Abstracts

A1: Plenary Session I (Friday 8:00-10:55)

Chair: Daniel K. Marble, Tarleton State University Science 102

1. *Building a National Digital Library for Computational Physics Education At All Levels*
WOFLGANG CHRISTIAN, Davidson College

Over the past dozen years we have produced some of the most widely used interactive computer-based curricular materials for the teaching of introductory and advanced physics courses. These materials are now hosted on and distributed from the Open Source Physics (OSP) Collection of the ComPADRE National Science Digital Library. This talk outlines the tripartite integration of ComPADRE with the Easy Java Simulations modeling and authoring tool and the OSP code library. The pedagogical and technical features of this learning platform and our current efforts to align this material with United States national and state standards for science teaching are described. The Open Source Physics Collection is available on the: http://www.compadre.org/osp/. Partial funding for this work was obtained through NSF grants DUE-0442581 and DUE-0937731

2. *Why, What, Who, and How – All About Medical Physics*
Dharanipathy Rangaraj, Scott & White Hospital

In this lecture the audience would be exposed to the field of Medical physics include what they do, how to become a medical physics, why one choses to be a medical physics and who are Medical physicist. This speaker is going to relate these topic with his own personal experience and career decision he made in the past several years. The audience would also be present with information how the field has changed and what the future of the field looks like. The speaker will also compare and contrast other field of physics with respect to technology, satisfaction and opportunities for the mind and body.

3. *Paths into the Schrodinger Equation via Classical and Quantum Field Theories*
MARLAN SCULLY, Texas AM University

The time-dependent Schrodinger equation is a cornerstone of quantum physics and governs all phenomena of the microscopic world. However, despite its importance its origin is still not widely appreciated and properly understood. We obtain the Schrodinger equation in two ways: 1) from classical statistical mechanics based on the Hamilton-Jacobi equation[1] and 2) by showing the deep sense in which the Maxwell equations for the photon are very analogous to the Schrodinger equation for the electron and/or the neutrino.[2]

4. *The 2-D World of Chemistry: Graphene and Other Interesting Materials*
GARY BEALL, Texas State University

As recently as 2004 theorist predicted that 2-D materials would not be stable. This view was turned on its ear by the discovery of graphene by researchers in England. Graphene is a single layer of graphite. It exhibits the highest electron mobility at room temperature of any material, thermal conductivity approaching diamond, and the highest tensile strength of any material ever measured. Details of these properties and the methods of producing graphene will be presented. This discovery prompted a worldwide research race to study graphenes properties but also ways to produce graphene cheaply. In this talk a method developed at Texas State will be described that produces graphene at lower cost than any other process. This method also produces graphenes that are functionalized at the edges allowing a host of new chemistries to be performed. Several applications of the graphene will also be presented. In addition a new 2-D material based upon transition metal cyanides has been developed in my laboratory. The talk will also discuss some of the unique properties of this new material.

B1: High Energy Physics I (Friday 11:12-11:48)

Chair: Jimmy J McCoy, Tarleton State University Science 102

2. *Clarifying the Structure of the Nucleon: Status of the SeaQuest Experiment (Fermilab E906)*[1]
LARRY DONALD ISENHOWER, Abilene Christian University, SEAQUEST COLLABORATION

SeaQuest (Fermilab E906) will make a number of measurements in kinematic ranges with a precision that have not been possible in previous experiments. It will probe the light antiquark sea of the nucleon to follow up on measurements made by Fermilab E866/NuSea, with a goal of answering important questions raised by that experiment. SeaQuest will determine the ratio of the anti-down to anti-up quarks in the nucleon at Bjorken x up to 0.4, where the number of anti-quarks in the nucleon is extremely small. Above x=0.25, NuSea data indicate this ratio could be changing in a surprising manner where the ratio could be dipping below one. SeaQuest started commissioning and data collection in March-April of 2012, just before the Fermilab 120 GeV Main Injector (MI) shut down for a year. The present status of the SeaQuest experiment as
it prepares to start back up this summer when the Fermilab MI resumes operation will be discussed. Some of the initial commissioning issues will be described, along with upgrades of the SeaQuest detector being made for high intensity running this year. Some of the other planned physics measurements that are possible will be outlined during this talk as well.

[1]Research supported in part by U.S. Department of Energy, NP Division, Grant #DE-FG02-03ER41243.

3. *Higgs in Hot and Dense Background*
SAMINA MASOOD, University of Houston Clear Lake

We study the leptonic decays of Higgs boson in hot and dense medium. It is shown explicitly that the currently known Higgs mass will suppress the temperature and density effects to the ignorable level. However, since Higgs scale is related to the symmetry breaking scale, it is still interested to see how the symmetry breaking mechanism is affected in hot and dense media.

4. *D-Dimensional Gauge Models*
DOUGLAS MOORE, JARED GREENWALD, GERALD CLEAVER, Baylor University

Utilizing the Gauge Framework software under development at Baylor University, we explicitly construct all layer 1 weakly coupled free fermionic heterotic string (WCFFHS) gauge models up to order 32 in four to ten large spacetime dimensions. These gauge models are well suited for large scale systematic surveys and, while they offer little phenomenologically, are useful for understanding the structure of the WCFFHS region of the string landscape. We present the gauge groups statistics for this swath of the landscape for both supersymmetric and non-supersymmetric models as well as consider a unique approach for analyzing model production.

B3: Computational Physics (Friday 11:00-12:12)

Chair: Bryant Wyatt, Tarleton State University Science 112

1. *Tangential Relations Between Distorted Angles vs. Original Angles of a Traveling General Triangle in Special Relativity*
Florentin Smarandache, University of New Mexico

Let's consider a traveling general triangle $\Delta $\textit{ABC,} with the speed v, along its side \textit{BC }on the direction on the $x-$axis; angles B and C are adjacent to the motion direction, while angle A is of course opposite. Let \textit{AM} be the perpendicular from A to the motion direction \textit{BC}. After the contraction of the side \textit{BC} with the Lorentz factor $C(v)=\sqrt {1-\frac{v^{2}}{c^{2}}} $, and consequently the contractions of the oblique-sides \textit{AB} and \textit{AC} with the oblique-contraction factor \[OC(v,\theta)=\sqrt {C(v)^{2}\cos^{2}\theta +\sin^{2}\theta } , \] where $\theta $ is the angle between respectively each oblique-side and the motion direction, one gets the general triangle $\Delta A'B'C'$ with the following tangential relations between distorted angles vs. original angles of the general triangle: \[\tan A'=\tan A\cdot C\left(v \right)\cdot \frac{1-\tan A_{1} \tan A_{2} }{1-\tan A_{1} \tan A_{2} C\left(v \right)^{2}}, \] where angles $A_{1} =BAM$and respectively $A_{2} =MAC$; \[\tan B'=\frac{\tan B}{C\left(v \right)}; \] \[\tan C'=\frac{\tan C}{C\left(v \right)}. \]

2. *Comparison of Correlation Function for Path Integral Formulation of Ortho-Positronium in Dense Fluids*
TERRENCE REESE, Southern University and A&M College, BRUCE MILLER, Texas Christian University

In previous work the Path Integral Monte Carlo (PIMC) technique was used to simulate
a quantum particle (qp) in a dense Lennard-Jones 6-12 fluid having the thermodynamic properties of Xenon. Because of the difference in thermal wavelengths between the qp and the fluid molecules the fluid molecules can be treated classically. This combination of using quantum mechanics for the qp and classical mechanics for the fluid molecules is known as a hybrid model. The path integral formulation represents a qp as a closed chain of P classical particles in which the quantum uncertainty in the position of the qp is manifested in the finite width spread of the polymer chain. The PIMC technique allows standard classical Monte Carlo techniques to be used to compute quantum mechanical equilibrium values like the ortho-Positronium pick-off decay rate. The Correlation Function, C(k), is the mean product of the difference of a variable at the times j and j+k with the average value divided by the variance. The correlation length, k, at which C (k) becomes zero, indicates the number of passes before values of the independent variable are statistically independent. The Correlation Function versus the correlation length has been plotted for the decay rate covering different polymer segment lengths, temperatures, densities, and fluid
molecule numbers. The number of statistically independent configurations has also been computed for each thermodynamic system.

