thorough understanding of ground state DNA CT in electronic configurations under biologically relevant conditions, where the fully base-paired, double-helical structure is preserved, is lacking. We explored the fundamentals of charge transport (CT) through double-stranded DNA monolayers on gold by assessing 17 base pair bridges at discrete points with a redox active probe conjugated to a modified thymine. This assessment is performed under temperature-controlled and biologically relevant conditions with cyclic and square wave voltammetry, analyzing the redox peaks to assess transfer rate and yield. We demonstrate that the yield of transport is strongly tied to the stability of the duplex, linearly correlating with the melting temperature. Transfer rate is found to be temperature-activated and to follow inverse distance dependence, consistent with a hopping mechanism of transport. These results establish the governing factors of charge transfer speed and throughput in DNA molecular wires for device configurations, guiding subsequent application for nanoscale electronics.
The image contains a page from a scientific conference program. The text is not clearly legible due to the image quality, but it appears to list session times, titles, and speakers. The visible text includes session titles such as "Transport Properties of Ferromagnet-Superconductor Hybrids near the Superconducting Transition Temperature" and "One-Step Microwave Synthesis of Size Controlled Monodisperse Noble Metal and Bimetallic Nanoparticles using Polymers." The program also includes the names of the speakers, which are not clearly visible due to the image quality.
Springs, PINCHUK NANOPHOTONICS RESEARCH GROUP TEAM — The size controlled synthesis of tunable, near monodisperse and stable noble metal Au and Ag nanoparticles with a narrow size distribution was achieved through the development of a parameter dependent one-step microwave assisted dendritic polymer stabilized technique. The one-step dendrimer assisted technique uses polyethelenimine (PEI) as both a reducing and stabilizing agent that encapsulates the nanoparticles for the synthesis of stable, size controlled noble metal Au and Ag nanoparticles with a narrow size distribution. PEI was chosen to ensure stability of the nanoparticles produced. The effect of the parameters of time and temperature on the size of the nanoparticles produced was explored through the Box-Behnken design. Size control was achieved through a dual faceted process by modifying the mass ratio of metal salt to dendrimer or maintaining the mass ratio and modifying the temperature. Nanoparticle sizes were estimated using Mie theory calculations of the extinction spectra for an identical size nanoparticle. The mass ratio of metal salt to dendrimer was varied between 1:1 to 1:10. We subsequently characterized the electrical properties of the thin films between room temperature and 10 K. The optical properties were determined through spectroscopy measurements between 300 to 1,000 nm by recording transmission and reflection data and extracting the absorption coefficient of our samples. A linear model for TOC is also discussed. The observed correlations suggest that positron spectroscopy may be a useful tool in characterizing shale. *Participant in the summer 2014 TCU REU program in Physics and Astronomy funded by the National Science Foundation under grant PHY-1358770.

D1.00002 Internal stress, microscopic, and spectroscopic analysis in cadmium telluride grown by close-space sublimation, JESSICA SALAZAR, STELLA QUINONES, ARYZBE DIAZ, WILLIAM DURRER, JOSE VALDEZ, CELIA GARCIA, FELICIA MANCUI, University of Texas at El Paso — Cadmium telluride remains one of the materials of interest in the fabrication of photovoltaic cells and infrared devices, mainly because of its suitable crystal structure as well as of its small, direct bandgap of 1.5 eV. Since development of such devices requires a high quality and low defect material, the goal of this study is to microscopically and spectroscopically examine the crystallinity of the material. This information is valuable if optimization of sample growth conditions is envisioned. Crystallinity of the samples was investigated by Fourier transform infrared absorption and Raman spectroscopies. The far-infrared transmission data show the presence of transverse optical and surface optical modes, the latter being direct evidence of confinement in such a material.

D1.00003 Positron Annihilation Analysis of the Barnett Shale, JAMES BUFKIN*, Angelo State University, JOAH CHUIN*, Colorado College, HELGE ALSLEBEN, Geology Dept., TCU, C.A. QUARLES, Physics and Astronomy Dept., TCU — Measurements are reported of positron annihilation lifetime and Doppler broadening parameters on 52 samples of Barnett Shale core selected from 196 samples ranging from depths of 6107 to 6402 feet. The Barnett Shale core was taken from EOG well Two-O-Five 2H located in Johnson county TX. The selected samples are dark clay-rich mudstone consisting of fine-grained clay minerals. The samples are varied in shape, typically a few inches long and about 1/2 inch in width and thickness, and are representative of the predominant facies in the core. X-ray fluorescence (XRF), petrographic analysis and geochemical analysis of total organic carbon (TOC) were already available for each of the selected samples. The Doppler broadening data determine two parameters, S (shape) and W (wing), which provide information on annihilation by valence or core electrons in the sample. Correlations of the lifetimes, intensities, the average lifetime and S and W parameters with TOC and XRF parameters are discussed. A linear model for TOC is also discussed. The observed correlations suggest that positron spectroscopy may be a useful tool in characterizing shale. *Participant in the summer 2014 TCU REU program in Physics and Astronomy funded by the National Science Foundation under grant PHY-1358770.
D1.00006 Analysis of CME and CIR driven storms based on observations made by the TWINS Mission, GUNNER ROBISON, BIANCA TRIGO, Texas Lutheran University, AMY KEESEE, West Virginia University, JERRY CARR JR., Texas Lutheran University — Geomagnetic storms are categorized into two different groups: Coronal mass ejection, CME, and corotating interaction regions, CIR, driven storms. For CME driven storms there are intense and moderate storms based on their magnetic intensity, moderate is -78Dst anything below is categorized as an intense CME storm driver. This work will attempt to validate statements made by Keese 2013 by comparing two wide angle imaging neutral spectrometers, TWINS, data. Data was collected for an intense CME driven storm on September 26 2011 and a CIR driven storm on October 13 2012.

D1.00007 Improvements in Drift Chamber 5 for the COMPASS II polarized Drell-Yan experiment, JAMES MALLON, Abilene Christian University — The COMPASS project is a fixed-target nuclear physics experiment at CERN which explores the internal structure of the proton, and COMPASS II’s polarized Drell-Yan experiments will be exploring the quark angular momentum contribution to the spin of the proton through Semi-Inclusive Deep Inelastic Scattering. As a part of this process, Drift Chamber 5 (DC5), based on DC4 built by CEA-Saclay, must be constructed to replace a faulty straw chamber. The 23 total frames of DC5 have an outside measurement of 2.94m by 2.54m, with the 8 anode frames having a total of 4616 approximately 2m-long wires, giving a detection region of 4.19m (squared) with a resolution of 200 microns. These wire planes are orientated with the x- and x’-frames in the vertical x-direction, the y- and y’-frames in the horizontal y-direction, the u- and u’-frames offset +10deg from the vertical x-direction, and the v- and v’-frames offset -10deg from the vertical x-direction, and are strung with 100 micron field wires and 20 micron sense wires. In order to solve left-right ambiguity, x’, y’, u’, and v’ are shifted by 4mm, or one drift cell. The x- and y-frames have 513 wires strung across them, with the field wires at 400g of tension, the sense wires at 55g on the x-frames, and 70g on the y-frames. The u- and v-frames will have 641 wires, with the field wires at 400g, and the sense wires at 55g. DC5 will also have an updated front end electronics setup, using a new pre-amplifier-discriminator chip, in order to allow the recording of more events per second.

1This research was supported in part by the DOE under grant number DE-FG03-94ER40860

D1.00008 Optical V-Band Observations of Active Galactic Nuclei, TAYLOR HUTCHISON, RAINA MUSSO, FRANCIS MACINNIS, Southwestern University — Southwestern University astrophysics students participated in an international observing campaign to study twelve active galactic nuclei (AGN). As part of the project, the students measured optical V-band light variations of four targets within the range of the SU Fountainwood Observatory research telescope. Target images and a sample light curve of one target (NGC 5548) are presented.

D1.00009 Mega-SH0ES: Near Infrared Cepheid P-L Relation from Milky Way to M101, WENLONG YUAN, LUCAS MACRI, Texas A&M Univ., SAMANTHA HOFFMANN, Johns Hopkins Univ., ADAM RIESS, Johns Hopkins Univ. & STScI, THE MEGA-SH0ES TEAM — The Mega-SH0ES project aims to obtain accurate and precise distances to host galaxies of type Ia supernovae within 50 Mpc, as part of an effort to measure the Hubble constant with percent-level uncertainty. We studied the H-band P-L relation in M101 by combining archival ACS optical data with recent WFC3 near infrared data to derive the distance modulus to this galaxy. To assist the ongoing HST parallax project, we are observing dozens of Milky Way Cepheids using ground-based telescope. This project will help to measure the assumption-free zero point of P-L relation and improve the distance ladder. We present the analysis and preliminary results for both projects.

1We acknowledge support by NASA & NSF.

D1.00010 An Atmospheric Transmission Monitoring Camera for Dark Energy Survey, TING LI, Texas A&M Univ — Traditional color and airmass corrections can typically achieve 0.02 mag precision in photometric observing conditions. A major limiting factor is the variability in atmospheric throughput, which changes on timescales of less than a night. We have built an Atmospheric Transmission Monitoring Camera which consists of four telescopes and four detectors each with a narrow-band filter that monitors the brightness of suitable standard stars. Each narrowband filter is selected to monitor a different wavelength region of the atmospheric transmission, including regions dominated by the precipitable water vapor and aerosol optical depth. The colors of the stars are measured by this multi narrow-band imager system simultaneously. The measured colors can be used to derive the atmospheric transmission of a site. We installed such system at the Cerro Tololo Inter-American Observatory and it started autonomous observation every night since Sept 2014. We derive hourly atmospheric transmission model from the observation; these atmospheric transmission model will be used to improve photometric precision of Dark Energy Survey and achieve 0.01 mag photometric precision.

D1.00011 M-Dwarf Metallicity through Analysis of Binary Partners, DANIEL NAGASAWA, JENNIFER MARSHALL, TING LI, Texas A&M Univ — We present work on determining the metallicity of M-dwarfs through analysis of M-star containing binary pairs and discuss its potential use with regards to exoplanet host population studies. It is notoriously difficult to directly measure the metallicity of M-dwarfs via their spectra due to the complexity of their composition; by study of the spectra of M-dwarfs and their binary partners, a technique to determine the metallicity of M-dwarfs via spectra analysis can be developed. Assuming that the metallicity of two stars in a binary pair is similar, by studying the metal content of the more easily measured solar type star and correlating that to various spectra line indices in the accompanying M-dwarf, we can indirectly measure the metal content of the M-dwarf. We use both high and low resolution spectra of 50+ halo binary stars in the northern hemisphere collected at McDonald Observatory to perform this analysis.

D1.00012 Spectra and Elliptic Flow of Hadrons in Nuclear Collisions In a Blast Wave Model With Shear Stress, ZHIDONG YANG, RAINER J. FRIES, Cyclotron Institute and Department of Physics and Astronomy-TAMU — Collisions between heavy nuclei at high energies probe the properties of nuclear matter at high temperature and density. Hadrons observed at low transverse momenta (< 2 GeV/c) at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) imply that the hot and dense matter created at those Colliders is close to thermal equilibrium at its kinetic freeze out. Hadron observables can be described well by fluid dynamics or blast wave parameterizations. Here we present a blast wave model that incorporates corrections from finite shear stress due to the inhomogeneities in the system. We also use this model as an input to calculate hadron spectra from quark recombination at higher transverse momenta (> 2 GeV/c).

D1.00013 Implementation and testing of a hypersurface finder for event-by-event (3+1)D hydrodynamics, STEVEN ROSE, RAINER FRIES, Texas A&M Univ — Hydrodynamic simulations of nuclear collisions can model the expansion and cooling of the fireball created in such collisions. Many applications require a fast and efficient algorithm to find and parameterize hypersurfaces; e.g. the isothermal surface at the freeze-out temperature can be used to calculate a final distribution of particles in the collision via the Cooper-Frye procedure. An algorithm proposed by Pang, Wang, and Wang is evaluated and compared to standard algorithms in AZHYDRO and Cornelius.
D1.00014 Hydrocarbon based hybrid fusion-fission nuclear reactor, ABUL HASANAT MUHAMMAD JAHANUR RAHMAN, Texas A&M Univ — Hydrocarbon resources can be used in more efficient ways through hybrid fission-fusion reactions. This offers longer supply of energy by using only a very small amount of fuel. Fusion reaction energy can be initiate using proton tunneling catalytic reactors that bypass the nuclear repulsion barrier at lower temperatures. This reactor uses mesosphere support made of pyroelectric and piezoelectric crystals. Pyroelectric convert the fusion temperature into electricity and piezoelectric control the diameter of porosity to determine diffusion and fusion reaction rate. This active catalyst is a quasi-crystal of fullerene covered by a single layer of graphene. By using magnetic field, variable mass Dirac fermions (for example cooper electron-hole/phonon pairs) can be introduced within different conductive layers (heterogeneous topological layers or parallel quantum wells). Hydrocarbon by-products enter this catalyst from mesospheres through microphones by carrier fluids which need to be supercritical and superfluid at input temperature and pressure. Zero mass Dirac fermions are very sensitive to the applied field by piezoelectric crystal supports which produce maximum charge carriers compared to other layers where electron pairs have less mass. The higher the momentum of these ions, the higher the mass of the Dirac fermions (electron). At the collision where Dirac electron mass higher than the effective electron, the probability of fusion increases due to an increase in gravitational pull between higher masses. This is controlled by resonance phonon frequency and the electric field.

1Undergraduate student (Electrical & Chemical eng.)

D1.00015 Experimental measurement of equation of state for isotropic suspension of nanoplates, ABHIJEET SHINDE, XUEZHENG WANG, Texas A&M University, RODRIGO GUERRA, Harvard University, ZHENGDONG CHENG, Texas A&M University — Liquid crystalline phases of disk suspensions are of importance in science and in industry for various applications such as conductive polymers, synthetic clay and semiconductors. We studied the self-assembly of highly anisotropic and narrowly polydispersed nanoplates of Zirconium Phosphate (ZrP). Here we report, measurement of the equation of state for isotropic phase. We generated the EOS by studying attenuation of x-ray in gravity sedimented suspension of exfoliated ZrP nanoplates. We compare our equation of state with the one obtained through simulation by others.

1We thank NSF and NASA for the financial support.

D1.00016 Comparison of Hydration Free Energy from Orthogonal Space, Random Walk, Polarizable Force Field, and Bennett Acceptance Ratio, SUNILKUMAR ANUMULA, GAMZE KAYA, NECATI KAYA, HANS A. SCHUESSLER, Texas A&M University — We have investigated how mixing of two gases (H\textsubscript{2} and Ne) with significantly different ionization potentials (IPs) modifies the high harmonic generation (HHG). We observed an efficient low pass filter or filter function in order to increase the resolution of a brain MRI image, and at the same time, decrease the time required to produce the image. In this paper, K-space was constructed from the MRI image of the human brain using the MATLAB software. Different proposed filters were applied on the full K-space in order to find the most efficient filter that can be used to produce best MRI image.

D1.00017 Electron dynamics in an inhomogeneous magnetic field, ALLEN KIESTER, YURI ROSTOVTSIV, DUNCAN WEATHERS, Univ of North Texas — We study the interactions of an electron with an inhomogeneous magnetic field using the time dependent Schrodinger equation. A simulation of an initially localized electron in an axially symmetric magnetic field of increasing intensity is presented. The electron initially is placed in a uniform magnetic field with components of momentum both transverse and longitudinal to that field. The simulation explores the energy exchange mechanism between on-axis and off-axis kinetic energies for a particle in a conservative system to describe magnetic reflection from a quantum mechanical perspective and the effect of reflection on the Landau levels. Analysis of the axial kinetic energy exchange, reflection, and transmission coefficients of a Gaussian wave-packet traveling from a uniform magnetic field into an inhomogeneous is presented.

D1.00018 Study of the Medical Imaging of a Human Brain, JINHO KANG, SOO HWAN PARK, HAYOUNG KYUNG, University of Texas — In order to produce image domain from MRI, a complex computational process that requires an intensive analysis is involved. Often, the process of transformation from frequency domain to image domain requires time because Inverse Fourier Transformation takes every frequency points to determine the final output image. However, if a proper function is multiplied to K-space, it results in reduced domains of frequency, which will be used to determine output images. The purpose of the present research is to develop an efficient low pass filter or filter function in order to increase the resolution of a brain MRI image, and at the same time, decrease the time required to produce the image. In this paper, K-space was constructed from the MRI image of the human brain using the MATLAB software. Different proposed filters were applied on the full K-space in order to find the most efficient filter that can be used to produce best MRI image.

D1.00019 Estakhr’s Quantum Spacetime, Quantum Gravity as Expected Spacetime or Expectation value of Spacetime Operators, AHMAD REZA ESTAKHR, Researcher — Quantum Mechanics and General Relativity can be realized as a fully consistent theory. Spacetime is fundamentally discrete and not continuous. Spacetime Interval and the electric field.