3. *Functional Programming in Scientic Computing*
DOUGLAS MOORE, Baylor University

We look at the typical design goals of scientic/mathematical computing and consider ways in which a functional programming style can be used to achieve them. Programming examples for various domain-specic problems, e.g. constructing the root structure of semi-simple lie algebras, are presented in various popular languages such as C/C++ and MATLAB as well as the functional language Haskell for contrast.

4. *Endohedral fullerene as acceptor: A DFT study on charge transfer states of Sc_3N@C80-porphyrin complex*[1]
FATEMEH AMERIKHEIRABADI, LUISBASURTO, RAJENDRA ZOPE, TUNNA BARUAH, The University of Texas at ElPaso

C60 fullerene and its derivatives are the most popular acceptors which are used in molecular/polymeric complexes used in organic photovoltaics. Endohedral fullerenes are shown to produce long lived charge separated states. The Sc3N@C80, the third most abundant fullerene after C60 and C70, has a larger cage with a radius of 4.1 Ang. We have carried out a DFT study on the electronic structure of ground and charge transfer states of a model Sc3N@C80-Zn tetraphenyl porphyrincofacial complex. The C80 cage used in our calculations has icosahedral symmetry. We nd that the lowest charge transfer state with a hole on the porphyrin and an electron on the Sc3N@C80 is at 2.1 eV above the ground state. The calculations show that dif- ferent orientations of the Sc3N unit to the porphyrin plane do not signicantly alter the electronic structure. The electronic structure of the complex and its components along with the exciton binding energies will be presented.

[1]Supported by NSF through grant no. DMR 1205302.

5. *Orthogonal Polynomial Projection Quantization: A New Hill Determinant Formulation*[1]
CARLOS HANDY, DANIEL VRINCEANU, Texas Southern University

We present a new formulation[2] (OPPQ) of the configuration space Hill determinant (HD) approach,[3] and its momentum space counterpart (MRF),[4] that has none of the instabilities of the former,[5] nor the limitations of both. Let Ψ(x) = Σn an Pn(x) R(x), where the Pn's are the orthogonal polynomials for a given reference function, R(x)> 0 . If the system admits a linear recursive moment equation representation, the an's become a finite sum with respect to the Moments p=sxpΨ(x). Constraining aN= 0,...,aNms= 0 gives impressive results for the discrete state energies, surpassing MRF. Contrary to HD, OPPQ is an L2formulation in which R(x): (i) does not have to be analytic; and (ii) can be adapted to the asymptotic form of Ψ. It has been applied to 1D and 2Danharmonic potentials, including pseudo hermitian systems, as well as the difficult two dimensional dipole problem for modeling edge structures in nanomaterials.6

1NSF -HRD-1137732, NRC 38-10-935
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5A. Hautot, Phys. Rev. D 33, 437 (1986).
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6. *Follow-on Studies of Hydrogenic Quantum Systems Using the Feynman-Kac Path Integral Method*
J.M. REJCEK, N.G. FAZLEEV, Department of Physics, University of Texas at Arlington

The Feynman-Kac path integral method is applied to the atomic hydrogen quantum system for the purpose of evaluating eigenvalues of the corresponding eigenfunctions of the Hamiltonian of the system. These are computed by random walk simulations on a discrete grid. The study provides the latest simulation analysis and includes rescaling and the use of symmetry that allows eigenvalues of the corresponding higher order eigenstates to be computed. The method provides exact values in the limit of innitesimal step size and innite time for the lowest eigenstates.

D1: Astrophysics and Space Physics I (Friday 2:00-3:24)

Chair: Shaukat Goderya, Tarleton State University Science 102

1. *O-C Calculations for Two New Binaries and V1097 Herculis*
JAMES JOHN MEIER, RICHARD OLENICK, ARTHUR SWEENEY, JEFFREY SCHNIEDERJAN, MATTHEW HEUSER, University of Dallas, STEXTS TEAM

We report the results of time-resolved CCD photometry of two new binaries and V1097 in the constellation Hercules. Our observations were carried out using a six-inch, wide angle lens astrograph with a set focal length of 200 mm, three-degree Field of view and f/1.5 stopped down to an f/2.8 in Pitkin, Colorado in the R band for 35 nights during the early summer of 2012. We exposed each image for one minute and took 300 images per night, obtaining 10,500 images in total. Using Peranso software, Lomb-Scargle period analysis was carried out for the binaries. We will present the O-C calculations for the two new binaries, GSC 2087- 0364, GSC 2083-1870 as well as for V1097 Her.

2. *Using virtual satellite passes through Earth's magnetosphere to infer properties of the ionosphere*
ROBERT BRUNTZ, RAMON LOPEZ, University of Texas at Arlington

The Sun continuously emits a solar wind, composed of charged particles embedded in a magnetic field, which flows out through the entire solar system. As the solar wind passes Earth, it interacts with Earth's magnetic field, both through a purely magnetic interaction and through a more friction-like viscous interaction. The viscous interaction is typically weaker than the purely magnetic interaction and is affected by the solar wind magnetic field in a non-linear way, making
it very difficult to quantify. We are investigating a technique in which we simulate the solar wind-magnetosphere interaction using the Lyon-Fedder-Mobarry (LFM) magnetohydrodynamic (MHD) simulation, then fly a "virtual satellite" through the region of the viscous interaction, in order to measure the interaction directly. These results can be compared to actual satellite passes that occurred during similar conditions, to ascertain their validity. Earth's magnetic field is linked directly to the ionosphere, the upper layer of the atmosphere, so the virtual satellite passes will
provide information about plasma motion in the ionosphere, as well.

3. *Abell Cluster Catalog for the Purpose of Supernova Discovery*
JAMES BOSHART, MICHAEL HIBBS, Tarleton State University

The violent death of a star in the form of a supernova provides much scientic data. However, due to the infrequency of supernova per galaxy per year, there is little known about them. My research was focused around finding possible supernovae by taking images of Abell Clusters (large distant clusters of galaxies). By using a set of criterion that maximized our probability of finding a supernova, I have established a baseline of images by which subsequent images can be compared to so as to find any anomalies that could be a supernova. The primary goal of my research was to establish an image catalogue of various Abell Clusters with Tarleton State University's 0.8 meter reecting telescope that can be used in subsequent research by colleagues in the future.

4. *Comparison of Neutron Star Models Using Various EOS*
MICHAEL NAIZER, CARLOS BERTULANI, WILLIAM NEWTON, Texas A&M University - Commerce

Several modern equations of state (EOS) for neutron stars can be ignored because they predict a neutron star mass limit lower than observed masses. Also, some EOS mass/radius curves fall far outside the error bounds of observed values and can be ignored as well. These observational constraints narrow down the search for an accurate EOS signicantly.