D1.00020 New possibilities for the efficiency enhancement of the high harmonic generation process in gas mixtures of Ne and H\textsubscript{2}, MUHAMMED SAYRAC, ALEXANDRE A. KOLOMENSKI, SUNITKUMAR ANUMULA, GAMZE KAYA, NECATI KAYA, HANS A. SCHUESSLER, Texas A&M University — We have investigated how mixing of two gases (H\textsubscript{2} and Ne) with significantly different ionization potentials (IPs) modifies the high harmonic generation (HHG). We observed up to a 2.5 fold enhancement of HHG compared to pure H\textsubscript{2} and up to 3x10\textsuperscript{5} enhancement compared to pure Ne at moderate laser intensities at the gas jet \textsim 1.5x10\textsuperscript{14} W/cm\textsuperscript{2} when the backing pressure of H\textsubscript{2} was fixed at 0.7 bar and the Ne pressure increased in steps of \~ 0.4 bar up to \~ 2.8 bar; the optimal Ne pressure was found to be \textsim 0.5 - 1 bar for different harmonics order. Initially, HHG in H\textsubscript{2} gas takes place due to its low IP, inducing excited states and facilitating ionization and HHG in the Ne gas with high IP [1]. For simulation of HHG in mixtures we employed a phenomenological model that took into account also the changes in the matching conditions, affecting the HHG process. Thus, mixing of gases with low and high ionization potentials opens up new possibilities for the efficiency enhancement of the HHG process. This work was supported by the Robert A. Welch Foundation Grant No. A1546 and the Qatar Foundation under the grant NPRP 5 - 994 - 1 - 172.

D1.00021 Wide-bandwidth solar energy harvest by using non-linear optics and fluid dynamic, ABUL HASANAT MUHAMMAD JAHANUR RAHMAN, Texas A&M University, Physics & Astronomy Department researcher — Existing solar technology converts only limited bandwidth of radiation into electricity due to Shockley-Queisser limit of the solar diodes. Rest get wasted by heating up the solar array or reflected back. This paper represent mechanical method of producing more electricity by absorbing wide-bandwidth of sun-rays. Thin organic solar panel sheet or perovskite cell is coated with nanoparticle for reflecting non-absorbed bandwidth of sun rays. This sheet can be bend into concave shape with different focal radius. By using solar cell mirror made of this panel with MPPT, a solar farm can be made that converts some of the solar energy into electricity and reflects rest of the solar bandwidth into one single focus location where a series of lenses and prisms are located. These lenses convert incoming-rays into collimated-Gaussian-beam, which goes through two multimode circular prisms with different refractive indexes in close loop waveguide for ring lasing pulse generation. This introduce Doppler broadening into these two anti-collinear beam across the cross-section of the laminar fluid flow, where center fluid layer has higher velocity than the boundary layer. So, higher frequencies come out near the circumference of one of the prism and lower frequencies come out from its center. And the other one has opposite effect. Two beams are tuned to be out of phase, which increases absorption by fluid. Similar to laser-cooling technique, all fluid atoms are excited to same virtual-energy-state in exchange of solar-power and fluid-momentum. This two photon absorption release narrow-bandwidth-high-intensity pulse that produce electricity in multi-channel-plates (MCP).

D1.00022 Analyzing Hurricane Sandy1, ANGELYN CONVERTINO, STEPHAN MEYER, REBBECA EDWARDS2, Southwestern University — Post-tropical Storm Sandy underwent extratropical transition shortly before making landfall in southern New Jersey October 29 2012. Data from this system was compared with data from Hurricane Ike (2008) which represents a classic hurricane with a clear eye wall and symmetry after landfall. Storm Sandy collided with a low pressure system coming in from the north as the hurricane made landfall on the US East coast. This contributed to Storm Sandy acting as a non-typical hurricane when it made landfall. Time histories of wind speed and wind direction were generated from data provided by Texas Tech’s StickNet probes for both storms. The NOAA Weather and Climate program were used to generate radar loops of reflectivity during the landfall for both storms; these loops were compared with time histories for both Ike and Sandy to identify a relationship between time series data and storm-scale features identified on radar.

1We would like to acknowledge Texas Tech.’s Wind Research department and HHMI for their support
2Dr. Edwards is the advising professor on this research project.

D1.00023 Sensitive Molecular Spectroscopy of Crude Oil and Well Gas Samples, YAKUP BORAN, Texas A&M University, A.H.M JAHANUR RAHMAN, Texas A&M University in Qatar, Doha, Qatar, NECATI KAYA, Texas A&M University, JAMES STROHABER, Florida A&M University, ALEXANDRE KOLOMENSKII, Texas A&M University, MAHAMOD AMANI, VAASILIOS KELESSIDIS, Texas A&M University in Qatar, Doha, Qatar, HANS SCHUESSLER, Texas A&M University — We have developed several sensitive laser and mass spectroscopy based analytical instruments for oil and gas analysis. Some of the approaches have the potential for near well applications. A portable quadrupole mass analyzer is capable of measuring hydrocarbons having hundreds of atomic mass units as well as methane and carbon dioxide. In addition, a small prototype handheld optical absorption sensor is available. Here we use the quadrupole mass analyzer and reflector-type time-of-flight ion mass spectrometer. An important advantage of the reflector apparatus is due to the use of femtosecond laser radiation. Such strong field radiation can defeat the dissociation rate of molecules allowing for intact molecular ions to be detected. Fragmentation free detection of target molecular ions facilitates interpreting the amount of a particular molecular hydrocarbon. We will present results on crude oil and well gas analysis, which yields information on wide range of hydrocarbon constitutes. Supported by the Qatar foundation under grant NPRP 6-465-1-091 and the Robert A. Welch Foundation under grant No. A1546.

D1.00024 Optimum conditions of high order harmonic generation with a gas jet1, MUHAMMED SAYRAC, ALEXANDRE A. KOLOMENSKI, SUNIL KUMAR ANUMULA, YAKUP BORAN, GAMZE KAYA, NECATI KAYA, HANS A. SCHUESSLER, Texas A&M University — We experimentally studied how high harmonic generation (HHG) with noble gases (argon, hydrogen) depends on pressure changes in the gas jet causing variations of the matching conditions and absorption. The pressure dependence of output of high harmonics was studied at moderate laser intensities ~ 1.5x1014 W/cm² in the interaction region. To enable measurement over a larger mass to targets, such as methane and carbon dioxide with an additional chamber (~20 cm³) volume enclosing the gas jet. By increasing the gas jet pressure up to the maximum of ~ 3 bar with Ar, and ~ 2.25 bar with H2, we observed the increase of the HHS output until pressure in the jet reached optimum of ~ 0.5 bar for Ar, and ~ 2 bar for H2, beyond which the output started decreasing.

1This work was supported by the Robert A. Welch Foundation grant No. A1546 and the Qatar Foundation under the grant NPRP 5-994-1-172.

D1.00025 Mechanical models for Electromagnetically induced transparency and quantum amplification by superradiant emission of radiation, STEVEN LANIER, YURI ROSTOVTSVEV, Department of Physics, University of North Texas — Quantum amplification by superradiant emission of radiation is a new promising path to develop powerful sources of coherent radiation. It is related on the quantum spatial coherence excited in an atomic medium via interaction with laser radiation. We develop mechanical models that allow us to gain physical insights on how the spatial coherence build. Also we develop a mechanical model for electromagnetically induced transparency where the temporal coherence is excited in the atomic system and “dark” states are formed allowing light to be decoupled from the interaction with atomic system.

D1.00026 Vibrational Spectra, Theoretical Calculations, and Two-Dimensional Potential Energy Surface for 2,4,7-trioxa(3.3.0)octane, HYE JIN CHUN, Dept. of Chemistry, Texas A&M University, College Station, TX 77843-3255, NIKLAS MEINANDER, Dept. of Military Technology, Finnish National Defense University, Helsinki, Finland, JAAN LAANE, Dept. of Chemistry, Texas A&M University, College Station, TX 77843-3255, 4.7-Triodio(3.3.0)octane (247TOO) is an unusual bicyclic molecule which can exist in four different conformational forms which are determined by which directions the two rings pucker. The vibrational assignments of 247TOO have been made based on its infrared and Raman spectra and theoretical density functional theory (DFT) calculations. The two ring-puckering motions (in-phase and out-of-phase) were observed in the Raman spectra of the liquid at 249 and 205 cm⁻¹ and these values correspond well to the DFT values of 247 and 198 cm⁻¹. Ab initio calculations were utilized to calculate the structures and conformational energies for the four energy minima and the barriers to interconversion, and the data were utilized to generate a two-dimensional potential energy surface (PES) for the two ring-puckering motions. The resulting quantum state energies for this PES were then calculated in order to better understand the patterns that are produced when the PES has four energy minima at different energy values. The wavefunctions corresponding to the different quantum states were also calculated. For lower energy states these clearly correspond to just one of the wells in the PES. For higher energy states the probability is distributed over more than just one conformational form.
D1.00027 Coherent population trapping on vibrational levels in stimulated Raman scattering. ADAM VOGT, YURI ROSTOVITSEV, Department of Physics, University of North Texas — We study stimulated Raman scattering in molecular media. The role of rotational levels has been investigated by applying two strong laser fields in a two-photon resonance with a vibrational transition. It has been shown that the molecular vibrational coherence strongly depends on the effect of coherent population trapping for rotational levels. The obtained results are important for application of Raman spectroscopy to molecular detection for engineering, chemical, and biological applications.

D1.00028 Filament propagation length of femtosecond pulses with Gaussian and Bessel-Gaussian modes. NECATI KAYA, MUHAMMED SAYRAC, GAMZE KAYA, YAKUP BORAN, Texas A&M Univ, JAMES STROHABER, Florida A&M University, ALEXANDRE KOLOMENSKII, HANS SCHUESSLER, Texas A&M Univ — We experimentally studied intense femtosecond pulse filamentation and propagation in water for Gaussian and Bessel-Gaussian incident beams. The transverse modes for incident laser pulses were created from a Gaussian beam of a Ti:sapphire laser system by using a computer generated hologram technique. We found that the length of the filament induced by the Bessel-Gaussian incident beam was longer than that for the Gaussian transverse mode under the conditions of the same peak intensity, pulse duration, and the size of the central part of the beam. To better understand the Bessel-Gaussian beam propagation, we performed a more detailed study of the filament length as a function of the number of radial modal lobes. The length increased with the number of lobes, implying that the radial modal lobes serve as an energy reservoir for the filaments formed by the central intensity peak. This work was supported by the Robert A. Welch Foundation Grant No. A1546 and the Qatar Foundation under the grant NPRP 5-994-1–172.

D1.00029 Motion of Light on a Rotating Platform. CHARLES ROGERS, RICHARD SELVAGGI, Texas A&M University - Commerce — This experiment uses a laser to determine the deflection of light in a rotating frame of reference. Our hypothesis asks what affect does circular motion have on the measured trajectory of photons? Does the trajectory of light measured in a rotating platform differ from that measured in a non-rotating platform? The apparatus design, operation, and measured results are presented.

D1.00030 Molecular rotational constants measured with photoelectron ionization yield. GAMZE KAYA, NECATI KAYA, NATHAN HART, MUHAMMED SAYRAC, SUNIL ANUMULA, Texas A&M Univ, JAMES STROHABER, Florida A&M University, ALEXANDRE KOLOMENSKII, HANS SCHUESSLER, Texas A&M Univ — We determined rotational constants of linear molecules by measuring the electron photoionization yields with the femtosecond pump-probe technique. By creating a rotational wave packet with linearly polarized pulsed pulse in N2, O2, CO2, CO, and C2H2 molecules, we measured the temporal evolution of the photoelectron yield produced by the probe pulse with variable delay. The positions of the peaks and the rotational constants derived from the rotational revival periods of linear molecules are in good agreement with the literature values. This work was supported by the Robert A. Welch Foundation grant No. A1546 and the Qatar Foundation under the grant NPRP 5-994–1–172.

D1.00031 Optical Properties of Permalloy Oxide Grown by reactive RF magnetron sputtering. YUBO CUI, FIDELE TWAQIRAYEU, WILHELMUS GEERTS, Department of Physics, Texas State University — Permalloy oxide (PyO) is being studied to be applied in hematite based water splitting cells, shows promise to be applied in resistive random access memory devices, and has shown to increase the performance of spin valve hard disc reading heads. In this research, we investigated the optical properties of PyO thin films grown on quartz and Si/SiO2 substrates. A series of different samples was made as a function of the deposition temperature (24°C-600°C). The PyO was deposited in an AJA Magnetron System using a gas flow of 10 sccm (20% O2), and 240w RF power. The substrate was rotated at 60rpm deposition. The optical properties were measured by a Woollam M2000 variable angle spectroscopic ellipsometer at 8 different angles (50° – 85°) from 200-1000 nm. The optical properties and the thickness were calculated in two steps. First a single peak Cody-Lorentz model was used to estimate the optical properties. This result was used as a start for a B spline model to calculate the complete spectra of PyO. The MSE of the fits are below 4. The spectrum shows peaks around 2.4, 4, and 5 eV. The peaks of the spectra calculated from the thin films on Si/SiO2 are less sharp. The estimated thickness is in agreement with the sputter rate measured by a crystal thickness monitor.

D1.00032 Measurement of the Absorption Coefficient of Biological Materials Using Integrating Cavity Ring-Down Spectroscopy. MICHAEL CONE, JOHN MASON, ELEONORA FIGUEROA, BRETT HOKR, JOEL BIXLER, Texas A&M, CHERRY CASTELLANOS, TASC Inc., JEFFERY WIGLE, United States Air Force, GARY NOO-JIN, TASC Inc., BENJAMIN ROCKWELL, United States Air Force, VLADISLAV YAKOVLEV, EDWARD FRY, Texas A&M — An accurate knowledge of optical absorption coefficients for cells and their constituents is critical to the continued progression of biomedical procedures and medical diagnostics. Biological materials often exhibit multifaceted optical properties due to the complex nature of the samples. We use a novel, simple, and high-sensitivity method to measure the optical properties of biological samples. By integrating the light through a cavity, we are able to measure the absorption coefficient of highly scattering media even in the presence of larger scattering cross sections and small absorptions. Using a fully-enclosed cylindrical cavity made from a new diffuse reflecting material, an isotropic field of illumination is created eliminating scattering losses in ring-down measurements. Our presentation discusses the technique in great detail and discusses experimental results using retinal pigment epithelium cells.

D1.00033 Measurement of the Absorption Coefficient of Biological Materials Using Integrating Cavity Ring-Down Spectroscopy. MICHAEL CONE, JOHN MASON, ELEONORA FIGUEROA, BRETT HOKR, JOEL BIXLER, Texas A&M, CHERRY CASTELLANOS, TASC Inc., JEFFERY WIGLE, United States Air Force, GARY NOO-JIN, TASC Inc., BENJAMIN ROCKWELL, United States Air Force, VLADISLAV YAKOVLEV, EDWARD FRY, Texas A&M University — Integrating cavities are a common and indispensable tool in the modern optics laboratory. The diffuse reflecting walls of the cavity allow one to collect and spatially integrate the radiant flux emitted from a source, making them ideal for applications in radiometry and photometry. In addition, integrating cavities can be used to make very sensitive optical absorption measurements. Recently we have developed a new diffuse reflecting material with the highest diffuse reflectivity ever measured in the visible and UV portions of the spectrum. The material is a packed fumed silica powder (i.e. quartz powder), and can be used to make high-reflectivity integrating cavities. We have used these quartz powder cavities in a variety of spectroscopic applications including: the detection of organic toxins via Raman spectroscopy, the detection of water contaminants through fluorescence spectroscopy, and measurements of the absorption coefficient of pure water in the UV. Furthermore, we have developed a variation of cavity ring-down spectroscopy (CRDS) that we call integrating cavity ring-down spectroscopy (ICRDS). ICRDS allows for direct measurements of the absorption in a sample, even in the presence of strong scattering. Currently, the commercially available diffuse reflectors have insufficient reflectivity for ICRRDS, but our high-reflectivity fumed silica cavities have made ICRDS a reality.

Saturday, October 18, 2014 3:35PM - 5:11PM
Session E2 Atomic, Molecular and Optical Physics II MIST 102 - Ed Fry, Texas A&M University

3:35PM E2.00001 A Novel Diffuse Reflecting Material for Applications in Integrating Cavity Spectroscopy. MICHAEL CONE, Texas A&M University, JOSEPH MUSSER, Stephen F. Austin State University, JOHN MASON, ELEONORA FIGUEROA, JOEL BIXLER, BRETT HOKR, CHASE WINKLER, VLADISLAV YAKOVLEV, EDWARD FRY, Texas A&M University — Integrating cavities are a common and indispensable tool in the modern optics laboratory. The diffuse reflecting walls of the cavity allow one to collect and spatially integrate the radiant flux emitted from a source, making them ideal for applications in radiometry and photometry. In addition, integrating cavities can be used to make very sensitive optical absorption measurements. Recently we have developed a new diffuse reflecting material with the highest diffuse reflectivity ever measured in the visible and UV portions of the spectrum. The material is a packed fumed silica powder (i.e. quartz powder), and can be used to make high-reflectivity integrating cavities. We have used these quartz powder cavities in a variety of spectroscopic applications including: the detection of organic toxins via Raman spectroscopy, the detection of water contaminants through fluorescence spectroscopy, and measurements of the absorption coefficient of pure water in the UV. Furthermore, we have developed a variation of cavity ring-down spectroscopy (CRDS) that we call integrating cavity ring-down spectroscopy (ICRDS). ICRDS allows for direct measurements of the absorption in a sample, even in the presence of strong scattering. Currently, the commercially available diffuse reflectors have insufficient reflectivity for ICRRDS, but our high-reflectivity fumed silica cavities have made ICRDS a reality.
3:47PM E2.00002 Improved Design for Cosine Collectors, ELEONORA FIGUEROA, TAMU — A cosine collector is a detector whose response to incident light is proportional to the cosine of the angle between the incident light and collector’s surface normal. These detectors have been used for many years to measure relative and absolute spectral intensity of a multitude of radiant sources. After close inspection of commercial cosine collectors we noticed a systematic problem with most of the collectors offered - they do not adequately measure the cosine value they claim to measure. We have designed a new cosine collector that accurately measures the cosine of incident light with unprecedented accuracy. The strength of this detector lies in the geometry used for the detector aperture. It allows over 99% of incident light to be collected while acting as a slit to produce the expected cosine behavior.