5. *The Physics of Spacecraft Propulsion Via Quark Pair Production from Parallel Electric and Magnetic Fields*
GERALD CLEAVER, APS

Matter/antimatter (MAM)-based propulsion systems are viable options for both intrasolar system and interstellar travel. For example, the feasibility and functionality of on-board Schwinger electron-positron pair production via high power lasers has received growing interest lately. In this talk an alternate in-situ MAM production method will be discussed. Production of quark-antiquark pairs via interaction of parallel electric and magnetic elds associated with chiral symmetry breaking will be reviewed. Emphasis will be on the physics involved in the quark pair production and in the basic design of a related propulsion system

6. *A Three-decade X-band VLBI Study of the Nuclei in the Lobe dominated Quasars 3C207 and 3C263*[1]
DAVID HOUGH, Trinity University

We report X-band VLBI observations of the nuclei in the lobe-dominated quasars 3C207 and 3C263 from 1981 to 2010, mostly obtained with the NRAO VLBA. The goal is to follow ux density outbursts and to fully determine the jet morphology and kinematics on 1-100 pc scales. In 3C207, the core region has ux outbursts roughly every 7 yr, which are actually double outbursts from a stationary true core and a swinging component 0.5 mas apart. The position angle (PA) of the swinging component varies by 40 degrees, while the PAs of the jet components span 25 degrees. The jet extends to 25 mas. Average superluminal speeds are about 10c. One component shows apparent acceleration from 7c to 14c at 2-3 mas from the true core, in a jet recollimation zone that redirects the ow toward PA 90 degrees. Individual jet components expand until reaching the recollimation zone. In 3C263, some of the same phenomena are seen, including non-radial ejection of jet components, superluminal motion, and apparent acceleration, but to a lesser degree. Possible physical interpretations involving, e.g., jet precession and a binary black hole system, will be discussed. (This abstract repeats and extends results in Hough, D. 2012, BAPS, 57, 11, for which the oral presentation was cancelled.)

[1]NRAO is a facility of the NSF operated under cooperative agreement by AUI. We are grateful for a AAS Small Research Grant.

7. *PHOEBE Modeling of Three New Binaries in Hercules*
JEFFREY SCHNIEDERJAN, RICHARD OLENICK, ARTHUR SWEENEY, JAMES MEIER, MATTHEW HEUSER, University of Dallas, STEXTS TEAM

We report the results of modeling of three new binaries in Hercules discovered through time-resolved photometry by the Small Telescope Exoplanet Transit Search (STExTS) project. Observations were made with a 200 mm astrograph f/1.5 stopped down to an f/2.8 in the R band over a period of seven weeks in summer 2012 in Pitkin, CO. A total of 10,500 calibrated images and PHOEBE were used to model the light curves of the newly discovered binaries GSC 2087-1870, GSC 2083-1875, and GSC 2087-0364. The binaries' parameter and classifications will be presented.

D2: Physics Education (Friday 2:00-4:00)

Chair: Eric Hagedorn, University of Texas at El Paso Science 109

1. *Why You Should Have LAs: A Student Perspective*
JESSICA CONN, ELEANOR CLOSE, Texas State University-San Marcos

In 2012 Texas State University's Physics Department created a Learning Assistant Program to further develop students' conceptual understanding of physics through the introductory physics sequence. Through this program, undergraduate students have the opportunity to work with fundamental physics concepts more deeply both during time spent with other LAs while preparing for the following week's lesson and while working directly with students in the classroom or the Physics Help Center. This program also provides an opportunity for physics majors who are interested in physics education research to learn about and participate in the field while still an undergraduate. I will discuss how being a Learning Assistant helped deepen my own conceptual understanding of Newtonian Mechanics and peaked my interest in physics education research, and what kinds of research I hope to engage in next school year

2. *Investigative study on the correlation between high school student Mental Rotation Test (MRT) scores and state assessment scores and grades in STEM classes*
ALFONSO HINOJOSA, RAMON LOPEZ, University of Texas at Arlington

We are investigating the effects that student spatial representations have on student success in state assessment exams and STEM courses. Previous work indicates an increase in a student's cognitive load when mentally manipulating three-dimensional images. In physics, student difficulties with mentally manipulating 3-D images while retaining related material may be connected with spatial intelligence issues. To investigate this, we conducted a study (9 sections) on student spatial intelligence during the fall 2012 semester using the introductory physics and chemistry classes. All students were administered the MRT, which consists of 20 spatial intelligence problems. The scores were then statistically correlated with the corresponding student state assessment scores, as well as class grades. We will contrast those correlations with the correlations between student exam performance and high school courses taken.

3. *My Learning Assistant experience at Texas State*
TAYLOR SHIMEK, ELEANOR CLOSE, Texas State University-San Marcos

The learning assistant (LA) program is a program designed to better help undergraduate students understand concepts in physics. This semester I am a sophomore at Texas State University-San Marcos and have been a learning assistant. With my experience in the program so far I have seen how the LA program helps students understand what is being taught in class. I have also gained a better understanding of physics though working with the program as well as how to teach physics. The pedagogy course that goes along with the program has helped me to better understand the trouble students have learning new concepts. This class also involves conducting a clinical interview to determine a person's mental model(s) on energy. I will discuss the results of this project in my talk.

4. *Simplifying Avogadro's Number an Activity for Teachers*
JAMES ROBERTS, BETTY CROCKER, University of North Texas

One of the outstanding discoveries of the 19th century was the observation that a volume of gas molecules conned to 22.4 liters at standard pressure and temperature had a fixed number. This number is Avogadro's number. One of the activities of the Regional Collaborative for Excellence in Science Teaching at UNT is for the teachers to understand the concept of this large number and to then use an activity with current flow through a Copper Sulfate solution to get a number that is proportional to Avogadro's number through electron counting. This activity shows how very large numbers can be arrived at by taking fractions of the whole and extrapolating to large numbers. The activity uses a known count of pennies whose mass is obtained and this fraction used to obtain the number of units (coins) that would be in a mass of Avogadro's number of coins. The coins are assumed to be proportional to atoms. Faraday's laws of electrolysis are used in the electroplating process to extract Copper ions from solution to form Copper. The mass of the Copper is obtained, the fact that it is bivalent is used to show that it takes two electrons to form Copper from the Copper ion extracted from the solution by electric current flow.