3:59PM E2.00003 Simple but efficient optical condensers based on liquid droplets, DARSHAN DESAI, DANIEL DOMINGUEZ, AYRTON BERNUSSI, LUIS GRAVE-DE-PERALTA, Texas Tech University — Optical condensers used in microscopes illuminate the object under observation at inclined angles, thus providing enhanced resolution. However, these condensers contain many parts such as diaphragms, lenses etc. that make them bulky. Recently, we have found that liquid droplets over the surface of the object under observation can be used as efficient condensers that can provide sub-wavelength resolution. Also, an interesting way to analyze and characterize the droplet-based condensers using Fourier plane imaging microscopy (FPIM) technique and the potential for achieving deeper sub-wavelength resolution shall be discussed in detail.

4:11PM E2.00004 Active mode-locking of mid-infrared quantum cascade lasers, YONGRUI WANG, ALEXEY BELYANIN, Department of Physics and Astronomy, Texas A&M University — Active mode locking, i.e. modulation of gain or losses at the cavity round-trip frequency is one of the methods for generating ultrashort pulses in lasers. For Quantum Cascade Lasers (QCLs), it is believed that their short gain recovery time ~ 1 ps as compared to a much longer cavity round-trip time (~50 ps) prohibits generation of mode-locked pulses. We perform space-time domain simulations of QCL dynamics solving coupled density-matrix equations and Maxwell’s equations with a realistic transport model of the active region. We find that active gain modulation of a short section of a two-section monolithic laser cavity leads to robust mode locking and generation of picosecond pulses over a broad range of laser parameters. This finding shows a viable path towards achieving ultrashort pulse generation in QCLs.

4:35PM E2.00006 Changing the optical and electrical properties of a dielectric surface, CRISTIAN BAHRIM, MD KHAIRUZZAMAN, MD MOZAMMAL RAJU, WEI-TAI HSU, Department of Physics, Lamar University — The optical response of a dielectric surface to an incident laser radiation can be shifted when the surface is illuminated with a thermal source of radiation or when a uniform electric field is set up along the surface. Using a blackbody source one can generate an entire curve of dispersion for wavelengths lesser than the wavelength of the probe laser. A low capacitor voltage across the dielectric can shift the wavelength of the probe laser as perceived by the dielectric surface toward smaller values. This shift is due to an increase of the vibrational frequency of the electric dipoles located on the dielectric surface. The change in the polarization properties of the dielectric surface suggests the use of this configuration as an optoelectronic switch driven by a relatively small capacitor voltage. We report results of relative permittivity for flint and crown glasses for wavelengths lesser than the wavelength of the probe laser. A low capacitor voltage across the dielectric can shift the wavelength of the probe laser as perceived by the dielectric surface toward smaller values.

4:47PM E2.00007 Electronically Controlled Condensers for Sub-Wavelength Microscopy, SANCHARI SEN1, DONGYU CAO2, AYRTON BERNUSSI3, LUIS GRAVE DE PERALTA4, Texas Tech University — We are exploring the use of hemispherical Electronically Controlled Condensers (ECCs) with no moving parts, lenses, or mirrors, to improve the sub-wavelength resolution capabilities of optical microscopes. ECCs consist of a number of light emitting diodes (LED) placed inside a hollow hemisphere. Electronically controlling individual or groups of LEDs spatially and temporally gives the condenser numerous advantages over common optical condensers. ECCs are a simple solution to achieve a variable numerical aperture (NA) depending on the illumination incident angle. Our approach allows for the realization of bright field (NA0 > NAc) and dark field (NAc > NA0) optical microscopy in the same setup. We anticipate a number of applications for ECCs. LEDs emitting at different wavelengths, will enable the realization of quasi-monochromatic or polychromatic ECCs where the wavelength selection will be determined by the microscopy application. Near IR optical Tomography and panoramic microscopy can be realized by controlling the spatial and temporal illumination of the LEDs. ECCs can also be used to perform Fourier Ptychography to achieve both wide-field view and high resolution.

1 Physics and Electrical engineering department
2 Physics department
3 Electrical engineering department
4 Physics department.
4:59PM E2.00008 Spectroscopic analysis of gas separated from liquid\(^1\), JAMES BOUNDS, FENG ZHU, AYESNUR BICER, ALEXANDRE KOLUMENSKII, Department of Physics, Texas A&M University, College Station, TX 77845, VASSILIOS KELESSIDIS, Science and Petroleum Departments, Texas A&M University in Qatar, Doha, Qatar, HANS SCHUESSLER, Department of Physics, Texas A&M University, College Station, TX 77845, SIBOR TEAM — After the Deepwater Horizon oil spill, large concentrations of methane were observed dissolved in the Gulf of Mexico corresponding to a huge release of methane along with the discharge of oil from the site. It has been proposed that quantifying the amount of released methane could help quantify the magnitude of such a spill. We propose to build a system for extracting dissolved trace gases from collected sea water samples that is capable of operating on board a research vessel. This system will enable on-site analysis of gas content without the need to transport large volumes of water samples back to the laboratory. The system is designed to continuously circulate a sample volume of water through a membrane filter that will extract dissolved gases into an evacuated collection cylinder. The extracted gases can then be analyzed on-site with infrared cavity ringdown spectroscopy. We present our initial results on the gas-liquid separation and on the ringdown spectroscopy of methane. The high sensitivity cavity ringdown spectrometer enables isotopic analysis of \(^{13}\)C, which can also serve to differentiate between carbon sources of natural and anthropogenic sources.

\(^1\)Supported by the Qatar Foundation under grant NPRP 6-465-1-091 and the Robert A. Welch Foundation under grant No. A1546.

Saturday, October 18, 2014 3:35PM - 5:35PM – Session E3 Nuclear Physics I

3:35PM E3.00001 Current Status of the TAMUTRAP Facility, MICHAEL MEHLMAN, Texas A&M Univ — The primary goal of the upcoming Texas A&M University Penning Trap (TAMUTRAP) facility is to test the standard model for the presence of a scalar current in the beta decay of \(T=2\) superallowed beta-delayed proton emitters. By observing the shape of the proton energy spectrum one can deduce the beta-neutrino correlation parameter due to kinematic effects that expose the neutrino momentum. The TAMUTRAP decay station is centered around a unique, compensated cylindrical Penning trap, which is employed to both confine and detect the protons from these decays with high efficiency. This talk will provide a general overview of the TAMUTRAP facility and its current status. In particular, offline tests of the electrostatic beam transport system will be discussed, and the current status and development schedule for the phase-space reducing radio frequency quadrupole cooler/buncher will be presented.

3:47PM E3.00002 A Novel, Cost-Effective Positron Emission Tomography (PET) Scanner, BRIAN KELLY, Texas A&M — Positron Emission Tomography (PET) allows physicians and researchers to visualize metabolic data in the human body and is widely used in cancer and neurological imaging. Traditional PET scanners consist of a thin ring of scintillators coupled to photo detectors but these scanners often take long periods of time to acquire an image, are very costly, and are too complex to fit inside other machinery such as MRI. In response to this, we are building a novel PET detector that utilizes non-traditional scintillators and photo detectors in an attempt to significantly decrease cost, allow combined PET/MRI modalities and reduce scan time. In this talk, we will discuss the relevant theory, design and construction of our prototype.

3:59PM E3.00003 Scientific Modeling of Strip Positron Emission Tomography, FRANK CHU, LEONARDO A. BELLO PUENTES, Texas A&M Univ — Recent developments in medical imaging has shown promise in strip type PET scans. We designed a simulation package with Java and MATLAB that implements user drawn scintillating detectors which records back to back photon emissions from a free drawn source array. Additionally, it utilizes scripts which reconstruct the image using a multistep linear transformation. The resolution and amount of data acquired is dependent on the ADC frequency, size of the detector, and detector spacing. One of the challenges is to obtain high resolution images and data quantity while limiting detector size and spacing. In the future, we plan on improving the simulation to account for probabilistic special case scenarios, adding three dimensional image reconstruction, and including energy based analysis.

4:11PM E3.00004 Neutron Activation Analysis Screening of Scintillator Material for Low Background Experiments\(^1\), BRIAN ZAMARRIPA-ROMAN\(^2\), University of Texas at El Paso — Low background neutron experiments require a well understood system to avoid unwanted interference. The neutron experiment at the SNOLAB uses certain wavelength shifters to detect low energy neutrons. The wavelength shifters were analyzed using neutron activation analysis to determine the elemental composition of the substances and determine the amount of isotopes that could decay and interfere with the experiment. When activating the substance in a neutron flux, the decay of the activated substance emits radiation specific to the isotopes decaying in the substance. These decay are analyzed and are compared to activated samples with added isotopes to calculate initial quantities.

\(^1\)Made possible by the NSSC MSI Research Fellowship
\(^2\)Will be presenting under the mentorship of Efrain Ferrer and Vivian Incera.

4:23PM E3.00005 Garfield Simulation of Beta Particle Detection Emitted from Radiolabeled Peritoneal Tumors, JOSHUA MEDFORD, AMIT BASHYAL, MINGWU JIN, YVONNE NG, RONALD MUSSER, TIMOTHY WATSON, ANDREW WHITE, JAE YU, Univ of Texas, Arlington — Secondary peritoneal carcinomatosis (PC) is one of the most lethal forms of cancer with little to no cure. Several different procedures (“Hot Chemo” and cytoreductive surgery) have been attempted in various ways with not much success. The University of Texas at Arlington high energy physics (HEP) group has been developing a highly efficient, high resolution sensor using the Gas Electron Multiplier (GEM) technology. A synergistic fusion of HEP and medical physics is ongoing to target high confidence identification and location of PC tumors to significantly improve the survival rate of PC. With the use of Garfield, a computer program designed for detailed simulation of two and three dimensional drift chambers that was developed by CERN, we plan to duplicate beta particles emitted from tumor tissue loaded with fluodeoxyglucose (\(^{18}\)F-FDG) or copper-64 (radiolabeled biomarkers) that are then imaged by a small, triple GEM detector configuration setup. This simulation will lay a solid foundation for precise and accurate mapping of PC that enables physicians to target and eradicate it with minimally invasive procedures.
4:35PM E3.00006 MR Imaging to Screen for Breast Cancer: Transformational magnetism makes it affordable, AKHDiyor Sattarov Sattarov, Peter McIntyre, Leszek Motowidlo, Texas A&M University — Contrast-enhanced magnetic resonance imaging (CE-MRI) is a highly sensitive screening procedure for early detection of breast cancer. We have developed a magnetic design for a 1.5T open-MRI magnet based on Nb3Sn superconductor, suitable for use in breast cancer screening. The magnet produces the required homogeneous field only in two spherical regions required for breast imaging. The magnetic design required optimization of the placement of multiple windings that could produce that field distribution with minimum requirement of superconductor. For that purpose we developed a new design methodology in which a domain where windings are permitted is divided into a mesh of independent current elements, the multipole content in the target region is calculated for currents in from each element, and the pattern of optimized currents is calculated through successive orthogonalizations. The optimized windings can be fabricated within a support structure that supports Lorenz forces exerted on individual windings. The approach also accommodates the use of ferromagnetic steel to shield fringe fields. A first design of the a 1.5T open-MRI magnet for double breast screening will be presented.

4:47PM E3.00007 A Modified Bogoliubov Approximation, William Bassichis, Texas A&M University — The Bogoliubov approximation has been used in nuclear physics, solid state and many other areas. Decades ago a soluble model for a Boson system was proposed which was amenable to an exact solution. The accuracy of the Bogoliubov approximation could then be determined at least for this model. Attempts have previously been made to improve upon the approximation with little success. Here a modification to the Bogoliubov approximation is obtained which results in results closer to the exact over a wide range of parameters.

4:59PM E3.00008 $^{56}\text{Fe}$ Inelastic Neutron Scattering Cross Sections Deduced from $\gamma$-Ray Production Cross Sections, Thaddeus Howard, S.F. Hicks, University of Dallas, M.T. Mcellistrem, University of Kentucky, J.R. Vanhoys, U.S. Naval Academy, A.J. French, S.L. Henderson, R.L. Pecha, University of Dallas, E.E. Peters, T.J. Ross, University of Kentucky, Z.C. Santonil, L.C. Sidwell, University of Dallas, B.K. Thompson, U.S. Naval Academy, S.W. Yates, University of Kentucky — Inelastic neutron scattering cross sections have been deduced from $\gamma$-ray production cross sections for $^{56}\text{Fe}$. Measurements were made at the University of Kentucky Accelerator Laboratory using the neutron production and detection facilities located there. A natural iron sample (91.72% isotopic abundance of $^{56}\text{Fe}$) was bombarded with a nearly mono-energetic incident neutron beam with energies in a range from 1.5-4.7 MeV. Gamma-ray excitation functions were determined for each observed $\gamma$ ray in this energy range; from these, branching ratios and $\gamma$-ray production cross sections were determined and neutron scattering cross sections deduced. Gamma-ray excitation functions were also measured for $^{27}\text{Al}$, $^{48}\text{Ti}$, and $^{51}\text{V}$ to investigate using the deduced neutron scattering cross sections as standards to normalize absolutely the $^{56}\text{Fe}$ cross sections. Cross sections determined in this work are compared to evaluated data from the National Nuclear Data Center.

5:11PM E3.00009 Determination of Decay Characteristics of $^{54}\text{Fe}$ Excited Levels through Inelastic Neutron Scattering, R.L. Pecha, S.F. Hicks, A.J. French, S.L. Henderson, Z.C. Santonil, University of Dallas, B.K. Thompson, J.R. Vanhoys, U.S. Naval Academy, Erin Peters, Timothy Ross, S.W. Yates, University of Kentucky, University of Dallas Team, US Naval Academy Team, University of Kentucky Team — Due to the importance of neutrons for the successful and safe operation of fission reactors, it is necessary to obtain accurate and expansive knowledge about how they interact with the surrounding materials. Iron is commonly used to build reactor components, and how neutrons interact with Fe can affect the efficiency and rate of reaction within a reactor. This research studies the gamma ray emission and neutron scattering probabilities from two common iron isotopes, $^{54}\text{Fe}$ and $^{56}\text{Fe}$, when bombarded with a monoenergetic neutron beam in the 1.5 MeV-4.7 MeV range. This talk will focus on the gamma ray emissions from an enriched $^{54}\text{Fe}$ sample that has been excited by inelastic scattering of neutrons. From these emissions, a nuclear excitation level scheme was built, and new information about the excitation of $^{54}\text{Fe}$ nuclei was obtained. A basic overview of the experimental equipment used, measurements taken, results, and final level scheme will be discussed and compared to previous measurements.

5:23PM E3.00010 Sensitivity of inferred electron temperature from X-ray emission of NIF cryogenic DT implosions1, Michael Klem, Lawrence Livermore National Laboratory, University of Dallas, T. Ma, N. Izumi, S. Khan, A. Mackinnon, P.K. Patel, Lawrence Livermore National Laboratory — The National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory seeks to achieve thermonuclear ignition through inertial confinement fusion. The accurate assessment of the performance of each implosion experiment is a crucial step. Here we report on work to derive a reliable electron temperature for the cryogenic deuterium-tritium implosions completed on the NIF using the x-ray signal from the Ross filter diagnostic. These x-rays are dominated by bremsstrahlung emission. By fitting the x-ray signal measured through each of the individual Ross filters, the source bremsstrahlung spectrum can be back-calculated, and an electron temperature of the implosion hot spot inferred. Currently, each filter is weighted equally in the analysis. The optimized windings can be fabricated within a support structure that supports Lorentz forces exerted on individual windings. The approach also accommodates the use of ferromagnetic steel to shield fringe fields. A first design of the a 1.5T open-MRI magnet for double breast screening will be presented.

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1This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.
3:35PM E4.00001 Observation of the Stratorotational Instability in Flow between Rotating Concentric Cylinders.1, RUY IBANEZ, BRUCE RODENBORN, HARRY SWINNEY, The University of Texas at Austin — We present a laboratory model of rotating protoplanetary disks. The study is motivated by the need for understanding the fluid instabilities that are involved in the formation of planets. We examine instability in a fluid contained between concentric cylinders as a function of the ratio of cylinder rotation rates, \( \mu = \Omega_{\text{outer}}/\Omega_{\text{inner}} \). This “Stratorotational Instability” (SRI) occurs in rotating sheared flows with an axial density dependence. In our experiment a fluid density that decreases exponentially with height is achieved by using water that is very salty at the bottom of the fluid annulus and pure water at the top of the cylinder. Disturbances in this density-stratified fluid oscillate with a natural “buoyancy frequency” \( \gamma \), which is varied in the range 0.25-1 Hz. We visualize the flow with a suspension of 45 \( \mu \)m diameter flakes and make digital movies that are analyzed using temporal and spatial Fast Fourier Transforms in order to determine the onset of instability. For each instability we find the axial wavenumber is proportional to \( \Omega_{\text{inner}}/N \). We also find that, contrary to theory, the SRI instability occurs for \( \mu > \eta \), where \( \eta \) is the ratio of the radii of the two cylinders.

1Supported by The Sid W. Richardson Foundation.

2D A Shalybkov, Physics Uspekhi 52, 915 (2009).

3:47PM E4.00002 Fluidic Dynamics in Accretion Disk Fragmentation Model of Binary Protostar Twin Formation2, AARON HERRIDGE, None — Among the models that have been proposed for the development of binary star systems, the binary protostar model has benefitted from affirming evidence in recent astronomical observations. Accretion disk fragmentation surrounding an initial forming star is considered a potential origin for the companion star in binary protostar systems. This research will apply fluidic dynamic analysis to the accretion disks of forming protostars to explain how disk fragmentation forms the companion in the binary protostar model.

3:59PM E4.00003 Large Field Polarimetry Measurements using the Texas A&M Observatory, FEDJA KADRIBASIC, Graduate Student, LIFAN WANG, Professor — With the announcement that the BICEP2 polarization signal is due to Milky Way dust instead of the Big Bang, there has been a keen interest recently in properly calibrating for Milky Way dust polarization. At the Texas A&M Observatory, we have installed a wide-field telescope to measure the polarization of large parts of the sky as a pilot for a long-term project using the 0.8 m telescope at McDonald Observatory with a similar field of view and higher light-gathering power. The telescope is a 110 mm William Optics FLT-110 apochromatic refractor with a 1 degree field of view that has three optical polarizers at 60 degree intervals and an SBIG ST-8/SE/8XE camera to take data. By recording the polarizations of many galaxies, we can make a polarization map to correct for changes in shear that could be caused by the Milky Way dust. This is especially important since several large galaxy surveys, such as SDSS and DES, coming online need to make precise gravitational shear measurements to measure dark matter content. With this newfound data, we aim to better address the scientific goals of projects relying on polarimetry, such as BICEP, or that may need to take it into account, such as SDSS and DES, in the hopes of learning more about our Universe through the lens of a polarizer.

4:11PM E4.00004 Experimental Observation of Internal Gravity Waves1, CONNER LARUE, MICHAEL ALLSHOUSE, University of Texas at Austin, Center for Nonlinear Dynamics, Department of Physics, FRANK LEE, University of Texas at Austin, Department of Physics, HARRY SWINNEY, University of Texas at Austin, Center for Nonlinear Dynamics, Department of Physics — In the oceans, internal gravity waves transport energy and momentum from local generation near the seafloor to the ocean surface. These internal waves, present for density-stratified fluids in a gravitational field, play a significant role in ocean mixing. Our goal is to determine how internal waves modify the fluid’s density field. We investigate internal wave dynamics in a 4-meter long laboratory tank filled with water whose density increases with depth, just as in the oceans. Density perturbations by internal waves distort the light paths through the tank. The optical distortion is examined using a “synthetic schlieren” technique, which measures the index of refraction field. Digital movies of light transmitted through the tank are used in the schlieren technique to deduce the time-dependent density gradient field. From the density gradient field we compute the energy flux in the internal gravity waves. Internal wave energy plays a significant but poorly understood role in the energy budget of the oceans.

1Research supported by the Office of Naval Research.

4:23PM E4.00005 Kinematic and Metallicity Comparisons between Dwarf Galaxies and Brightest Cluster Galaxies, JIMMY, Texas A&M University — Integral Field Unit (IFU) spectroscopy allows us to analyze the entire 2-dimensional surface of a galaxy as opposed to long slit or single fiber methods which provide a more limited view. Using the VIMOS IFU spectrograph on the Very Large Telescope (VLT), we spatially map the kinematic properties of 10 nearby Brightest Cluster Galaxies (BCGs) and 4 nearby companion galaxies at z <= 0.1. We measure \( \lambda_{\text{H}_\alpha} \) as a proxy for angular momentum, in order to determine whether these galaxies are fast or slow rotators. We find that 30% (3/10) of the BCGs and 100% of the BCG companion galaxies (4/4) are fast rotators. We also find that when comparing BCGs to similarly massive early-type galaxies, the ratio of fast rotating galaxies in the two populations is the same, suggesting that mass plays a more important role than environment when determining whether a galaxy is fast or slow rotating. We have also obtained metallicity measurements of these BCGs and find that most exhibit very shallow metallicity gradients. We extend this analysis to low stellar masses with a sample of nearby dwarf galaxies. Current results suggest that although the dwarf galaxies exhibit far lower metallicities, the metallicity gradients are similarly flat in the low mass and high mass regimes.

4:35PM E4.00006 A New Star-Formation Rate Calibration from the Polycyclic Aromatic Hydrocarbon Emission Features: Application to High Redshift Lensed Galaxies, HEATH SHIPLEY, CASEY PAPOVICH, Texas A&M University — Our goal is to calibrate polycyclic aromatic hydrocarbon (PAH) luminosity in the mid-infrared (mid-IR) as a star-formation rate (SFR) indicator that can be used in galaxies that host active galactic nuclei (AGN), where every other SFR indicator is contaminated by the AGN. We use mid-IR spectroscopy from the Spitzer Infrared Spectrograph (IRS) and optical spectroscopy from various instruments to calibrate the mid-IR PAH features using \( L_{\text{IR}} = 0.020 \times L_{24 \mu m} \) equivalent to dust-corrected \( H_\alpha \) measurements (Kennicutt et al. 2009). Our sample consists of 226 galaxies corresponding to a range of total IR luminosity, \( L_{\text{IR}} = L (8-1000 \mu m) = 10^{4.12} L_\odot \) over the redshift range from 0 < z < 0.6. We find using a unity relation, fit to the star-forming only galaxies (118 galaxies), correlates linearly to \( L_{\text{IR}} = 0.020 \times L_{24 \mu m} \) with a gaussian scatter of <0.15 dex. As a result, we present a SFR relation for the PAH luminosity with uncertainties. We then apply our relations to a sample of high-redshift lensed galaxies (1 < z < 3) with previously estimated SFRs from other SFR indicators that are consistent to our PAH SFRs within uncertainties.
4:47PM E4.00007 Time Series Photometry with Small Aperture Telescopes, Ryan Oelkers, Texas A&M University, AGGIECAM COLLABORATION, CSTAR COLLABORATION — In the past decade small aperture telescopes (d < 20 cm) have been show to produce high quality photometry. These telescopes have advantages over their larger counterparts by being highly reproducible, low cost and accessible. Texas A&M University has been involved in two projects using small aperture telescopes, CSTAR and AggieCam, to study the time series nature of variable stars, exoplanet migration theory and stellar formation. We present the preliminary results of these studies and possible future collaborative efforts to install another such telescope in the Indian Himalayas.

4:59PM E4.00008 The Star-Formation Sequence: Tracking the Stellar Mass Growth of Galaxies since 2 Gyr after the Big Bang, Adam Tomczak, Texas A&M University, ZFOURGE COLLABORATION — Using data from the ZFOURGE Galaxy Evolution Survey in combination with public far-infrared imaging from the Spitzer and Herschel satellites we measure the relation between star-formation rate and stellar mass (SFR-M∗) for galaxies as early as when the universe was 12% of its current age. Similar to recent work from Whitaker et al. (2014) we find that the slope is not constant with stellar mass but tends to steepen towards lower masses. We also track the evolution of the cosmic star-formation density (SFD) as a function. Despite hosting the largest SFRs amongst star-forming galaxies, massive galaxies (>10^11 M⊙) only constitute at most roughly 13% of the cosmic star-formation budget. Furthermore, the proportional amount of the SFD as a function of galaxy stellar mass evolves weakly with time. Finally, we compare the mass growth curves for galaxies that follow the average SFR-M∗ relation to the modern technique of tracking galaxy descendants via abundance matching. We find a tension between these two approaches where the predicted mass growth from abundance matching is systematically lower than the integrated star-formation form the SFR-M∗ relations by 0.1-0.3 dex.

5:11PM E4.00009 The Star-Formation Rate and Stellar Mass Relation of Distant Galaxies, Brett Salmon, Texas A&M University, CANDELS COLLABORATION — Distant star-forming galaxies show a correlation between their star-formation rates (SFR) and stellar masses, and this has deep implications for galaxy formation. In this talk, I present a study on the evolution of the slope and scatter of the SFR-stellar mass relation for galaxies at high redshift, z > 3.5, using multi-wavelength photometry from the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDLES). We find that distant star-forming galaxies follow a nearly unevolving correlation between stellar mass and SFR that follows SFR = M^α with α ≈ 0.6. This evolution requires a star-formation history that increases with decreasing redshift (on average, the SFRs of individual galaxies rise with time). The measured scatter in the SFR-stellar mass relation is tight for galaxies with log M^⋆/M⊙ > 9 dex. This implies that the true intrinsic scatter in the SFR at fixed stellar mass is even smaller, σ(log SFR) < 0.2 - 0.3 dex. Assuming that the SFR is tied to the net gas inflow rate of galaxies (SFR~d(M_gas)/dt), then this result implies a low scatter in the gas inflow rate, favoring the theory of smooth gas accretion for star-forming galaxies at high redshift.

Saturday, October 18, 2014 3:35PM - 4:59PM
Session E6 Society of Physics Students
MPHY 213 - Timothy Head, Abilene Christian University

3:35PM E6.00001 Comparison of CME and CIR driven storms based on observations made by TWINS; Bianca Trigo, Gunner Robison, Texas Lutheran University, Amy Keesee, West Virginia University, Jerry Carr Jr., Texas Lutheran University — The analysis of data collected from the TWINS missions for an intense CME driven storm on September 26 2011 and a CIR driven storm on October 13 2012 will be presented. Geomagnetic storms are categorized into two different groups: Coronal mass ejection, CME, and corotating interaction regions, CIR, driven storms. For CME driven storms, there are intense and moderate storms based on their magnetic intensity, moderate is ~78Dst anything below is categorized as an intense CME storm driver.

3:47PM E6.00002 Reproduction of Heinrich Hertz’s Experiment of 1887, Zachary Williams, Hunter Sullivan, Stephen F. Austin State University — In 1887, Heinrich Hertz confirmed the transmission of electromagnetic waves which was theorized by James Clerk Maxwell. In his experiments, Hertz was able to detect and measure the wavelength and frequency of the transmitted wave. Hertz concluded that Maxwell’s electromagnetic waves do in fact propagate through space at the speed of light. In this reproduction, a similar model was constructed to detect these electromagnetic waves. The initial design was constructed to confirm consistent successful transmission. This design included a RLC circuit and a one-meter diameter loop detection antenna made from copper tubing. Work is now being performed to measure both the wavelength and frequency in order to confirm the velocity of propagation for electromagnetic waves is the speed of light.

3:59PM E6.00003 A Multi-band Extension of the Analysis of Variance Period Finding Algorithm. Nicholas Mondrik, Jennifer Marshall, James Long, Texas A&M University — One of the largest challenges facing modern astronomical surveys is the automated classification of sources. In the case of variable stars, periods are among the most useful features for classification algorithms. In surveys such as the Dark Energy Survey, which cover a large area of the sky with relatively few visits, single band period finding algorithms can struggle due to poor phase coverage in any one band. However, these single band algorithms throw away data in the form of other bands that can potentially hold more information about the period of the variable source. We present here an extension of a single band period finding algorithm to include information about the period contained in other bands. We generate light curves of RR Lyrae stars in 5 bands and compare the performance of the multi-band algorithm to its single band implementation. By including these extra bands we show improved performance for poorly sampled light curves over long baselines in simulated data.

4:11PM E6.00004 Development of a RF-Driven H−/H+ Surface Plasma Ion Source for the Spallation Neutron Source, Jeffrey Breitschopf, Jerry Carr Jr., Texas Lutheran University, Vadim Dudnikov, Rol Johnson, Muons Inc., Robert Welton, Martin Stockli, Sydney Murray, Manuel Santana, Terry Pennisi, Baoxi Han, Chip Piller, ORNL — A Surface Plasma ion Source (SPS) equipped with an external Saddle-type Antenna (SA) powered by 13.56 MHz Radio Frequency (RF) was tested at the Spallation Neutron Source (SNS) test stand at the Oak Ridge National Laboratory. Hydrogen ions were extracted from the source, and modifications were implemented to increase the ion beam output and optimize the source. The source was tested under a duty factor of 5-100% at 150Hz with power ranging from 0.8 to 3.3 kW. Cesium was also used to optimize the H− beam output. The highest beam current the source produced was 15 mA at 3 kW of RF power with an ion production efficiency of ~5 mA/kW. The current source at the SNS produces 30-40 mA of H− (~1 mA/kW) of accelerated beam, operating with 50-60 kW of RF power and a duty factor of 6%. Future work will be to test the SA RF SPS under the conditions and requirements of the SNS. The development of alternative sources for the SNS, such as this one, may figure prominently in future technology and reliability upgrades.
The effect of oxygen vacancies and strain on the optical bandgap of strained SrTiO$_3$ thin films, NATHAN STEINLE, BARRY KOEHNE, Undergraduate Research Assistant, RYAN COTTIER, Postdoc, DANIEL CURRIE, Postgrad, NIKOLETA THEODOROPOULOU, Research Advisor — SrTiO$_3$ (STO) films were grown on single crystal SrTiO$_3$ p-Si (001) substrates using molecular beam epitaxy (MBE). The single-phase STO/Si films were of high crystalline quality as verified by x-ray diffraction (XRD) and atomic force microscopy (AFM) with an rms roughness of less than 0.5 nm. Oxygen vacancies were introduced by controlling the oxygen pressure (varied from $10^{-8}$ to $10^{-7}$ torr) during growth. Both thickness variation and oxygen pressure alter the crystal structure and electronic properties of STO. The lattice mismatch of STO on Si causes a 1.7% bi-axial, compressive strain. The oxygen vacancies cause a tensile strain because of the different Ti$^{4+}$ and Ti$^{3+}$ ionic radii. This agrees with our XRD measurements that show a decrease of the out of plane lattice constant as either the thickness or the oxygen pressure during growth increases. We used a Variable Angle Spectroscopic Ellipsometer M-2000 by Woolam and the VASE software to measure and model the optical properties of the films using Tauc-Lorentz oscillators for the STO layer and directly measured optical properties of Si and STO substrates. Our results show that the indirect bandgap of STO decreases as either the thickness increases or the oxygen vacancies decrease, in agreement with theoretical calculations. [1]

A comprehensive evaluation of the performance and materials chemistry of a silicone-based replicating compound, MICHAEL KALAN, University of Dallas, Irving, Texas, MICHAEL BRUMBACH, Sandia National Laboratories, Albuquerque, New Mexico — The objective of this project was to characterize the performance and chemistry of a silicone-based replicating compound. Some silicone replicating compounds are useful for critical inspection of surface features. Common applications are for examining micro-cracks, surface pitting, scratching, and other surface defects. Materials characterization techniques were used: FTIR, XPS, ToF-SIMS, AFM, and Confocal Microscopy to evaluate the replicating compound. These techniques allowed for the characterization and verification of the resolution capabilities and surface contamination that may be a result of using the compound. The AFM and Confocal Microscopy results showed the compound does accurately replicate the surface features to the claimed resolution. XPS and ToF-SIMS showed there is a silicone contaminant layer left behind when a cured replica is peeled off a surface. Attempts to clean off the contamination could not completely remove all silicone. The methods and results for the compounds will be presented.

Charging and interaction of two-particle system within a glass box immersed in a low-vacuum argon plasmaootnote{Supported by NSF grant #1262031.}, MICHAEL HOFF, University of Dallas, BAYLOR CASPER COLLABORATION — Due to Debye screening, the interaction between charged dust particles within a plasma may not be considered as a simple Coulomb force. In order to observe particle interaction, the top particle in a vertical, two-particle chain is pushed from its equilibrium position using a high-power Verdi laser, and as it returns to equilibrium will interact with the second particle. In order to isolate the particle interaction force, the electrostatic force and neutral drag force are subtracted from the net force acting on the particle by using a single particle laser-pushing. It is found that in both the horizontal and vertical dimensions the electric field depends linearly on the particle's distance from its equilibrium position, and the linear coefficient to describe the field in turn has a linear dependence on plasma power. After isolating the particle-particle interaction force, what is expected to be an equal and opposite interaction force between the particles is instead found to be asymmetric, and possible causes for this are discussed.

Saturday, October 18, 2014 7:00PM - 9:00PM
Session F1 Banquet  Annenberg Banquet -

7:00PM F1.00001 Banquet —

Sunday, October 19, 2014 8:15AM - 9:27AM
Session G1 Plenary III  MPH 203-205 -

8:15AM G1.00001 The High Altitude Water Cherenkov observatory: from the project to the early science, ALBERTO CARRAMIÑANA, National Institute for Astrophysics, Optics and Electronics

8:51AM G1.00002 Search for New Physics in the Cosmic Rays with the Alpha Magnetic Spectrometer, PAOLO ZUCCON, MIT — The AMS measurements of the cosmic ray fluxes are revealing structures in the cosmic positron and electron energy spectra. Different interpretations on the origin of this spectral features have been advanced. One of the most appealing is that they could originate from Dark Matter decay or annihilation. The most recent AMS results will be presented and the AMS capability in discriminating different models, by means of high statistic measurements of electron and positron fluxes will be discussed.
9:45AM H2.00001 Macroscopic optomechanical superposition via periodic qubit flipping1, WENCHAO GE, M. SUHAUL ZUBAIRY, Institute for Quantum Science and Engineering (IQSE) and Department of Physics & Astronomy, Texas A&M University, College Station, Texas 77843, USA — We present a new kind of light amplifier (called the QASER) based on collective parametric resonance which, contrary to a laser, does not need any population in the excited state and generates high frequency coherent radiation by driving an atomic ensemble with a much smaller strong coupling rate of an optomechanical system. The emitted photon can be either super-radiant photon or sub-radiant photon, and we can also tune their frequency and linewidth by simply changing the polarization of the incident photon or the atomic separation.