5. *Winter Break Effect in General Education CLASS Results*
DAVID DONNELLY, HUNTER CLOSE, ELEANOR CLOSE, Texas State University-San Marcos

The Winter Break Effect is a shift in student attitudes toward more expert-like during the break between the first semester and second semester of a course. We have CLASS data from a two semester general education course that seems to demonstrate a Winter Break Effect. However, more detailed analysis of matched responses between the end of the first semester and the beginning of the second semester indicates that no significant shift in overall favorable percentage occurred between the first and second semester. We do however observe a statistically significant decrease in the overall unfavorable percentage. This shift persists throughout the second semester of the course

6. *Conceptual Inventory and Assessment Results from a Department at Risk*
BETH THACKER, Texas Tech University

Assessment results from a large-scale assessment of the introductory courses of a department at risk are presented. The results compared the understanding of students taught traditionally to those with Physics Education Research Informed (PER-informed) instruction in the labs and recitations only to those with PER-informed instruction in labs, recitations and lecture sessions. The results reflect those found in other studies that indicate that student-centered pedagogy is more effective at increasing students' understanding. Still, the majority of physics faculty at Texas Tech University (TTU) are hesitant to introduce student-centered pedagogy into the lecture instruction, at odds with results of studies, such as those in the Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) report that indicate that the adoption of interactive, student-centered introductory physics curricula is an important component in increasing retention

7. *Student Gestures about Complex Wave Functions for One-Dimensional Potentials*
CATHERINE SCHIBER, HUNTER CLOSE, ELEANOR CLOSE, DAVID DONNELLY, Texas State University- San Marcos

A quantum wave function for a particle in a one-dimensional potential may be purely real at some instant, or there may be no such instant, depending on the potential. When the time dependence of the wave function is factored in, any function will surely have both real and imaginary parts. The complex nature of the wave function in these cases is perhaps best shown using three dimensions rather than with a two-dimensional drawing. We asked upper-division quantum mechanics Students in an oral exam to show with their hands what the shape of wave functions for various potentials would look like, and how these functions would evolve in time. We analyze the Students' gestures to understand their thinking; in particular, we investigate the difference between gestures that trace static structures and those that represent dynamic evolution, and how students extend mathematical knowledge from two-dimensional contexts into three.

8. *Integrating computational physics problems into upper division physics curriculum*
TIKHON BYKOV, McMurry University

In recent years computational physics is starting to become a standard part of undergraduate physics curriculum. There are two alternative approaches on how computational physics can be taught. It can either be a standalone computational physics course or various computational physics problems can be integrated into existing upper division physics curriculum. McMurry physics department has chosen the second approach. It appears that learning computational physics methods in the context of typical physics problem enhances understanding of both numerical and programming aspects. In this talk, I will give examples of the types of computational physics problems being considered in Classical Mechanics, Thermodynamics and Electricity & Magnetism courses to illustrate the main numerical methods used in physics.

9. *Students' dynamic geometric reasoning about quantum spin-1/2 states*
HUNTER CLOSE, CATHERINE SCHIBER, DAVID DONNELLY, ELEANOR CLOSE, Texas State University-San Marcos

Quantum states are traditionally cognitively managed exclusively with algebra rather than geometry. One reason for emphasizing algebra is the high dimensionality of quantum mathematical systems; even spin-1/2 systems require a 2-d complex number space for describing their quantum states, which can be hard to visualize. Using "nested phasor diagrams," which use nesting to increase the dimensionality of graphic space, we taught undergraduate students to represent spin-1/2 states graphically as well as algebraically. In oral exams, students were asked to identify which spin-1/2 states, expressed numerically, would generate the same set of probabilities as each other (i.e., they are the same except for a different overall phase factor). Video records of oral exams show that no students (N=13) performed this task successfully using an algebraic method; instead, all students solved the problem graphically. Furthermore, every student who succeeded used a certain gesture to solve the problem

10. *Recognizing the Unobservable Properties of the Physical Universe*
LIONEL HEWETT, Texas A&M University- Kingsville

Observational science defines the physical universe as consisting of that and only that which can be verified or disproven through experimental observations. Everything else is considered to be metaphysical and subject to a philosophical debate regarding reality. However, as the resolution of a physical observation is probed toward its limit, one finds that the observable properties of the universe must be expressed in terms of unobservable properties. The failure to distinguish between the observable and un-observable properties of the universe results in much of the confusion regarding the various interpretations of quantum mechanics and general relativity. Recognizing this distinction renders an explanation of such phenomena as quantum gravity, entangled states, double-slit experiment, Schrodinger's cat, and the collapse of the wave function of the entire universe.

D3: General Physics (Friday 2:00-3:00)

Chair: Carlos Handy, Texas Southern University Science 112

1. *Electron Nuclear Dynamics Simulations of Proton Collisions with Water in Proton Cancer Therapy*
JIEUN YOO, Physics Department, Texas Tech University, AUSTIN PRIVETT, CHRISTOPHER STOPERA, JORGE MORALES, Chemistry Department, Texas Tech University

Proton cancer therapy (PCT) uses high-energy proton projectiles to kill cancerous cells. With water composing 70 % of the human body, the main destructive effects of PCT processes include the radiolysis of water due to proton collisions. Water radiolysis products include radicals and ions formed by fragmentations and ionizations, which can cause damage to the DNA of cells. We conducted electron nuclear dynamics (END) simulations of proton collisions with water clusters $(H_2O)_n$ n=1-5, at 100 keV. These clusters represent a progressive approximation to actual bulk water. END is a time-dependent, variational, direct, and non-adiabatic method that simultaneously models the dynamics of electrons and nuclei in a molecular system. In its current implementation, END uses a classical description for the nuclear degrees of freedom and a single determinant quantum mechanical description for the electronic degrees of freedom. We conducted END simulations revealing mechanistic details and calculated cluster-to-proton electron-transfer integral cross sections (ICSs). Comparison of those ICSs with experimental results involving single water molecules shows good agreement.

2. *Quantitative Phase Microscopy of Cellular Fluctuations Modulated by Optogenetic Stimulation*
BISHORUP BANJARA, NELSON CARDE-NAS, SAMARENDRA MOHANTY, University of Texas at Arlington

Significant progress has been made in the application of optogenetic stimulation as a means to
modulate and control cellular functions within chemically-identical groups of cells. High resolution imaging can detect subtle morphological (shape/refractive index) changes in cells subsequent to optogenetic stimulation. Invasive topographical measurement methods such as mainstream AFM and other scanning probe techniques suffer from low temporal resolution and restricted field of view, resulting in reduced throughput. QPM, integrated with optogenetic stimulation incorporates a wide-field, label-free, non-invasive optical imaging technique for all optical stimulation and detection with high spatial and temporal resolution. We dynamically monitored phase of cells, sensitized with and without ChR2, using quantitative phase microscopy with and without light stimulation. The variation of phase in optogenetically stimulated cells (expressing ChR2) was found to be higher than that of the control cells. We report that our method could potentially evaluate effectiveness of various opsins and stimulation parameters including cellular function under different physiological surroundings via spatially-modulated optogenetic stimulation and wide-field quantitative phase imaging.

3. *Polynomial preconditioned GMRES-DR*[1]
QUAN LIU, Baylor University

GMRES-DR (Gneralized Minimal Residual algorithm with Deated Restarting), developed by Dr. Ronald Morgan in 2002, is a well known algorithm in QCD matrix calculation. We did a modified version of regular GMRES-DR by combing it with the polynomial conditioning method, which can help improve the eigenvalue spectrum of the lattice QCD matrix, especially for ill-conditioned matrix with small eigenvalues.
[1]Walter Wilcox, Baylor University

4. *A Classical Model of Helium*
JAMES ESPINOSA[1], Rhodes College, JAMES WOODYARD, West Texas A&M University

We present a preliminary model of the Helium atom that stays within the Newtonian framework. The three body Coulomb problem is greatly simplied by taking into account the delayed action at a distance character of the electromagnetic force. This time delay is amply represented by our modied Ritzian force law between two charged particles. In addition, we will use chemical and scattering data to arrive at a pictorial model of the atom. From this mechanical picture we will derive its stability, the magnetic properties, ground state energy, and spectra of Helium. We will conclude with a series of models that will be used for the rest of the noble gases.
[1]Present employer TGS

5. *Electronic structure and charge transfer states of a multichromophoric heptad antenna*
LUIS BASURTO, TUNNA BARUAH, RAJENDRA ZOPE, University of Texas at El Paso

A multichromophoric Heptad molecule containing Zn-tetraphenyl porphyrin, BDPY dye, bisphenyl anthracene, and C60 attached to a hexaphenyl -benzene core was synthesized by Gust et al. (J. Phys.Chem. B, 113, 7147 (2009)). The snowflake like molecule behaves like an antenna capturing photons at different wavelengths and transferring the energy to the porphyrin. We present a DFT based study on the ground state of the complex and also on the lowest two charge transfer (CT) states of the complex carried out using a perturbative delta-SCF method. The calculations, done using a mixed all-electron and pseudo-potential approach, show that the ionization potential of the porphyrin and the electron affinity of the C60 in the complex changes significantly from isolated molecules. Our calculated value of the lowest CT state is within 0.2 eV of the experimental estimate. This CT state contains a hole on the porphyrin HOMO and a particle on the C60 LUMO. A comparison of the energetics with experiment indicates that the process probably involves excitation from the HOMO-1 of porphyrin to the porphyrin LUMO followed by electron transfer and hole bubbling up, resulting in a CT state with the hole on the porphyrin HOMO and particle on the C60 LUMO.

D4: Society of Physics Students (Friday 2:00-4:12)

Chair: Bryant Wyatt, Tarleton State University Science 105

1. *An N-Body Study of Late Lunar-Forming Impacts*
JUSTIN EILAND, Tarleton State University, BRETT HOKR, JUSTIN HIGHLAND, Texas A&M University, TRAVIS SALZILLO, BRYANT WYATT, Tarleton State University

Jupiter has 63 moons some believed to be captured asteroids and others to have been formed from accumulations of Jupiter's circumplanetary disk. Mars has two distinct moons which are thought to be captured asteroids. Earth has only one moon, but what makes our moon interesting and unique is its large relative size compared to Earth and its lack of iron. Because of this, it is believed that the Earth-Moon system was formed by a giant impact which stripped off a large portion of the Earth's outer material to create our Moon. Impact studies have produced Earth-disk systems with the protolunar disk being sufficiently massive and iron-depleted but have not created an Earth-Moon system. Models have also been produced that show how a moon can be formed from a disk of debris similar to that produced by these collision simulations. However, there has currently been no model that produced both the Earth and the Moon from a single simulation. In this study we use a simplified body to body, gravity centered force model coupled
with General Purpose Graphics Processing Unit's (GPGPU) for computing power to accomplish what has previously eluded researchers

2. *Development of a NIFFTE Clean Glove Box*
WILLIAM LYNN, Abilene Christian University, NIFFTE COLLABORATION

The Neutron Induced Fission Fragment Tracking Experiment (NIFFTE) uses a Time Projection Chamber (TPC) to measure the probability that a fission reaction will occur when an actinide
target, such as Uranium or Plutonium, is struck with a beam of neutrons. If a fission reaction occurs, the resulting fission fragments travel through the TPC and are detected by the read-out electronics. This information is then used to construct a 3-D representation of the fission fragment as it travelled through the TPC. In order to protect workers from any radiation hazards associated with Plutonium targets, the targets must be installed in the TPC from within a glove box. The internal structure of the TPC is extremely sensitive to small amounts of dust and this necessitates that the TPC be disassembled and reassembled in a cleanroom environment. To satisfy both of these conditions, a decision was made to modify an existing glove box to produce a cleanroom environment with fewer than 10 particles (dust, etc.) per cubic foot inside of it. Variables such as glove type, filter, and cleaning agent were tested independently to determine maximum cleanliness, and a procedure for creating an acceptable environment inside the glove box for the TPC was developed.

3. *Measuring Light Emitting Diodes with a Scanner for Radiant Flux and Color Characterization*
ANTHONY PHUNG, CLINT NAQUIN, OMAR HASAN, WEI-TING LIOU, ROXANNE LEE, ARMAND HALBERT, AN-TING LIU, EMIN BURSA, DAVID TAYLOR, JASON SLINKER, The University of Texas at Dallas

Due to the performance requirements of displays and lighting applications, there is great need to measure the radiant flux and color of light emitting diodes (LEDs) simultaneously in a high throughput format. We evaluate the feasibility of obtaining reliable color and radiant flux values of light emitting diodes with a conventional commercially available scanner under factory settings versus conventional measurements. Color purity was evaluated against a spectrometer and a digital camera, while radiant flux was evaluated against photodiodes. Scanner color rendition of red, green, and yellow LEDs was of variable quality. The scanner showed better correlation to conventional radiant flux measurements, with linear least squares agreement between 0.934 and 0.985. A scanner represents a low cost and high throughput means of evaluating LEDs with simultaneous measures of both electroluminescent flux and emission color with operational time.

4. *Graphitic Carbon Nitride Fabrication*
ADAM COLLARD, University of Dallas, YANCEN LI, Mentor, JOEL THERRIEN, Advisor

Single atom thickness carbon nitride sheets have been predicted as good high speed semiconductors. However, it is difficult to synthesize large continuous single layer sheets. Although large amorphous multilayer sheets can be produced easily, single layer sheets require a precise deposition method and solution. We synthesized the carbon nitride at the University of Massachusetts Lowell in the Center for High-rate Nanomanufacturing. Synthesis starts by depositing solutions on silicon wafers using various deposition methods. Wafers are then baked in an ultrahigh purity argon environment where ammonia is removed thereby transforming the chemical deposit of Dicyandiamide into carbon nitride. After baking samples they are tested with Raman Spectroscopy and Atomic Force Microscopy. Single atom thickness samples are then patterned using negative photoresist lithography and coated with aluminum. Excess aluminum is removed and the samples are probed to test band gap and resistivity. Difficulties were encountered in finding a good solvent, proper concentration, and deposition method that worked. The synthesis techniques, solution types, baking specifications, characterization techniques, and results will be presented.

5. *The Mechanism, Safety and Prospect of Microwave Oven*
ANGELA LI, Collin College

The microwave ovens have been accredited with their convenience, but also questioned for their safety. To understand if the current models of microwaves are adequate for household use, the researcher conducted a study in the heating mechanism of microwaves. The studies also provide the outlook for improvements and further microwave applications for green energy use. METHODS A number of experiments have been conducted, including the Melting Marshmallow, detecting the energy density field around a household microwave, and energy efficiency estimation of microwave versus other heating apparatus. Theory-wise, a relatively comprehensive research was performed on the the nutritious values of microwave cooked food. FINDINGS The microwave oven heating is produced by the friction between water and food molecules. The electric field inside the oven cavity can be modeled by the computer. Household microwaves are not threats to health due to negligible wave leakage. The microwaves have also evolved throughout the years. However, the uneven heating has been the main reason that downgrades the texture of the microwave cooked food. CONCLUSION Microwave ovens are safe for household uses. As an efficient way of heating, microwave should be applied in a greater variety of fields. There are still technical challenges on directly increasing the quality of the microwave heated food.