1This research is supported by an NPRP Grant (No. 5-102-1-026) from Qatar National Research Fund.

9:57AM H2.00002 Single Photon Modulation by the Collective Emission of an Atomic Chain , ZEYANG LIAO, M. SUHAUL ZUBAIRY, Institute for Quantum Science and Engineering (IQSE) and Department of Physics and Astronomy, Texas A&M University, College Station, TX 77843-4242 — We study the collective spontaneous emission of a linear atomic chain excited by a single photon. The interaction between the atoms and the common vacuum field can significantly change the eigenenergy and the spontaneous emission rate of the system. The system can be in the superposition of the super-radiant and sub-radiant modes which results in the non-exponential decay dynamics. The emitted photon can be either super-radiant photon or sub-radiant photon, and we can also tune their frequency and linewidth by simply changing the polarization of the incident photon or the atomic separation.

10:09AM H2.00003 Quantum memory of single γ-ray photon by Doppler Frequency Comb , XIWEN ZHANG, Texas A&M University, WEN-TE LIAO, Max Planck Institute for Nuclear Physics, ALEXEY KALACHEV, Kazan Federal University, OLGA KOCHAROVSKAYA, Texas A&M University — We propose to store and retrieve a single γ-ray photon by a series of resonant Mössbauer targets each moves with different velocities. Such velocity spectrum forms a frequency comb due to Doppler effect, which we name as Doppler frequency comb (DFC). The performance of this γ-ray photon quantum memory scheme is similar to the usual atomic frequency comb (AFC) which is used for optical quantum storage. However, instead of burning comb structure in a broad inhomogeneous broadening profile, which is not available in Mössbauer solids, DFC utilizes very narrow resonant line-width to achieve quantum memory of energetic single γ-ray photon. Depending on the motion direction of the Mössbauer targets, a series of input γ-ray signal can be retrieved in either the same or reversed order of the input signals.

10:21AM H2.00004 Heisenberg Limit Superradiant Superresolving Metrology3, DAWEI WANG, MARLAN O. SCULLY, Texas A&M University, SCULLY TEAM — We propose a superradiant metrology technique to achieve the Heisenberg limit super-resolving displacement measurement by encoding multiple light moments into a three-level atomic ensemble. We use 2N coherent pulses to prepare a single excitation superradiant state in a superposition of two timed Dicke states that are 4N light momenta apart in momentum space. The phase difference between these two states induced by a uniform displacement of the atomic ensemble has 1/4N sensitivity. Experiments are proposed in crystals and in ultracold atoms.

3We gratefully acknowledge the support of the National Science Foundation Grants No. PHY-1241032 (INSPIRE CREATIV) and PHY-1068554 and the Robert A. Welch Foundation (Grant No. A-1261).

10:33AM H2.00005 Trade-off between information gain and fidelity under weak measurements1, LONGFEI FAN, WENCHAO GE, Texas A&M Univ, HYUNCHUL NHA, Texas A&M Univ at Qatar, SUHAUL ZUBAIRY, Texas A&M Univ — It is of general interest how a quantum measurement may disturb a quantum system while it gives information on the state of the system. We study a trade-off relation between the information gain and the output fidelity for a quantum non-demolition (QND) measurement scheme for photon numbers. To this aim, we obtain general expressions for the information gain and the output fidelity for an arbitrary initial state. We particularly investigate how the sum of these two quantities varies with the measurement strength for some general classes of states, through a single measurement or sequential measurements. We also show that the information on the photon-number distribution can always be fully retrieved for an arbitrary initial state by a large number of sequential measurements.

1NPRP Grant (No.5-102-1-026) from Qatar National Research Fund.

10:45AM H2.00006 Quantum amplification by superradiant emission of radiation1, ANATOLY SVIDZINSKY, LUQI YUAN, Texas A&M University, MARLAN SCULLY, Texas A&M University, Princeton University and Baylor University — A laser generates light through stimulated emission of radiation and requires population inversion. Quantum interference can yield lasing without inversion. However, such phase-sensitive quantum amplification still requires some atomic population in the excited state. We present a new kind of light amplifier (called the QASER) based on collective parametric resonance which, contrary to a laser, does not need any population in the excited state and generates high frequency coherent radiation by driving an atomic ensemble with a much smaller frequency. The amplification mechanism of the QASER is governed by the difference combination parametric resonance which occurs when the driving field frequency matches the frequency difference between two normal modes of the coupled light atom system. To achieve gain one must suppress AC Stark shift caused by the driving field. The resulting superradiant amplifier holds promise for a new kind of generator of high frequency (e.g. XUV or x-ray) coherent radiation utilizing a low frequency (e.g. infrared) drive. We present an experiment which demonstrates the QASER amplification mechanism in electronic circuit in the radio frequency range.

1We gratefully acknowledge support of the National Science Foundation Grants No. PHY-1241032 (INSPIRE CREATIV) and No. PHY-1205868, and the Robert A. Welch Foundation (Grant No. A-1261 and A-1547).

10:57AM H2.00007 Resonances and super-radiance in the strong picosecond pumping of dense Rubidium , CHRISTOPHER O'BRIEN, ANDREW TRAVERSO, LUQI YUAN, VLADISLAV YAKOVLEV, IQSE, Texas A&M University, MARLAN SCULLY, Texas A&M University, Princeton, and Baylor University — A recent series of experiments at Texas A&M University has observed sideband emission at the effective Rabi frequency as well as super-radiant emission in both the forward and backward direction from a dense Rubidium cell pumped by a very strong pico-second pulse. The forward and backward emission spectrum was collected as the pump pulse was scanned over resonances of the D2 and D1 lines. There are a number of interesting observations that can be made through analysis of these spectrums. The most intriguing of which, is the possible observance of a resonant version of the previously proposed QASER mechanism. I will briefly discuss the experiment then focus on how to theoretically understand the results.

1A. A. Svidzinsky, L. Yuan, M. O. Scully, PRX 3, 041001 (2013).
Towards Quantum Amplification by Superradiant Emission of Radiation, ZHENHUAN YI, MATTHEW MORRISON, CHRIS O’BRIEN, CHARLES BALLMANN, JONATHAN THOMPSON, ALEXEI SOKOLOV, Texas A&M University, College Station, TX 77843, USA; GOMBOJAV ARIUNBOLD, Texas A&M University, College Station, TX 77843, USA; National University of Mongolia, Ulaanbaatar 210646, Mongolia; MARLAN SCULLY, Texas A&M University, College Station, TX 77843, USA; Princeton University, Princeton, NJ 08544, USA; Baylor University, Waco, TX 76798, USA — Atomic coherence effect has revealed many fascinating phenomena. Recently, our group proposed a new amplification mechanism which requires no population in excited state yet light amplification at high frequency can be achieved by the parametric resonance between the driving field and the collective superradiant oscillations of the atomic coherence, thus named Quantum Amplification by Superradiant Emission of Radiation (QASER). To get enough gain, QASER requires high atomic density and a strong driving field. In order to observe this effect, we experimentally study the optical properties of dense Rubidium vapor which is strongly pumped by nanosecond laser pulses. Experiments were done with two different setups: (1) heated rubidium cell pumped by tunable pulsed laser and (2) rubidium heatpipe pumped by 1064 nm pulses from Nd:YAG laser. We observed possible coherent emissions in these systems. We also analyze some effects that could hinder the observation of QASER.

Numerical simulation of QASER in the three-level atomic system, LUOJIA WANG, LUQI YUAN, MARLAN SCULLY, Texas A&M Univ — Recently proposed QASER (quantum amplification by superradiant emission of radiation) generates light at higher frequencies than the pumping frequency and operates at the difference combination resonance $\nu_1 = \omega_2 - \omega_3$, which holds promise for a new kind of high-frequency radiation sources. Here we numerically simulate the QASER experiment with a near-resonance pumping pulse in a three-level atomic system as the model of Rb gas. We found the backward emissions of both transitions could have QASER-like gain. We considered possible effects of backward propagating fields to compare with the experimental data. This simulation would provide explanations for QASER experiments.

An abstract in this session.

A Limit on the Applicability of the FCI, MICHAEL VANDYKE, WILLIAM BASICHIS, Texas A&M University — The Force Concept Inventory exam, FCI, has been widely used to measure students’ knowledge of the conceptual basis of an introductory physics course. It has also been used to differentiate between different teaching methods, laboratory practices, textbooks, and curricula, as well as a measure of an individual instructor’s teaching performance. This study examines the correlation between a student’s performance on the FCI and their performance on midterm exams throughout a calculus-based mechanics course. The course is designed specifically for first year engineering students. It is found that, despite significant gains on the FCI, the correlation is extremely small for the first exam and even smaller for later exams. This lack of correlation persists whether one considers the FCI score at the beginning or at the end of the course. While this does not necessarily reflect adversely on the FCI as a measure of students’ conceptual understanding, it strongly suggests that its use as a determinant of the most effective method of teaching physics to engineering students should be quite limited.

9:57AM H3.00002 Measuring learning gain for undergraduate physics courses, EMANUELA ENE, Texas A&M — Classical learning gains are compared with a multidimensional ability gain chart. Rasch scalable instruments are employed.

Effect of Online Homework in Physics Learning, SUNIL KARNA, Texas A&M University, Kingsville — Online homework has been around for quite some time and many physics professors are familiar with its advantage and disadvantage. But few presentations at the joint Physics conference in Texas have been given. This talk represents some initial results using online homework in the College Physics classes for the first time at Texas A&M University Kingsville.
10:21AM H3.00004 Homework jiu jitsu. EVAN RICHARDS, Lee College — I have implemented a new homework scheme in my physics courses that has the students thanking me for the chance to turn in homework as opposed to being obligated to turn it in. In this talk, I’ll recap what events inspired this new scheme as well as what I am now seeing in my course evaluations about the homework.

10:33AM H3.00005 Electric Field Energy and Configuration (Potential) Energy. LIANXI MA, Blinn College — While electric field energy is the same as configuration energy in some special cases, in general they are two different concepts. Field energy stands for the energy caused by the existence of the electric field and configuration energy stands for the energy needed to assemble the system. A simple example is for a dipole, the field energy is positive according to $U = \frac{1}{2} \int \mathbf{E} \cdot \mathbf{D} dV$ while the configuration energy is negative according to $U' = -\frac{2}{3} q^2$. Although the apparent conflict has been explained by Jackson, in addition to the detailed mathematical derivation to show that the self energy is involved in the first equation but not in the second, we show that the configuration energy is equal to the field energy minus self energy. The infinity of the field energy of a point charge is avoided by supposing the charge be distributed in a ball with radius $R$. Electron’s and proton’s radii are calculated in this model.

10:45AM H3.00006 Framing the Questions: the Freshman Approach to Special Relativity. ELAINE TENNANT, Blinn College — Two inertial frames move at relativistic speeds with respect to one another. What does an observer in one of the frames see? This is often times the only question students answer in their freshman physics course. Could a more fundamental understanding of special relativity be instilled if a larger variety of insightful questions were asked? Examples from a question pool designed to expose students to the many different aspects of special relativity during the freshman course will be presented. Anecdotal experiences and preliminary results from the first deployment of the pool will be presented. Comparisons will be made with other prescriptions for early undergraduate special relativity education reported in recent literature.

10:57AM H3.00007 Student Understanding of the Physics of Hydrology1, JILL MARSHALL, ADAM CASTILLO, BAYANI CARDENAS, Univ of Texas, Austin — For a full understanding of physical hydrology, students must master conservation of mass, Newton’s laws of motion, the second in particular, laws of thermodynamics (conservation of energy), and the relationship between flux, resistance, and gradient (analogous to Ohm’s Law). Hydrology students do not always relate the specialized laws of hydrology to the fundamentals they learned in their physics class, and mathematical treatments do not always develop a conceptual understanding that promotes transfer. I will report on an extended study of student understanding in an upper division and graduate physical hydrology course, with and without the addition of COMSOL Multiphysics modeling activities in the curriculum. Student understanding was measured with a pre/post assessment and volunteer students were interviewed about their understanding in the course.

1Supported by National Science Foundation CAREER Grant EAR-0955750.

11:09AM H3.00008 DEEP: High Impact Hands-on Educational program for Physics & Engineering Students at Texas A&M. TATIANA ERIKHIMOVA, EDWARD FRY, Texas A&M University — We will present the results of an innovative program at Texas A&M University that aims to enhance the learning and research experiences of undergraduate and graduate students through their participation in high-profile outreach activities: the Texas A&M Physics & Engineering Festival and the Physics Shows. The goals are to enhance students’ knowledge of fundamental physics concepts through collaborative hands-on research and educational activities, to teach them effective communication skills and responsibility, and to enhance their opportunities for interactions with their peers and professors outside the classroom.

11:21AM H3.00009 From Research Assistant to Mentor: Outreach Opportunities in Graduate School. LES SHEFFIELD, None — Here I present the experiences I’ve gained by participating in the outreach programs at Texas A&M over the past 5 years. I will review the opportunities available to incoming graduate students and emphasize how faculty mentors can encourage student participation. Different types of outreach and public education will be included from the annual Physics Festival, to the Career Path Group, the DEEP Mentor Program, and the endless possibilities of social media. Unfortunately the stress of graduate school prevents many incoming students from taking advantage of these activities. I will discuss various levels of participation available to students in each arena and emphasize the many positive aspects of interacting with the public.

11:33AM H3.00010 Mitchell Institute Physics Enhancement Program for High School Teachers (MIPEP). ALEXEY BELYANIN, BHASKAR DUTTA, TATIANA ERIKHIMOVA, Texas A&M University, PAULA HILTIBIDAL, Region 15 Education Service Center, MARY HEAD, ICISD — The MIPEP is a two-week summer boarding school for physics teachers who had limited training in physics: usually 0-2 credit hours of college-level courses. The school was organized by the Mitchell Institute and Texas A&M Department of Physics and Astronomy during summers 2012-2014. Two weeks of intense training included lectures, physics labs, hands-on demos, tours of various campus research facilities, telescope observations, discussions and meetings with top researchers, and many other physics-related activities. We will review the results of the first three years of the school and plans for the future.


9:45AM H4.00001 Sensitivity to New Physics with the +MET Final State. RANDY WHITE, Texas A&M University — The Collider Detector at Fermilab (CDF) continues to search for new particles produced in the high energy proton anti-proton collisions produced at the Fermi National Accelerator Laboratory (Fermilab). In this talk we discuss the search for heavy, long-lived neutral particles, hypothesized by the Supersymmetry theory, that can be created and travel for awhile before decaying into a photon, the particle of light. Since these photons will arrive at the surface of the detector later than photons produced directly in the primary interaction, we can use custom instrumentation to search for these “delayed” photons with a nanosecond timing resolution. We present the results of this search and its implications on the recently discovered Higgs boson.
9:57AM H4.00002 An evaluation of the QCD uncertainties of $Z/\gamma^* \rightarrow \tau\tau$ background for the $H \rightarrow WW$ measurement, LI ZHOU, ROBERT KEHOE, HULIN WANG, Southern Methodist University — The instantaneous luminosity of the LHC Collider will increase during Run 2 to about $1 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$, and the center-of-mass energy will increase to about 14 TeV. This will increase the number of Higgs bosons for more precise physics study. This will also require more precise theoretical predictions. We evaluate the QCD uncertainties on the $Z/\gamma^* \rightarrow \tau\tau$ background extrapolated from control region to signal region. This is important for the study of $H \rightarrow WW$. Results are presented for the gluon-gluon-fusion event selections and the vector-boson-fusion event selections, respectively.

10:09AM H4.00003 Measurement of the Top Quark Mass in Dilepton Final States using Neutrino Weighting in Run II at DØ, HUANZHAO LIU, ROBERT KEHOE, AMITABHA DAS, YURY ILCHENKO, Southern Methodist University, DZERO COLLABORATION — A measurement is presented of the mass of the top quark ($m_t$) in inclusive dilepton final states of t$t\bar{t}$ events. The expected neutrino rapidity distribution is used to solve an otherwise underconstrained kinematic fit to the t$t\bar{t}$ hypothesis. Solutions are given weights according to the degree of agreement between their calculated imbalance in transverse momentum ($\not{p}_T$), and the events observed values of missing $E_T$. The first two moments of the distribution of weights as a function of $m_t$ are used to extract a measurement of $m_t$. Ensemble tests of pseudo-experiments are performed to calibrate and correct the extracted $m_t$, and to estimate its statistical uncertainty. Events corresponding to an integrated luminosity of 9.7 fb$^{-1}$ of DØ Run II data collected in the $e\mu$, $ee$ and $\mu\mu$ channels are used for this analysis. The calibration is performed using a t$t\bar{t}$ cross section expected for $m_t = 172.5$ GeV. A number of optimizations are developed and we expect the improvement to the statistical uncertainty of $m_t$ to be 20%.

10:21AM H4.00004 Neutral vector boson production in pp and pA collisions at hadron colliders, BOWEN WANG, Southern Methodist University, MARCO GUZZI, DESY, PAVEL NADOLSKY, Southern Methodist University — I discuss the $Z/\gamma^*$ gauge boson production in $pp$ and $pA$ collisions with the focus on non-perturbative contributions to the transverse momentum distribution based on the Collins-Soper-Sterman (CSS) resummation formalism. The dependence of the CSS resumed cross section on resummation scales and other factors is estimated. I also present a study of $Z/\gamma^*$ production in proton-proton and lead-lead collisions, where the small-$x$ shadowing and moderate-$x$ antishadowing effects are shown in transverse momentum and rapidity distributions.