6. *Learning New Skills with Undergraduate Research*
GREGORY BEUHLER, NIKOLETA THEODOROPOULOU, Texas State University-San Marcos

Undergraduate research can provide an opportunity to learn new skills as well as gain valuable work experience prior to graduation. This semester I am assisting a graduate student at Texas State University-San Marcos with testing for a two-dimensional electron gas between layers of strontium titanate oxide (STO) and bismuth ferric oxide (BFO). So far I am being trained in thin film deposition techniques, such as DC and RF sputtering, and transport measurements using a physical property measurement system. I have also been trained in the use of a state-of-the-art dual beam scanning electron microscope (Helios 400) to perform electron beam lithography, ion-beam milling, and gas injection deposition. I have thoroughly enjoyed my time in the lab so far and hope to encourage other students to get hands-on physics experience and continue learning.

7. *Elastic and Inelastic Neutron Scattering Cross Sections on ^{23}Na*[1]
L. SIDWELL, B. COMBS, S.F. HICKS, University of Dallas, J.R. VANHOY, United States Naval Academy, E.E. PETERS, B.C. CRIDER, A. KUMAR, M.T. MCELLISTREM, F.M. PRADOS-ESTEVEZ, S.W. YATES, University of Kentucky

Elastic and inelastic neutron scattering differential cross sections from ^{23}Na, useful in certain fission reactor applications, were measured using the neutron scattering and detection facilities at the University of Kentucky (UK) in June of 2012. A pulsed proton beam was accelerated using the 7-MV Van de Graaf accelerator, and neutrons were produced using the ^{3}H(p,n)^{3}He source reaction, which occurred when the proton beam was incident on a tritium cell at the end of the beam line. The neutrons were scattered off a ^{23}Na sample and detected by a C6D6 liquid scintillation detector using pulse shape discrimination and time-of-flight methods. Angular distributions of scattered neutrons were measured for incident neutron energies of 3.20 and 3.40 MeV. These incident neutron energies were chosen because they are of interest for reactor applications and because few previous measurements exist in this region. As the result of data analysis performed at the University of Dallas, the elastic and inelastic neutron scattering differential cross sections on ^{23}Na were determined for the 3.20 and 3.40 MeV incident neutron energy measurements. Results from this analysis and comparisons to evaluated nuclear data predictions for these cross sections will be presented.

[1]This work was supported by the Department of Energy, through the NEUP Program, and by the Cowan Physics Fund at the University of Dallas.

8. *The Acoustic Analogue of the Reissner-Nordstrom Metric*
DASITH DE SILVA, KENNY F. STEPHENS II, Hardin-Simmons University

Some analogues in solid state physics allow us to gain a better understanding of certain aspects of gravity. A canonical acoustic metric of a Bose-Einstein condensate based on the Schwarzschild metric has been developed M. Visser, Acoustic black holes: Horizons, ergospheres, and Hawking radiation," Class. Quant. Grav. 15, 1767 (1998) [gr-qc/9712010]]. We extend that approach to the Reissner-Nordstr om metric. To do this, we start by looking at a test charge in a plasma described by a Bose-Einstein condensate scalar field. The resulting potential, a modified Yukawa potential, is then used to determine an acoustic analogue of the Reissner-Nordstrom metric. We anticipate that this approach will yield a testable description of the analogue model.

9. *Trends in Light n-Capture Elements*
TRISTAN ODEKIRK, University of Central Arkansas, JACOB TEFFS, University of Central Arkansas, University of North Dakota

Elements are created in stars through a variety of processes including fusion and neutron-capture (n-capture). Some of these processes have been well studied and the source of these processes is believed to be known with some confidence. The elements strontium (Sr), yttrium (Y) and zirconium (Zr) reside in the mass range where there is uncertainty about the production mechanism early on the history of the Galaxy. Initially, the rapid n-capture process (r-process) was believed to be responsible for their production. No study as yet has been able to use the r-process abundances to match the lighter n-capture mass range. There may be secondary r-process responsible for this mass range. Seeking trends in the abundances of Light n-Capture elements is one tool for establishing the types of sites that might be the source of these elements.

10. *Comparing the 2MASS and WISE Infrared Databases for Classification of Background Stars and Embedded Young Stellar Objects*
JOHN GRZEHOWIAK, SAMANTHA SIMPSON, RICHARD BEACH, Baylor University Department of Physics, SACHINDEV SHENOY, NASA Ames Research Center, DWIGHT RUSSELL, Baylor University Department of Physics

The Taurus Molecular Cloud is a region of high rate of star formation. The 2MASS (Two-Micron All Sky Survey) online infrared database is an often used way to probe a Dark Molecular Cloud (DMC) such as Taurus Molecular Cloud. Using the J (1.25 microns), H (1.65 microns), and K (2.17 microns) bands, the 2MASS database can see through a visually opaque cloud to observe reddened background stars. The WISE (Wide-Field Infrared Survey Explorer) infrared database is also helpful in probing DMC's. It resides in the far infrared, with the bands w1 (3.4 microns), w2 (4.6 microns), w3 (12 microns), and w4 (22 microns). Because DMC's have star forming regions, there are stars embedded in the cloud, called Young Stellar Objects (YSO's). Using both databases to probe the Taurus Molecular Cloud we have compared the data collected on the stars received through color index graphs. The indices presented which stars are YSO's and which are background stars. The goal of this study is to compare the color index graphs of the 2MASS and WISE databases to find if the WISE database can determine which stars are YSO's better than 2MASS.

11. *PyCBC: A Toolkit for Advanced-Detector Era Gravitational Wave Data Analysis*
ANDREW MILLER, Abilene Christian University, Albert Einstein Institute, DUNCAN BROWN, Syracuse University, TITO DAL CANTON, BADRI KRISHNAN, Albert Einstein Institute, ALEX NITZ, Syracuse University, JOSH WILLIS, Abilene Christian University, Albert Einstein Institute

Gravitational wave detections are an important step into the future of astrophysics because they will be able to provide a new look at our universe, which will complement our traditional electromagnetic observations. Inspiraling compact binary systems are an important source for potential detections. As the sensitivity of ground-based interferometers is improved, searches for gravitational waves from these sources become more computationally intensive; more data-analysis tools are required to make these searches as efficient as possible. PyCBC is one such software toolkit that will provide a high-level framework for analysis, including the ability to transparently use GPU computing.

E3: APS Poster Session (Friday 3:00-4:00)

Chair: Travis Salzillo, Tarleton State University — Science 2nd Floor

1. *Optical Foucault Pendulum*
RICHARD SELVAGGI, CHARLES ROGERS, Texas A&M University - Commerce

This experiment uses the concept of a photon clock to measure the trajectory of light in a rotating cavity. Our hypothesis asks what affect does motion have on the measured trajectory of photons? Does measuring the trajectory by the non-accelerated reference frame differ from the same measurement made by the accelerated reference frame? Will not producing and not measuring, or producing but not measuring, or not producing but measuring, or producing and measuring the photons in the non-accelerated reference frame but reflecting it through the accelerated reference frame produce the same or different results? The apparatus set-up, operation, and measured results are presented.

2. *Effects of coherent population trapping on Raman scattering*
MARSHALL ROGERS, STEPHEN SCHILLER, YURI ROSTOVTSEV, Department of Physics, University of North Texas

We study Raman scattering in molecular media by applying two laser fields in a two-photon resonance with vibrational transition. The role of rotational levels has been investigated. It is 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.

3. *Correlation Between Corotating Interaction Regions' Magnetic Orientations and Magnetic Storm Strengths Near Earth*
JOSEPH SCHINCO, BLAKE BARNETT, KEVIN PHAM, RAMON LOPEZ, University of Texas Arlington

The solar wind occasionally contains irregularities called CIRs, or corotating interaction regions. A CIR occurs when a region of slow moving solar wind (slow-speed stream) is followed by a region of fast moving solar wind (high-speed stream). This setup causes a compression in the rear part of the slow-speed stream, since the high-speed stream eventually \catches up" and applies pressure to it. CIRs have been known to be directly linked to some magnetic storms in the near Earth environment. Although we do know that CIRs can create magnetic storms, we do not yet know if a specic magnetic type of CIR creates stronger storms than the rest. We have analyzed data from the solar wind that will allow us to compare multiple magnetic types of CIRs, in order to see which ones create the strongest storms.

4. *How the Fluctuation Amplitude of the Interplanetary Magnetic Field's Z Component Affects Geomagnetic Storm Strength*
CEZANNE NARCISSE, SPENCER DURRENBERGER, JAIME STERRETT, SOHA ASLAM, KEVIN PHAM, RAMON LOPEZ, University of Texas at Arlington

A corotating interacting region (CIR) is a region of compressed solar wind caused by a high speed stream (speeds > 500 km/s) that catches up to slower solar wind in which the source corotates with the sun. We are collecting data to find two case in which proton density, solar wind speed, and average magnetic field are similar except for the fluctuation amplitude of the interplanetary magnetic field's (IMF) z component. We used geomagnetic indices to quantify their related geomagnetic storm strengths. Our goal is to compare the geomagnetic storm strengths caused by the IMF's fluctuation in CIRs.

5. *Searching for the Evidence of Reduction of Viscous Potential for Northward Interplanetary Magnetic Field*
DENVER SCOTT, KYLE VAN ZUIDEN, MICHAEL MISHLER, AARON BACA, SHREE BHATTARAI, RAMON LOPEZ, University of Texas of Arlington

Solar wind consists of ionized particles originating from the Sun that carries along with it the solar magnetic field, which we call the inter-planetary magnetic field (IMF). The interaction of solar wind with the geomagnetic field occurs mainly by two different processes: viscous interaction and magnetic reconnection. The viscous interaction is generated due to velocity shear across the magnetopause forming a circulation pattern in the magnetosphere. Magnetic reconnection occurs in strongly conducting plasma, where magnetic fields realign and magnetic energy is transformed into kinetic, and/or thermal energies. The result of viscous interaction and magnetic reconnection during northward IMF produces a four-cell convection pattern in the ionosphere. We will be using OMNI data to obtain sustained, strong northward Bz, and analyze the ground based SuperDARN (Super Dual Auroral Radar Network) data in an attempt to see if the viscous potential is reduced for northward IMF during periods when Bz was three times greater than the magnitude of By.

6. *Analyzing solar wind magnetic field reversals for a variety conditions in an MHD simulation*
SPENCER DURRENBERGER, BRETT SCHOCK, ROBERT BRUNTZ, RAMON LOPEZ, University of Texas at Arlington

The solar wind flows out from the Sun, made up of charged particles and a magnetic field that interacts with Earth's magnetic field. We are simulating periods of steady magnetic field that also contain a reversal of the direction of that magnetic field. The solar wind produces motion in the plasma in the ionosphere, which is a layer of the uppermost part of the Earth's atmosphere that contains charged particles. We are looking at changes between modes of ionospheric circulation due to reversal events. We are simulating these events to analyze the changes in the magnetosphere and ionosphere, then changing the input values of these events to better understand the timing of changes in ionospheric modes, and under what conditions different modes occur. We will also be comparing some simulation results to actual observations.

7. *Temperature Dependent DNA Charge Transport*
CHRIS WOHLGAMUTH, MARC MCWILLIAMS, JASON SLINKER, The University of Texas at Dallas

Charge transport (CT) through DNA has been extensively studied, and yet the mechanism of this process is still not yet fully understood. DNA CT has been utilized in sensing proteins and DNA fragments, it has been postulated that it may assist DNA damage prevention and repair, and further understanding of this process will elucidate the biological implications of DNA CT and advance

sensing technology. Therefore, we have investigated the temperature dependence of DNA CT by measuring the electrochemistry of DNA monolayers modified with a redox-active probe. We compare square wave voltammetry of distinct DNA sequences under identical experimental conditions. Accordingly, we compare well matched DNA duplexes to those containing a single base pair mismatch. Additionally, we vary the probe location within the well matched DNA duplex in order to investigate distance dependent kinetics. Furthermore, a comparison of an A-T rich and G-C rich duplex is performed. Using a model put forth by O'Dea and Osteryoung and applying a nonlinear least squares analysis we are able to determine the charge transport rates (k), transport coefficients (α), and the active surface concentration (Γ) of the DNA monolayer. The transport rates of CT are shown to follow Arrhenius behavior.

8. Biological Effects of Electromagnetic Fields on Bacterial Properties[1]
DEREK SMITH, BABAK KEYGHOBADI, BEHESHTE EFTEKHARI, SAMINA MASOOD, University of Houston Clear Lake

Previous experiments have shown a significant effect from electromagnetic fields (EMFs) upon bacteria, such as an altered growth rate. We review previous experiments and their results in order to summarize the effects of EMFs upon bacteria, with a special interest in gram-negative bacteria. Emphasis is also placed upon the experimental equipment used for testing, the shape-dependent effects upon bacteria, the effects of varying field strengths, and the effects of using a liquid growth medium. Our preliminary study shows the effect of magnetic field is non-ignorable on most of the bacterial species.
[1]TSGC grant

9. *Antihydrogen-Gravity Experiment: An Analytical Model For Parallel Plate Geometry*[1]
J.R ROCHA, CARLOS ORDONEZ, University of North Texas

An analytical model is developed for an experiment that may be used to determine whether antihydrogen falls up or down in Earth's gravitational field. The model is the third iteration of an ongoing development to reduce the experimental run time necessary for an experiment at the CERN Antiproton Deccelerator facility. The experiment relies on methods developed by existing research collaborations: production, confinement, and detection of antihydrogen. The configuration consists of two parallel plates that have an axis of symmetry directed away from the center of the Earth. They are separated by a small vertical distance and include a series of circular apertures. An antihydrogen annihilation located a short distance beyond each barrier, within a \shadow" region, are asymmetric on the top or bottom annulus. The analytical model is used to determine the probability that an antiatom annihilates within one of the shadow regions, which would indicate the direction of the acceleration of antihydrogen due to gravity.

[1]This 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.

10. *Electronic structure of planar aggregates of boron clusters*
CARLOS DIAZ, LUIS BASURTO, TUNNA BARUAH, RAJENDRA ZOPE, UTEP

Using simulated annealing, random searches and basin hopping, we have searched for low lying isomers of boron cluster containing 27 atoms in its neutral and charged states. For those searches, the interatomic potential between boron atoms is described using density functional theory at the generalized gradient approximation level. The structures of low lying isomers found in our searches are predominantly quasi-planar. Several of these structures are seen as growth of smaller size boron clusters. The population of low energy neutral boron cluster isomers was used to study the influence that charge has on the structural pattern of charged boron clusters. The calculations indicate that the boron clusters also tend to prefer quasi-planar geometries. These are the largest planar boron cluster aggregates reported so far. Electronic properties such as ionization energies, vertical detachment energies and electron affinities and also the infrared and Raman spectra of neutral clusters will be presented.