10:33AM H4.00005 Probing Compressed Top Squarks at the LHC at 14 TeV, SEAN WU, BHASKAR DUTTA, WILL FLANAGAN, Department of Physics and Astronomy, Texas A&M University, ALFREDO GURROLA, WILL JOHNS, Department of Physics and Astronomy, Vanderbilt University, TERUKI KAMON, Department of Physics and Astronomy, Texas A&M University, PAUL SHELDON, Department of Physics and Astronomy, Vanderbilt University, KUVER SINHA, Department of Physics, Syracuse University, KECHEN WANG, Department of Physics and Astronomy, Texas A&M University — A feasibility study is presented for the search of the lightest squark ($\tilde{q}$) in a compressed scenario, where its mass is approximately equal to the sum of the masses of the top quark and the lightest neutralino $\chi^0_1$ and there exists no limit from the current 8-TeV data or from the 14-TeV projections. The study is performed in the final state of two b-jets, one lepton, large missing transverse energy, and two energetic jets with a large separation in pseudo-rapidity, in opposite hemispheres, and with large dijet mass. The analysis shows that the LHC could probe compressed top squarks mass $\sim 300$ GeV with an integrated luminosity of 300 fb$^{-1}$ for two ($t+\chi^0_1$) and three body ($b+W+\chi^0_1$) final states arising from the stop decay at 5$\sigma$ significance with no systematic uncertainty. After including the systematic uncertainties, the significance for $m_{\tilde{t}} = 200$ GeV and $\Delta M = 7$ GeV is expected to be 6(3)$\sigma$ for 300 fb$^{-1}$ luminosity with 3(5)% systematic uncertainty, while the significance becomes 4(2)$\sigma$ for the same top squark mass with $\Delta M = -7$ GeV.

10:45AM H4.00006 Monte Carlo Study of Leptonic Asymmetry of $t\bar{t}$ at the Fermilab Tevatron, XUJI ZHAO, Texas A&M University — Since the discovery of the top quark 20 years ago, physicists have been studying the properties of this fascinating particle and how it has been produced in collisions. Recent measurements at Tevatron, a proton-anti-proton collider, have shown that more top quarks are produced along the same direction as the proton than expected. In this talk, we discuss the methodology used in the measurement as well as the potential implications of this result.

10:57AM H4.00007 Exploring the Doubly Charged Higgs of the Left-Right Symmetric Model using Vector Boson Fusion-like Events at the LHC, TATHAGATA GHOSH, BHASKAR DUTTA, RICARDO EUSEBI, YU GAO, TERUKI KAMON, Mitchell Institute for Fundamental Physics and Astronomy, Department of Physics and Astronomy, Texas A&M University — In this talk we shall present the study of the pair production of the doubly charged Higgs boson of the left-right symmetric models using multilepton final state in the vector boson fusion (VBF)-like processes. The study is performed in the framework consistent with the model’s correction to the standard model $μ_{WW}$ parameter. VBF topological cuts, number of leptons in the final state and $p_T$ cuts on the leptons are found to be effective in suppressing the background. Significant mass reach can be achieved for exclusion/discovery of the doubly charged Higgs boson for the upcoming LHC run with a luminosity of $O(10^3)$ fb$^{-1}$.

11:09AM H4.00008 Simulation of Gas Electron Multiplier Detector for the CMS Experiment at the Large Hadron Collider, ALI CELIK, Texas A&M University, CMS COLLABORATION — The Compact Muon Solenoid (CMS) Collaboration is proposing an upgrade of the muon detector system by installing Gas Electron Multiplier (GEM), a new type of gaseous detector, in the forward region ($1.54 < |η| < 2.2$). It will consist of two layers of GEM chambers, which will be operating after the 3rd Long Shutdown of the Large Hadron Collider (LHC). The GEM system is expected to have better performance in tracking efficiency, time resolution, and position resolution for detecting muons even in large multiple interaction environment. This is also expected to maintain trigger rate for muons in the forward region in a LHC high luminosity operation. We report results of extensive development of its simulation package that is used for physics performance studies.

1For the CMS GEM Collaboration
11:21AM H4.00009 Search for Supersymmetry in Dilepton Final States with energetic Two-jets in Vector Boson Fusion-like Topology Using the CMS Detector at the LHC\textsuperscript{1}. ALI CELIK, Texas A&M University, CMS COLLABORATION — A search of supersymmetry using Vector Boson Fusion tagged jets is presented using 20 fb\textsuperscript{-1} of data from proton-proton collisions at center of mass energy of 8 TeV, collected by the CMS detector in 2012. Final states containing at least two leptons are expected in pair production of chargedinos and neutralinos. The number of observed events is consistent with the Standard Model expectation. Limits on production and chargino mass at 95% confidence level are set. The results are complementary to other searches through its direction production.

\textsuperscript{1}For the CMS Collaboration

11:33AM H4.00010 Track based alignment of the CMS muon detectors. RYAN MUELLER, YURIY PAKHOTIN, ANTHONY ROSE, ALEXEI SAFONOV, TERUKI KAMON, Texas A&M Univ — The muon detectors of the CMS experiment provide fast trigger decisions, muon identifications and muon track measurements. The reconstruction performance of high momenta muons requires an accurate alignment of the CMS muon system and therefore this will be important for a range of physics analyses in Run 2 of the LHC. A track-based alignment procedure for the CMS muon chambers is presented. In addition to discussing the details of the alignment algorithm, the limitations of the muon alignment procedure are reported.

11:45AM H4.00011 The Geneva Monte Carlo Framework. CALVIN BERGGREN, Texas Lutheran University, SIMONE ALIOLI, CHRISTIAN BAUER, Lawrence Berkeley National Laboratory, FRANK TACKMANN, DESY, JONATHAN WALSH, SABA ZUBERI, Lawrence Berkeley National Laboratory — The Geneva Monte Carlo framework is a next-generation event generator capable of combining higher-order resummation (NNLL) of large Sudakov logarithms with multiple next-to-leading-order (NLO) matrix-element corrections and parton showering (using Pythia 8) to give a complete description at the next higher perturbative accuracy in alpha_s at both small and large jet resolution scales. Results for e+e− + jets compared to LEP data and for Drell-Yan production are presented.

11:57AM H4.00012 Prediction of an extra gauge-boson coupling for scalar bosons. ROLAND ALLEN, Texas A&M University — A fundamental statistical picture that was proposed earlier is shown to lead to three predictions for scalar bosons (Higgses or sfermions) that should be testable in the near future at the LHC. The first is a modification of the propagators, the second is an unrenormalized value near zero for the self-coupling for scalar bosons (Higgses or sfermions) that should be testable in the near future at the LHC. A track-based alignment procedure for the CMS muon chambers is presented. In addition to discussing the details of the alignment algorithm, the limitations of the muon alignment procedure are reported.

12:09PM H4.00013 Radon Plateout on Copper to iLLUMINate Background Levels in the Super Cryogenic Dark Matter Experiment. MYISHA NAKIB, MATTHEW BRUEMMER, ROBERT CALKINS, JODI COOLEY, Southern Methodist University, SCDMS COLLABORATION — The Laboratory for Ultra-pure Material, Isotope and Neutron Assessment (LUMINA) at Southern Methodist University houses one of only five existing UltraLo 1800 production model alpha counters made commercially available by XIA LLC. The instrument has an electron drift chamber with a 707 cm\textsuperscript{2} or 1800 cm\textsuperscript{2} counting region which is determined by selecting the inner electrode size. The SMU team operating this device is part of SuperCDMS materials and screening working group, and uses the alpha counter to study the background rates from the decay of radon in materials used to construct the SuperCDMS experiment. We will present results from initial studies on copper samples exposed to thorium sources in our lab in order to understand radon plateau, on copper and compare storage inside of an aluminum and glass container.

12:21PM H4.00014 The Seasonal Dependence and Two Year Stability of the 30cmx30cm Gas Electron Multiplier Calorimeter. YVONNE NG, AMIT BASHYAL, JOSHUA MEDFORD, RONALD MUSSEY, TIMOTHY WATSON, ANDREW WHITE, JAEHOON YU, University of Texas at Arlington, UTARLINGTON ADVANCE DETECTORS TEAM — The Gas Electron Multiplier (GEM) is one of the detector technologies for high energy physics calorimetry. Its low power demand and high energy precision have made it one of the ideal candidates amongst other detectors. Since 2002, the UT Arlington Advance Detector team has been working on developing a prototype GEM detector to be used as the sensitive medium in a calorimeter for the Silicon Detector(SID) in the International Linear Collider project(ILC). Various sizes of prototype GEM detectors were built. Building upon the initial characterization of the 30cmx30cm detector in 2009, the seasonal dependence and long term stability of the detector’s performance is studied in this paper. The self-trigger mode of the GEM chip used in this system enables the corrections of the electronics gain variation of the chip and the external trigger for cosmic muons allow stability of the actual detector gains. The pedestal noise hits per channel over time is to study the aging of the chip and detector. Data taken over the past 2.5 years are studied. Results show that the prototype GEM is a stable device with a small variation in its gain over many years.

Sunday, October 19, 2014 9:45AM - 12:09PM
Session H5 Condensed Matter Physics and Materials Research MPHY 334 - Christopher J. Tymczak, Texas Southern University

9:45AM H5.00001 Dephasing time in graphene due to interaction with flexural phonons. WEI ZHAO, KONSTANTIN TIKHONOV, ALEXANDER FINKEL’SSTEIN, Texas A&M Univ — We investigate decoherence of an electron in graphene caused by electron-flexural phonon interaction. We find out that the flexural phonons can produce dephasing rate comparable to the electron-electron one. The problem appears to be quite special because there is a large interval of temperatures where dephasing rate cannot be obtained using the golden rule. We evaluate this rate for a wide range of density (n) and temperature (T) and determine several asymptotic regimes with temperature dependence crossing over from T−1 to T−2 to T−1 when temperature increases. We also find T−1 to be a non-monotonous function of n. These distinctive features of the new contribution can provide an effective way to identify flexural phonons in graphene through the electronic transport by measuring the weak localization corrections in magnetoresistance.
9:57AM H5.00002 The Hole-istic: Superconductor Theory and Experiment. HAMILTON CARTER, Texas A&M Univ — Do superconductors emit x-rays when they quench? Do holes lead double lives, undressing and pairing up as electrons when it gets cold? Can the London penetration depth be explained by holes lowering their kinetic energy and getting... well... fat? An experimental search is underway for the x-ray radiation predicted by Hirsch’s hole theory of superconductivity. Originally proffered 25 years ago as a model for high temperature superconductors, the theory as it now stands applies to all superconducting materials. The basics of the hole theory of superconductivity will be reviewed and a new experiment will be described. You’ll come away feeling more comfortable with covalent bonding, hopping amplitudes, Hamiltonians and coherent states. You’ll learn about pulsed magnetic fields and x-ray detection techniques. You’ll be the envy of your friends at parties as you describe both superconductor theory and cutting edge experiments on the frontier of modern physics with confidence and aplomb.

1 Funded by The Texas Academy of Science.

10:09AM H5.00003 Electrical transport properties of graphene field effect devices due to electron irradiation on PMMA/graphene. SUNG OH WOO, Department of Physics and Astronomy, Texas A&M University, College Station 77843, WINFRIED TEIZER, Physics and Astronomy, Texas A&M University, college station TX 77843 WPI-Advanced Institute for Materials Research, Tohoku University, Sendai, Japan — We study the change of the transport properties of graphene field effect transistor devices as a result of electron irradiation on a Poly Methyl Methacrylate (PMMA)/graphene bilayer and subsequent removal of PMMA. We observed that PMMA spun on graphene did not substantially degrade the transport properties of graphene. Instead, the PMMA/graphene bilayer showed slightly improved transport properties than a single graphene device. After electron irradiation on a PMMA/graphene bilayer and subsequent removal of the PMMA, the transport properties deteriorated. In addition, we observed the emergence of defects in graphene by Raman spectroscopy. We conclude that changes in the transport properties due to electron irradiation on PMMA on top of graphene stem from adsorption of atoms or molecules during the depolymerization process induced by energetic electrons. Furthermore, we argue that hydrogen, fragmented from PMMA, is the main element adsorbed on graphene.

10:21AM H5.00004 The pumpistor: understanding the flux-pumped dc SQUID by its electrical impedance. KYLE SUNDOVIST, Texas A&M University — Parametric amplifiers based on superconducting circuits have experienced recent popularity. It is possible to produce asymmetric circuits which may sustain and amplify coherent states of microwaves close to the quantum limit. Such systems currently enable experiments regarding qubit readout, vacuum squeezing, and quantum feedback. To this end, we describe a circuit understanding of the flux-driven dc SQUID. This is useful for developing insight into how these devices perform as active elements, providing parametric gain. We describe three- and four-wave mixing effects, and report on experimental progress. This understanding lends itself to many more testable predictions of otherwisecomplicated quantum systems.

10:33AM H5.00005 Energetic stability of SrTiO3 on GaAs(001) interfaces. JOELSON COTT, ROCIO CONTRERAS-GUERRERO, RAVI DROOPAD, BYOUNGHAK LEE, Texas State Univ-San Marcos — The successful growth of epitaxial SrTiO3 (STO) film on Si substrate using Molecular Beam Epitaxy (MBE) has proved that it is feasible to monolithically integrate the functional oxides with high mobility compound semiconductors [1,2]. While STO has been also deposited on GaAs without amorphous interfacial layers, the exact interface structure has been controversial; while Scanning Transmission Electron Microscopy (STEM) analysis indicates As/Sr interface layers, X-ray diffraction (XRD) measurement shows signs of Ga/SrO interface. Using ab initio calculations, we demonstrate that forming a fully oxidized layer directly top of GaAs substrate is thermodynamically unstable. Instead, an oxygen-depleted Sr metal layer stabilizes the SrTiO3/GaAs interface, in accordance with STEM measurement. We also show that the interface structure observed by XRD is possible under oxygen-rich conditions. The identification of different interface structures and the corresponding growth conditions can be useful for development of growth processes of oxide/semiconductor heterostructures.


1This work has been supported by US AFOSR through Contract No. FA9550-10-1-0133.

10:45AM H5.00006 Transport mechanisms in epitaxial SrTiO3−δ/Si (001) with varying oxygen deficiency. RYAN COTTIER, DANIEL CURRIE, NIKOleta THEODOROPLOU, Texas State University — Epitaxial SrTiO3 (STO) films were grown on p-Si (001) substrates using molecular beam epitaxy (MBE). Oxygen vacancies were introduced by controlling the oxygen pressure during growth resulting in oxygen deficient SrTiO3−δ with δ up to 0.004. The single phase STO/Si films were of high crystalline quality as verified by x-ray diffraction (XRD), transmission electron microscopy (TEM), and had a surface roughness less than 0.5 nm (RMS) as measured by atomic force microscopy (AFM). Transport measurements in a Van der Pauw configuration showed semiconducting behavior. The competing effects of disorder and increased carrier concentration (n-type measured by Hall) due to oxygen vacancies influence the conduction behavior. Low oxygen pressure during growth induces more oxygen vacancies and a larger number of carriers (n-type, measured by Hall) but also leads to more disordered films. Transport in these more disordered films is strongly localized and can be fit to a Variable Range Hopping (VRH) model. Transport in films with a smaller number of oxygen vacancies is thermally activated. We consider competing effects in STO/Si; lattice mismatch with Si, strain and defects due to oxygen vacancies, structural dislocations and the bulk STO antiferrodistortive phase transition at 105K.

10:57AM H5.00007 First-principles studies of physical properties of IV-VI derived semiconductor heterostructures and superlattices for thermoelectric applications. PABLO D. BORGES, Universidade de Vicoso, Brazil, JOHN E. PETERSEN, LUISA SCOLFARO, THOMAS H. MYERS, Texas State University — Doped PbTe is of great interest in high temperature thermoelectric devices. Looking at the qualitative improvements of the figure of merit, here we study the crystal and electronic structure of bulk PbTe, Thallium and Bismuth delta-doped layers in PbTe along the [100] crystalline directions and PbTe/SnTe heterostructures. The thermoelectric properties as a function of carrier concentrations and temperature were studied by solving the semiclassical Boltzmann transport equations in conjunction with ab initio electronic structure calculations, performed within Density Functional Theory. Based on maximally-localized Wannier functions basis set and the ab initio band energies, results for the Seebeck coefficient and figure of merit are presented and compared with available experimental data. Most cases showed good agreement between the calculated properties and experimental available data. Our predictions for temperature and concentration dependences of the figure of merit revealed a promising use of PbTe derived superlattices and heterostructures for thermoelectric devices applications.
Entropy and magnetic properties of Ni-Mn-In magnetocaloric materials, JING-HAN CHEN, Department of Physics and Astronomy, Texas A&M University, College Station, Texas, NICKOLAUS BRUNO, Department of Mechanical Engineering, Texas A&M University, College Station, Texas, EBRAHIM KARAMAN, Department of Materials Science and Engineering, Texas A&M University, College Station, Texas, YIJUN HUANG, JIANGUO LI, School of Materials Science and Engineering, Shanghai Jiaotong University, Shanghai, 200240, China, JOSEPH ROSS, Department of Physics and Astronomy, Texas A&M University, College Station, Texas — Materials showing the magnetocaloric effect (MCE) have been a source of growing interest because of their potential for an environmentally friendly and energy efficient refrigeration technology. Recently, alloys based on Ni-Mn-Z (Z=In, Sb, Sn) have been reported to show a large MCE across the martensitic transformation where a first order structural transition is coupled to a magnetic transition. In this study, Ni-Mn-In materials with compositions Ni3Mn1 and Ni3Mn1.5In0.5 were analyzed both through magnetization and field-dependent calorimetry. For measurements across the first-order transformation region, we designed a modified method for relaxation calorimetry. Based on these measurements we identified individual contributions to the entropy change, including an antiferromagnetic state at low temperatures and a large change at the first order transition. The NiMnIn results also include a large anomalous nonmagnetic contribution. We will conclude by discussing the relative cooling power, and the prospects of these materials for practical applications. We gratefully acknowledge the support by the National Science Foundation under Grant No. DMR-1108396, and by the Robert A. Welch Foundation (Grant No. A-1526).

11:21AM H5.00009 NMR Study of Cu2Se Superionic Conductor1, ALI SIRUSI ARVII, JOSEPH H. ROSS, JR., Department of Physics and Astronomy, Texas A&M University, College Station, Texas 77843, SEDAT BALLIKAYA2, Department of Physics, University of Istanbul, Vezneciler, Istanbul, 34134, Turkey, CITRAD UEHER, Department of Physics, University of Michigan, Ann Arbor, MI 48109, USA — We will report NMR measurements of Cu2Se which address the unusual movements of Cu ions in this compound. This material has attracted great attention recently because of attempts to identify high performance thermoelectric materials. Cu2Se is a superionic conductor with fast ionic motion at high temperatures and a structural phase transition around 410K. NMR is a powerful local probe which can provide information about electronic and structure plus dynamical properties of the compounds. Here we have performed 63Cu and 65Cu NMR at low and high temperatures. The spectra at low temperatures indicate slow Cu ionic motion is initiated at 90K, coinciding with the recent reports of a new phase transition at this temperature. The high temperature spectra show motional narrowing above room temperature. Over the range of 360-400K the gradual phase transition is clearly shown by broadening of the spectra. The Knight shift continues to increase at high temperatures which is a measure of electronic gap and charge carriers thermally induced at these temperatures.

1This work was supported by the Robert A. Welch Foundation, Grant No. A-1526.

11:33AM H5.00010 Quantitative Study of Na+ and/or Cl- doped LiFePO4 as a Cathode Material for Li-Ion Batteries, MICHAEL SEMMLINGER, SPS at Sam Houston State University, HUI FANG, Sam Houston State University Physics Department — In light of the growing need for high performance batteries, Li-ion cells with phospho-olivine cathode materials have received much attention. The overall goal of this research project is to improve the cathode material of lithium ion batteries, by doping lithium iron phosphate (LiFePO4) with sodium (Na+) and/or chloride (Cl-) ions. The objective is to quantitatively study the effects of Na+–Cl- doping on the electrochemical properties of LiFePO4 in order to find the most effective doping amounts. Therefore, several Na+ and Cl- doped samples, as well as Na+–Cl- co-doped samples, and a non-doped LiFePO4 sample for comparison purposes, were prepared using a solid-state reaction. All samples were subsequently carbon coated. After preparation, the sample powders were tested using an X-ray diffractometer to indicate the containing chemical compounds, as well as impurities. In order to measure the performance of the achieved cathode material, several cathodes were prepared from each sample, and then placed into button batteries. The subsequent testing of the batteries using an Arbin BT2000 battery testing system has been rendering data including the cell voltage, cell capacity, and conductivity.

11:45AM H5.00011 Determining the Stability Zone for Single Phase Synthesis of Fe doped Bismuth Titanate Water-Splitting Photocatalysts1, CEDRIC MAYFIELD, MUHAMMAD HUDA, Department of Physics, University of Texas at Arlington — Due to their ferroelectricity, high dielectric constant, and excellent catalytic properties bismuth titanate (BTO) polymorphs comprise an assortment of phenomenological wide band gap semiconductors that are used in everything from device applications to discoloration of organic pollutants. Recently, the potential for BTO as a high performance water-splitter has gathered serious attention. Without modification BTO already reduces water molecules upon UV irradiation. The band alignment is such that merely increasing the density of states will not only raise the Fermi level closer to the oxidation potential of water, but also reduce the band gap so that its photocatalytic property can be activated by visible light. Unfortunately, engineering the energy levels of BTO is stifled by a phase transition-prone chemical potential landscape. We have performed a DFT study pertaining to substitutional Fe doping of the cubic pyrochlore phase (Bi2Ti2O7). We aimed to understand the correlation effects that lead to an experimentally observed Fe doping threshold concentration. We found that different precursor materials had significant effects on single phase synthesis of BTO. We present the formation energy analysis of Fe doping configurations that aided in identification of the configurations associated with formation of secondary phases. We conclude that maintaining our proposed conditions for single phase synthesis will increase the Fe doping threshold and simplify the design of an enhanced BTO alloy.

1This work was supported by the National Science Foundation.

11:57AM H5.00012 Divine Proportion Shape Invariance of DLCA Fractal Aggregates: An Analytical Theory, CHRISTOPHER M. SORENSEN, WILLIAM R. HEINSON, AMIT CHAKRABARTI, Kansas State University — A restricted hierarchical model for Diffusion Limited Cluster Aggregates (DLCA) is presented that accurately predicts analytically the fractal dimension, scaling prefactor and shape of the aggregates. This three parameter description is both necessary and sufficient for a complete description of fractal aggregate morphology. We show that aggregate shape is poorly described by the principal radii of gyration and is best described by side length ratios of circumscribing rectangular solids with side directions determined by the principal radii of gyration. Remarkably, we find that aggregate shape is described by the Fibonacci series and Divine Proportion in two spatial dimensions and their generalization in three.

Sunday, October 19, 2014 9:45AM - 12:45PM
Session H7 Workshop: SPS Careers Toolbox

9:45AM H7.00001 SPS Workshop 1 —
1:20PM J2.00001 Raman Spectroscopy of Plants, DMITRI VORONINE, Texas A&M University — Raman spectroscopy has been used for fast, noninvasive tool for chemical analysis of complex biological systems such as plants. Application of lasers to plant identification and taxonomy offers advantages over traditional methods. Raman spectra provide spectroscopic signatures of plant chemical composition. New applications of portable and lab-based Raman spectroscopy and microscopy of plants will be presented. Advantages and limitations of current instruments will be discussed.

1:32PM J2.00002 Laser-Induced Breakdown Spectroscopy of Plant Materials, JEREMY KUNZ, Baylor Univ, DMITRI VORONINE, Baylor University and Texas A&M University, ALEXEI SOKOLOV, MARLAN SCULLY, Baylor University, Texas A&M University, and Princeton University — Plant stress can be caused by many factors including drought, pollution, and microbial infestations; to name a few. Because many of these issues can affect agricultural crop yield, we use focused femtosecond laser pulses to perform laser-induced breakdown spectroscopy (LIBS) on plant materials in order to detect the effects of stress on plant life. LIBS has the advantage of being simple in its set-up making it an ideal candidate for performing plant stress detection in the field.

1:44PM J2.00003 Raman Confocal Microscopy and its application on plant samples, NARANGEREL ALTANGEREL, graduate student, DWIGHT BOHLMeyer, program manager, ARUINBOLD GOMBOJAV, assistant research professor, MARLAN SCULLY, professor — We introduce our new Lab Ram-HR evolution Confocal Raman Microscope. We also discuss its application to the plant samples. It is including to record Raman spectra, to suppress some fluorescence, and to take Raman imaging.

1:56PM J2.00004 Raman Spectroscopy and Imaging of Red Blood Cells, ANSAM TALIB, SANDRA BUSTAMANTE, ZACHARY LIEGE, SARAH RITTER, ALEXZANDER SINYUKOV, DMITRI VORONINE, ALEXEI SOKOLOV, KENITH MEISSNER, MARLAN SCULLY, None — Raman spectroscopy is a powerful spectroscopic technique that can be used for vibrational imaging of biological systems. We demonstrate Raman spectra and images of red blood cells (RBC) and “ghost cells” with hemoglobin removed and replaced with other molecules. We investigate the dependence on various experimental parameters such as different laser wavelengths and intensities. Our preliminarily results confirm the detection of hemoglobin in RBC and have a potential for future applications in nanoscale cell surface imaging.

2:08PM J2.00005 TERS and AFM Mapping of Molecular Aggregates, ZACHARY LIEGE, Baylor University, Texas A&M University, ALEXANDER SINYUKOV, Texas A&M University, DMITRI VORONINE, ALEXEI SOKOLOV, Texas A&M University, Baylor University — Tip-enhanced Raman spectroscopy is a well-known analysis technique for surfaces and other material science. We combined TERS mapping with a simultaneous AFM mapping in order to correlate topographical features with corresponding Raman spectra. We applied this technique to image copper phthalocyanine molecular aggregates on a molybdenum disulfide substrate. Our results showed chemically-enhanced Raman “hot spots” on the sample surface. These did not correspond with the Raman hot spots observed without the tip. This is the first imaging of chemically-enhanced Raman hot spots on a semiconductor surface.

2:20PM J2.00006 Tip-Enhanced Raman Spectroscopy of Functionalized Nanoparticles, ABDULRAHMAN ALAJLAN, Texas A&M University, DMITRI VORONINE, Texas A&M University and Baylor University, ALEXANDER SINYUKOV, Texas A&M University, ALEXEI SOKOLOV, Texas A&M University and Baylor University, MARLAN SCULLY, Texas A&M University, Baylor University and Princeton University — Raman spectroscopy has been widely used for analyzing a wide range of materials. Tip-enhanced Raman spectroscopy (TERS) is one of the advanced strategies used to provide high spatial resolution and enhanced Raman signals simultaneously. TERS enhances Raman signals significantly for molecules located in the gap between plasmonic metal nanoparticles. This enhancement is attributed to the increase of electromagnetic field strength in the gap. However, some studies also show remarkable enhancements of Raman signals from molecules outside of the gap. We investigate the underlying mechanisms of TERS using nanoantenna formed by functionalized nanoparticles and nano tips. The results may be applied to studying bio-molecular interactions, which are essential for understanding the biological processes in living cells.

2:32PM J2.00007 Coherent Surface-Enhanced Resonant Raman Spectroscopy, XIAOHAN LIU, Xi’an Jiaotong Univ, DMITRI VORONINE, MARLAN SCULLY, Texas A&M Univ, IQSE TEAM — Spontaneous Raman scattering has been widely used to perform molecular chemical analysis but weak signals from small amounts of material present a challenge. Surface-enhanced Raman scattering (SERS) and coherent anti-stoke Raman scattering (CARS) spectroscopies are two of the most common techniques to enhance the Raman signals. Several attempts have been done to combine those techniques to reach the maximum signal enhancement. We investigate resonant Raman effects for enhanced Raman scattering and combine it with surface and coherence enhancements.

2:44PM J2.00008 Resolving Spectral Congestion in Time-Resolved Surface-Enhanced Coherent Raman Signals using Compressed Sensing, CHUANHONG LIU, Xi’an Jiaotong University, Xi’an, Shannxi, China 710049, DMITRI VORONINE, MARLAN SCULLY, Texas A&M University, College Station, TX 77845, IQSE TEAM — Experimental noise often limits spectral and temporal resolution in coherent nonlinear optical spectroscopy. For example, in time-resolved surface-enhanced coherent anti-stokes Raman scattering (SECARS) spectroscopy the spectral resolution increases with a decreasing size of the pulse shaper slit but the signal-to-noise ratio decreases [1-3]. The theoretical limits of resolution in time-resolved CARS have previously been discussed [4]. We apply the compressed sensing (CS) technique to improve data analysis and to reach the theoretical spectral resolution in noisy SECARS signals.
2:56PM J2.00009 Coherent anti-Stokes Raman scattering with a single broadband pulse, YUJIE SHEN, Texas A&M University, DAMIRI VORONINE, ALEXEI SOKOLOV, Texas A&M University, Baylor University, MARLAN SCULLY, Texas A&M University, Princeton University, Baylor University — Here we demonstrate single-beam coherent anti-Stokes Raman scattering (CARS) with a spectral notch consisting of a narrow wire placed in a 4-f pulse shaper. This was previously done by using resonant photonic crystal slab. Our current setup can be used in both forward detection and epi-detection, and is promising in achieving low-wavenumber Raman shift (< 200 cm⁻¹) measurements.

3:08PM J2.00010 Ultrasound Pulse Microscopy for Three-Dimensional, In-Vivo Biological Imaging, BRIAN KELLY, Texas A&M — As laser technology continues to advance, optical imaging is becoming more prevalent in biological applications. Commonly used methods, such as confocal microscopy, offer high resolution and three-dimensional imaging capabilities, but often harm the sample. Thus, there is a need for methods that offer such advantages while doing no harm. Ultrasound Pulse Microscopy (UPM), an optical imaging method utilizing sub 10-fs laser pulses, may be the solution to this problem. UPM offers the ability to obtain multimodal, three-dimensional in-vivo images of a biological sample. In this talk, we will discuss the relevant theory, instrumentation and implementation of our UPM system.

Sunday, October 19, 2014 1:20PM - 3:20PM
Session J3 Nuclear Physics II MPHY 332 - Rainer J. Fries, Texas A&M University

1:20PM J3.00001 Clustering in Alpha Conjugate Nuclei Reactions, KRIS HAGEL, Cyclotron Institute, Texas A&M University — Reaction products from alpha conjugate nuclei systems of 35 MeV/u Ta, 40Si, 40Ca + 12C, 40Ca + 16O, 48Ca + 40Ca, 16O + 16O, 28Si, 28Si, 28Si, 12C and 28Si + 12C Ta are presented. Alpha particles and alpha conjugate fragments emitted in these reactions are observed with large probabilities. Alpha particles appear to be emitted from a neck like source. Reactions are compared to model calculations as well as the reconstructed asymmetry of quasi-projectiles. Studying the asymmetry difference of fragments produced in reactions of Zn and Ni at 35MeV/nucleon will allow us to examine the equilibration that occurs in these systems.

1:32PM J3.00002 Equilibration between projectile and target in heavy-ion nuclear collisions, LARRY MAY, ZACHARY KOHLEY, GIACOMO BONASERA, PAUL CAMMARATA, LESLIE GALVAN, KRIS HAGEL, LAUREN HEILBORN, JUSTIN MABIALA, PAOLA MARINI, ALAN MCINTOSH, GEORGE SOULIOTIS, JOHN VU, SARA WUENSCHEL, MICHAEL YOUNGS, ANDREW ZARRELLA, SHERRY YENNELLO, Cyclotron Institute - Texas A&M University — Understanding equilibration in heavy-ion collisions is of significant importance to nuclear physics. Since nuclei are composed of neutrons and protons, the difference in the number of neutrons and protons, or asymmetry, can be used to study equilibration processes in the nucleus. We can study the equilibration occurring between two nuclei with differing asymmetry compositions in Fermi energy heavy-ion collisions by using the ratios of the yields of fragments, as well as the reconstructed asymmetry of quasi-projectiles. Studying the asymmetry difference of fragments produced in reactions of Zn and Ni at 35MeV/nucleon will allow us to examine the equilibration that occurs in these systems.

1:44PM J3.00003 Nucleation and cluster formation in low-density nucleonic matter: A mechanism for ternary fission, SARAH WUENSCHEL, HUA ZHENG, KRIS HAGEL, Texas A&M University Cyclotron Institute, BRAD MEYER, Clemson University, MARINA BARBUI, Texas A&M University Cyclotron Institute, E.J. KIM, Chonbuk National University, GERD ROPKE, University of Rostock, J.B. NATOWITZ, Texas A&M University Cyclotron Institute — Ternary fission yields from the reaction of 241Pu(nth,f) are studied in the context of nucleation moderated equilibrium. The temperature, density, proton fraction and fission time required to fit the experimental data will be discussed. This model provides natural explanations of some known problematic features of ternary factor yield distributions. In addition, the systematic behavior of this model across several fissioning nuclei will be presented.

1:56PM J3.00004 Measurement of the plasma astrophysical S factor for the 3He(d, p)4He reaction in exploding molecular clusters, M. BARBUI, Cyclotron Institute, TAMU, TX, W. BANG, University of Texas at Austin, TX, A. BONASERA, Cyclotron Institute, TAMU, TX, J.B. NATOWITZ, Cyclotron Institute TAMU, TX, K. HAGEL, K. SCHMIDT, R. BURCH, G. GIULIANI, H. ZHENG, M. BARBARINO, Cyclotron Institute, TAMU, TX, G. DYER, H.J. QUEVEDO, E. GAUL, A.C. BERNSTEIN, M. DONOVAN, T. DITMIRE, University of Texas at Austin, TX, S. KIMURA, M. MAZZOCCO, INFN, Italy, F. CONSOLI, R. DE ANGELIS, P. ANDREOLI, ENEA, Italy — The plasma astrophysical S factor for the 3He(d, p)4He reaction was measured for the first time at temperatures of few keV, using the interaction of intense ultrafast laser pulses with molecular deuterium clusters mixed with 3He atoms. Different proportions of D2 and 3He or CD2 and 3He were mixed in the gas jet target in order to allow the measurement of the cross-section for the 3He(d, p)4He reaction. The yield of 14.7 MeV protons from the 3He(d, p)4He reaction was measured in order to extract the astrophysical S factor at low energies. Results of the experiment performed at the Center for High Energy Density Science at The University of Texas at Austin will be presented [PRL, 111, 082502].

2:08PM J3.00005 A Static Potential from QQ Free Energy Lattice QCD Data, SHUAI LIU, RALF RAPP, Texas A&M University — A long-standing problem in the physics of the QGP is the definition of the intermediate potential between two heavy quarks QQ. We develop a formalism that enables us to obtain a potential from QQ free energy lattice QCD data. The resulting potential lies significantly above the QQ free energy and more closely resembling the internal energy. This potential is characterized by a significant long-distance contribution from the remnants of the confining force. This long range potential provides more binding than free energy and generates a larger transport coefficient. The set-up in this paper gives insights into the long-standing problem of finding the QCD force in medium.

2:20PM J3.00006 Hot Nuclear Correction to J/psi suppression in dAu collision at 200GeV, XIAOJIAN DU, RALF RAPP, Cyclotron Institute, Texas A&M University — The production of J/ψ mesons in high-energy collisions of heavy nuclei is believed to be a sensitive probe of the possible formation of a new state of matter in these collisions, the quark-gluon plasma (QGP). The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Lab affords us with a lot of experimental information on J/ψ production in different collision systems. The dAu collisions usually provide us information on so-called cold nuclear matter effects. However, recently it has been conjectured that also in these small systems a hot thermal medium could form. In the present work we theoretically investigate whether such a hypothesis can be consistent with J/ψ and ψ′ suppression data. To do so, we adapt our charmonium transport approach, developed for AuAu collisions, to the smaller dAu system. In this way we extend our cold matter theoretical result to include hot medium corrections, and compare the results to J/ψ and ψ′ data from the PHENIX collaboration. We find indications that the data are better described when including hot nuclear matter effects. This has the potential to better quantify the relevant mechanisms in heavy systems, and thus provide deeper insights into the physics of the quark-gluon plasma.
Applications to Thermalizing Color Glass

∂ hydrodynamic calculations have become key tools for successful calculations of hard probes, heavy quarks, electromagnetic probes etc., in heavy ions. Evidence that quark gluon plasma in those collisions, behaves like a liquid and cools and expands hydrodynamically. In recent years precision energies can be described by relativistic hydrodynamics. The experimental heavy ion programs at RHIC and LHC have finally provided strong evidence that gold ions exist within the beam halo, and the ongoing task is to use Glauber Monte Carlo methods. How the Glauber Model identifies type of ions in collisions will be explained, and data taken from a Single Beam Fixed Target test run at RHIC will be examined. The conclusions reached so far indicate that heavy ions exist within the halo, and the ongoing task is to use Glauber Monte Carlo methods to determine definitively if they are gold ions.

Accelerator Driven Systems: a human-scale solution for responsible nuclear energy

Accelerator driven systems (ADS) provide an option to instead destroy this dangerous waste and extract additional energy from these reserves, extending the non-recyclable fuel horizon by an order of magnitude. A plan for molten salt-based ADS in the US will be presented, along with design for the key components.

Superconducting Cable-in-Conduit: New Basis for Practical Applications

A single layer of round-wire superconductors is cabled onto a thin-wall metal spring tube, then sheathed in a high-strength tube. The CIC cable integrates the mechanical support, cryogenic cooling, quench protection within the cable so it can be fabricated into windings for magnets, motors, generators, and energy storage applications with far less complication than any previous conductor. Three applications will be summarized: a 4.5 T NbTi dipole for a 100 TeV hadron collider, a 3 T solenoid for superconducting magnetic energy storage, and a 3 T transport gantry for proton- and ion-beam cancer therapy.

What does the distribution of satellites around galaxies 8-11 billion years ago tell us about their dark matter halos? The distribution of satellites around galaxies at high redshift is crucial for understanding the dark matter buildup. We derive a semi-analytic model of galaxy harassment, and compare it to the observed distribution of satellite galaxies around massive central galaxies. The model is tested against the satellite distribution in the nearby LRG sample.

Pseudo-bolometric calibration of IIP Supernovae using Unfiltered Photometry

Type IIP supernovae are the most frequent core collapse supernovae. These events seem to occur from progenitors of mass $M \sim 8 - 20 M_\odot$ that are able to retain their hydrogen envelope throughout their life. Their luminosity rises rapidly to peak soon after the shock breaks out, with the most luminous contribution coming from UV photons (up to 80%). The post-peak phase is followed by a characteristic photospheric plateau/recombination phase that normally lasts for $\sim 100$ days. This phase is characterized by the optical photons in the most part. Because of such homologously expanding ejecta in a long duration photospheric phase, IIPs have been used as accurate cosmological distance probes using the Expanding Photospheric Method (EPM). Bolometric properties of such events are not only crucial for the EPM analysis, but also to extract explosion kinematics. We present an empirical calibration of pseudo-bolometric light curve for some well observed IIPs using open CCD (clear) and broadband data. We show that a direct comparison of clear flux with integrated $BVRI$ flux yields $\sim 13\%$ residual, while a color dependent calibration yields better than $2\%$ residual. From this calibration, we derive the pseudo-bolometric lightcurve for events that lack filtered photometry.
1:44PM J4.00003 Swift Ultraviolet Observations of Supernovae1, PETER BROWN, Texas A&M — The Swift satellite’s Ultra-Violet Optical Telescope has observed over 300 supernovae during its first nine years in operation. This represents an order of magnitude increase in the number of ultraviolet observations and has enhanced many active lines of inquiry. These include shock breakouts, bolometric light curves, progenitor constraints, and evolution with redshift. Ultraviolet observations are also very sensitive to many of the effects leading to possible systematic errors in using type Ia supernovae as cosmological distance indicators. I will describe the whole Swift supernova sample and highlight some of the most interesting objects observed by Swift.

1This work is supported by NASA grants NNX13AF35G and NNX14AC52G.

1:56PM J4.00004 Bolometric Spectra and Lightcurves of Type Ia Supernovae, MICHAEL SMITKA, Texas A&M Department of Physics and Astronomy, Texas A&M SUPERNOVA GROUP TEAM, CARNEGIE SUPERNOVA PROJECT collaboration — The use of Type Ia supernova as distance indicators in the optical revolutionized cosmology by revealing the accelerating universe and are widely viewed as a valuable tool in efforts to distinguish between differing cosmological models. I will discuss our work observing nearby (\(< 0.015\)) SNe Ia in the ultraviolet, optical and near-infrared and our method of combining these observations into bolometric spectra and lightcurves to gain a full-spectrum view of rest-frame SNe Ia evolution. I will highlight the importance of this data set with regard to our basic understanding of the underlying physics of SNe Ia and also its utility in analyzing SNe found at higher redshifts by large surveys like Dark Energy Survey and LSST.

2:08PM J4.00005 Image stacking through a geometrical phase retrieval algorithm for JWST1, ELIZABETH CARLISLE, Abilene Christian University, SCOTT ACTON, Ball Aerospace & Technologies Corp., JAMES WEBB SPACE TELESCOPE TEAM, BALL AEROSPACE COLLABORATION — The James Webb Space Telescope is an 18-element cryogenic telescope scheduled to be launched in 2018. Since it has a deployable primary mirror, part of its commissioning process requires aligning and phasing the mirror segments. The current proposed method, image stacking, is a long, complicated process that could take more than a week. Phase retrieval could be capable of handling the task without a good starting estimate for the phase. We have adapted a geometrical phase retrieval (GPR) algorithm for use along with the traditional phase retrieval to phase the primary mirror. This talk will focus on the operation of the GPR algorithm, as well as a demonstration of its effectiveness.

1This research was funded by NASA contract NAS5-02200.

2:20PM J4.00006 Interactive Cosmological Modeling with Easy Java Simulations: Constraints from a New Growth of Structure Module of CosmoEJS1, JACOB MOLDENHAUER, WILLIAM ZIMMERMAN, University of Dallas — Several cosmological observations suggest the universe’s expansion is accelerating. Some possible explanations include a cosmological constant, or other form of repulsive dark energy, i.e. negative pressure and negative equation of state, a modification to general relativity at cosmological scales of distances, or an apparent effect of inhomogeneities in the universe. CosmoEJS is an interactive simulation package that allows educators and researchers to investigate cosmological models by simultaneously fitting several observations numerically. Previously, this package only used expansion history data sets, like supernovae, gamma ray bursts, baryon acoustic oscillations, the Hubble parameter, and the cosmic microwave background radiation; but data sets which measure the growth of galaxy structure formation, or clustering, have been shown to be more constraining for particular sets of models. We present a new module that enables constraints from growth data sets for various cosmological models. When combined with expansion history observations, these constraints from the growth of structure can drastically reduce the number of competitive cosmological models. CosmoEJS is available from Compadre Open Source Physics website, i.e. http://www.compadre.org/osp/items/detail.cfm?ID=12406.

1Cowan Physics Fund

2:32PM J4.00007 Fractal Analysis in a One-dimensional Universe, YUI SHIOZAWA, BRUCE MILLER, Texas Christian University — While the universe we observe today exhibits local, filament-like, structures with galaxy clusters and large voids between them, the primordial universe is believed to have been nearly homogeneous with slight variations in matter density. To understand how the observed hierarchical structure was formed, researchers have developed a one-dimensional analogue of the universe that can simulate the evolution of a large number of matter particles. Investigations to date demonstrate that this model reveals structure formation that shares essential features with the three-dimensional observations. In the present work, we have expanded on this concept to include two species of matter, specifically dark matter and luminous matter. In our simulation, luminous matter is treated in a way that loses energy in interaction. The results of the simulations clearly show the formation of a Cantor set like multifractal pattern over time. In contrast with most earlier studies, mass-oriented methods for computing multifractal dimensions were applied to analyze the bottom-up structure formation.

2:44PM J4.00008 Characterization of Gravitational Waves from Primordial Relativistic Turbulence, DAVID GARRISON, University of Houston - Clear Lake — This work is a follow-up to the paper, “Numerical Relativity as a Tool for Studying the Early Universe.” In this article, we present the first results of direct numerical simulations of primordial plasma turbulence as it applies to the generation of gravitational waves. We calculate the normalized energy density, strain and degree of polarization of gravitational waves produced by a simulated turbulent plasma similar to what was believed to have existed at the electroweak scale, 246 GeV. The initial random magnetic field amplitude was allowed to vary between otherwise identical data runs. We find that in the absence of plasma turbulence, no magnetic field is produced but as the magnetic field increases, gravitational waves with normalized energy densities as high as \(10^{-47}\) may be produced. We also observed a significant degree of polarization in gravitational waves produced by the turbulent plasma field in agreement with Kahniahvil’s results. The spectrum of gravitational waves produced appeared to mirror the spectrum of density and temperature fluctuations as expected. These and future results can be used to determine the conditions of the early universe, specifically the magnitude of primordial magnetic fields, from future gravitational wave observations.

2:56PM J4.00009 Probing the First Billion Years of Universe, V. TILVI, C. PAPOVICH, Texas A&M University, S.L. FINKELSTEIN, University of Texas, J. LONG, Texas A&M University, M. SONG, University of Texas, M. DICKINSON, NOAO, H. FERGUSON, A. KOEKEMOER, STScI, M. GIVALISCO, University of Massachusetts, B. MOBASHER, UC Riverside — Most of the major events in the history of the universe occurred during the first billion years. However, this era also remains one of the least explored epoch. Specifically, our knowledge about when and how did the first stars and first galaxies form and how did the entire universe transition from a neutral to an ionized phase, called the epoch of reionization, remains limited. To probe this epoch of reionization, we have recently obtained extremely deep spectroscopic observations of galaxies within the first 800 Myrs after the Big Bang. Our results suggest that universe is significantly neutral by redshift of about 8 (nearly 650 Myrs after the Big Bang) and this transition occurs over a very short time interval of about 300 Myrs.
1:30PM J5.00001 Exploring the Vacuum with High Intensity Lasers. DANIEL TENNANT, University of Texas at Austin — Strong field processes in Quantum Electrodynamics are believed to cause polarization and even breakdown of the vacuum in the presence of fields strengths soon to be accessible in high intensity laser experiments. Less explored consequences of strong field electrodynamics include effects from Born Infeld type of electromagnetic theories. I propose that Four Wave Mixing, a nonlinear optical effect, can differentiate between these two extensions of Maxwell’s electrodynamics.

1:42PM J5.00002 Biological and Chemical Evaluation of Biocidal Plasma Jets1, KARL STEPHAN, Ingram School of Engineering, Texas State University, ROBERT MCLEAN, Department of Biology, Texas State University, GIAN DELEON, VADIM MELNIKOV, Ingram School of Engineering, Texas State University — Plasma jets that produce “cold” plasma can disinfect or sterilize surfaces without the need for elevated temperatures or aggressive liquid chemical treatment. The active ingredients in most cold plasmas are reactive oxygen species (ROS) such as singlet oxygen, OH, and hydrogen peroxide. While many studies of plasma jets for biological applications have been published, there is a need to develop a quantitative measure of the plasma’s biological activity that is simpler than testing the jet with biological samples. In this paper, we study a simple method developed to evaluate a plasma jet’s ability to cause oxidative stress to biological targets. The method uses a ferrous-oxidation-xylene-orange chemical indicator to quantify the presence of ROS, which is then correlated with measurements of the plasma jet’s biological activity. The physical chemistry of the plasma-to-solution transfer process can be modeled and correlated with bacterial survival data. Our long-term objective is to refine this antimicrobial technology for applications on a number of surfaces.

1This work was partially supported by a Research Enhancement Grant from Texas State University.

1:54PM J5.00003 Collective Bases for Spin 1/2 Systems. PHILIP VETTER, None — Robert H. Dicke studied collective spontaneous emission from a small cloud of atoms, and in 1954 predicted that collective states would have qualitatively different decay rates vs. individual atomic states. Recent experiments have reportedly harnessed this phenomenon, for example, to produce “superradiant lasers” of high spectral purity. Central to superradiance is the notion of the symmetric Dicke state, a collective quantum state created by the superposition of many individual atomic spin states. This symmetric Dicke state is the maximally symmetric state with a total of one excitation. It can be asked whether there are pseudo-symmetric states that can complete the state space, and if so, what can we say about them? This problem becomes combinatorially complex as the number of excitations increases. Mathematically, this problem involves the tensor product of spin representations. There is a beautiful expression for the decomposition of this tensor product into irreducible representations. In one particular geometry, a surprising connection with coding theory has physical significance.

2:06PM J5.00004 Demonstrating Entanglement in a Classical Device1. BRIAN LA COUR, The University of Texas at Austin — We describe a proposed experiment to measure entanglement in a classical device. The experimental procedure and data analysis protocol follow that of a previous experiment to measure an entanglement witness with polarized photons prepared in a mixed state [M. Barbieri et al., Phys. Rev. Lett. 91, 227901 (2003)]. Numerical simulations suggest excellent agreement can be achieved with both the aforementioned photon experiment and quantum mechanical predictions.

1This work was supported by the Office of Naval Research under Grant No. N00014-14-1-0323 and an Internal Research and Development grant from Applied Research Laboratories, The University of Texas at Austin.

2:18PM J5.00005 An Extension of the Ritz Force Law. JAMES WOODYARD, West Texas A&M University, JAMES ESPINOSA1, Rhodes College — In 1908, Walter Ritz published a detailed theory of electromagnetism that remains inside the framework of Newtonian mechanics. Unfortunately, his untimely death in 1909 did not allow him to further refine this theory. We will show how to extend his equation in order to be able to describe blackbody radiation correctly and indicate how this formula can be modified to describe microscopic systems such as the hydrogen atom.

1current employer: TGS

2:30PM J5.00006 Most observed phenomena cannot be explained by any existing theory of physics. SERGIO PISSANETZKY, UHCL — Scaling, fractals and power laws remain a mystery [M. Mitchell, “Complexity”]. No existing theory of Physics can explain them. The same applies to emergence, self-organization, adaptation, semantics, brain function. The theories themselves do not scale. A new fundamental theory of Physics is needed. To build the theory, we look for symmetries, structure, meaningful invariants. The working hypothesis is that information is fundamental, not spacetime or matter. Start from the principle of causality. Represent any system, at any scale, as a discrete set of cause-effect pairs — a causal set C. Find the groupoid G of C, the block system B induced by G on C, and the (smaller) causal set C’ of B. Repeat for C’. You get a fractal hierarchy of physically meaningful invariants. This means: information is universally recursive, fractal, structured, always scales, always obeys power laws. The invariants can be anything: particles, galaxies, thoughts, companies, species, theories. It works. There are already confirmed predictions: 1: Dendrite trees in the brain are optimally short (published). 2: The Traveling Salesman problem is solved, and P=NP is confirmed (under review). In my talk I will explain how heuristics make theories loose scalability.

2:42PM J5.00007 A Newtonian Hydrogen molecule. JAMES ESPINOSA1, Rhodes College, JAMES WOODYARD, West Texas A&M University — We will present a model of the hydrogen molecule that utilizes only Newtonian mechanics. First, we will review the electromagnetic force formula of Walter Ritz and adapt it to microscopic phenomena. Its most important attribute for us will be its ability to have two electrons be attracted to each other, something non-Newtonian theories such as Maxwell’s is unable to do. This electron attraction will be pivotal to modeling the chemical bond. After this pictorial review, we will present simulation results that model both stability and vibrational frequencies.

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The Fermilab Tevatron is one of only two places in the world where a particle accelerator was able to create top quarks in a collision and study their properties; the other being the Large Hadron Collider (LHC). We study the top quarks produced at the Tevatron from proton antiproton collisions. In this case, the top quarks are expected to be produced in a direction closer to the initial proton beam. We present our results and find that some deviations have been observed, and discuss the potential implications for particle physics.