11. *A New Algorithm Development on the Frequency Analysis*
RICHARD KYUNG, CRG, EUGENE LEE, Stuyvesant HS

A numerical algorithm to analyze the frequencies of beam structures is developed based on mode synthesis method. The physical domains are assumed to be composed of group of sub-domains or components that are interconnected with each other. After reducing the degrees of freedom of each element by means of the new algorithm, natural mode shapes of each of the components are found. The dynamic characteristics obtained are combined into a complete domain. The effects of dividing for the domain and the number of modes adopted in the interface region are also taken into consideration. The results are compared to those from the commercial program that can carry out modal analysis such ANSYS. The proposed algorithm is applied to the domains with a large number of sub-domains, and the results show numerical efficiency over the classical modal analysis.

12. *Density functional theory (DFT) study of the electronic structure of $Bi_2O'Ti_2O_6$ for hydrogen production by water splitting*[1]
DAVID BARKER, CEDRIC MAYFIELD, Physics Department University of Texas at Arlington,
VAIDYANATHAN SUBRAMANIAN, Chemical and Materials Engineering, University of Nevada, Reno,
MUHAMMAD HUDA, Physics Department University of Texas at Arlington

BTO pyrochlore ($Bi_2O'Ti_2O_6$) is a promising photocatalyst material for hydrogen production by water-splitting. Study of such materials is crucial for the understanding of energy conservation, and to better understand the optical and electronic properties of pyrochloric materials. However, BTO's electrical and optical properties have not yet been studied in greater detail. In this study, density functional theory (DFT) was used to calculate the volume of the cell as well as the energy, and as a result of this calculation the most stable crystal structure was determined. In addition, previous studies have indicated that Fe doped BTO has preferable electronic structure as a photocatalyst. Here, this is studied in depth by placing Fe at different sites in BTO and observing how electronic properties are affected. For example, through the study of the band structure for both BTO and Fe doped BTO; band gaps and the nature of the gaps will be presented, as well as the optical properties of both systems. Examination of the solubility of Fe in different sites of BTO, the most stable structure for Fe doped BTO, the formation energy and the contributions of the different atoms orbitals on the total band structure will be presented as well.

[1]The research is funded by the National Science Foundation

13. *Phase Transitions within Ferro Fluid and Piezoelectic Fluid*
BRYAN WOFFORD, University of Central Arkansas

Ferrofluids and piezoelectric fluids undergo phase transitions under the action of magnetic and electric fields, respectively. These materials are simple metamaterials. We are in the process of probing the properties of ferrofluids ultrasonically. Preliminary results and experimental designs will be presented.

14. *Characterization of multiferroic BiFeO3 synthesized by RF magnetron sputtering*[1]
GREGORY SPENCER, RYE JOHNSON, ANUP BANDYOPADHYAY, Texas State University

Bismuth ferrite is a material which exhibits multiferroic behavior including the simultaneous appearance of both ferroelectric and antiferromagnetic properties. It is of great practical interest for device applications because of its relatively high ferroelectric Curie temperature (TC 1100 K) and high Neel temperature (TN 643 K) which are both well above room temperature. BiFeO3 (BFO) has been synthesized by a variety of methods including MBE, pulsed laser deposition, and sputtering. We report on the synthesis and characterization of thin BFO thins by RF sputter deposition onto an STO/Si substrate at temperatures from 400 ˚C to 600 ˚C. The resulting polycrystalline films, ranging in thickness from 80 to 200 nm, were characterized by X-ray diffraction to determine the crystallinity. We have also measured the magnetic behavior by vibrating sample magnetometer as a function of temperature between 4K and 300K. Imaging and EDS by SEM was performed to study the film morphology as well as AFM imaging. The SEM images revealed structures that formed spontaneously during the thicker film depositions. These results and comparison with others will be presented.

[1]Supported in part by NSF grant MRI 0414202 and IGERT 0549487.

15. *Ellipsometric Analysis of Silicon Nanoparticles Formed by Rapid Thermal Annealing*[1]
CHAD WAXLER, GREGORY SPENCER, ANUP BANDYOPADHYAY, Texas State University-San Marcos

Since the discovery of visible photoluminescence (PL) of silicon nanostructures, interests in silicon nanoparticles has increased due to their possible applications in photovoltaics and optoelectronic devices. In this study, we investigate the surface morphology and optical properties of silicon nanoparticles formed on a silicon-on-insulator substrate by rapid thermal annealing in an argon environment at atmospheric pressure. We analyze the formation of silicon nanoparticles as a function of silicon layer thickness (3-10 nm), annealing temperature (600-800 ˚C), and annealing duration (30-120 seconds) using atomic force microscopy (AFM) and we analyze the optical properties via effective medium approximations (EMA) models using a variable angle spectroscopic ellipsometer (VASE).

[1]Supported in part by NSF grant MRI 0414202 and IGERT 0549487 and material donations from Spansion Inc.

16. *Heating induced structural and chemical behavior of KD2PO4 in the 25 ˚C to 215˚C temperature range*
ANDRES ENCERRADO MANRIQUEZ, ADAN ANCHONDO, JOSHUA MORRIS, CRISTIAN BOTEZ, University of Texas at El Paso - Physics

We have used powder x-ray diffraction (XRD) to investigate the structural and chemical modifications undergone by KD2PO4 (DKDP) upon heating from room temperature to 215 ˚C. Full-profile (Le Bail) analysis of our temperature-resolved data shows no evidence of polymorphic structural transitions or deuterium-hydrogen isotope exchange occurring below Ts = 185 ˚C. The lattice parameters of DKDP vary smoothly upon heating to Ts and are approximately 0.4% greater than those of its isostructural hydrogenated counterpart KH2PO4 (KDP). Moreover, XRD isotherms collected at Ts indicate the absence of any structural or chemical changes in DKDP at this temperature. Upon further heating, however, the tetragonal DKDP phase becomes unstable, as evidenced by its transition to a monoclinic DKDP modification and eventual chemical decomposition via dehydration.

17. *Regenerated Spider Silk Possess Mechanical Properties of Super and Cyclic Contraction in Response to*

Environmental Humidity
SHAN LU, GANESH SWAMINATHAN, SAMUEL EVANS, TODD BLACKLEDGE, University of Akron

Major Ampullate (MA) spider silk is among the most impressive biomaterials due to its unparalleled mechanical properties, such as super-contraction and cyclic response to changes in humidity. Electro-spinning enables the generation of engineered silk fibers with controlled parameters and dimensions for various medical and commercial applications. However, their applications hinge on the ability to reproduce the mechanical properties such as a precise expansion-contraction response existed in natural silk fibers. Here, we successfully reproduced MA spider-silk fibers from solutions of natural MA silk proteins via electrospinning, which exhibit the super-contraction and cyclic response to humidity change in a manner mirroring
the natural fibers.

18. *Density Functional Study of the Oxygen Adsorption on the Cu(110) Surface*[1]
ANTOINE OLENGA, N.G. FAZLEEV, Department of Physics, University of Texas at Arlington

Copper based catalysts are of importance to a number of industrial processes including the synthesis of methanol, the reduction and decomposition of nitrogen oxides, and treatment of waste water. In copper catalysis surface oxidation and oxidic overlayers are believed to play a crucial role. In this work using density functional theory within the generalized gradient approximation we have studied the stability and associated electronic properties of different adsorption phases of oxygen on the Cu(110) surface. Especially, we have focused on studies of changes in the interlayer spacing, electron work function, surface energy, electronic density, density of states, and band structure of the Cu(110) surface with oxygen coverage. We have examined the cases of the adsorption of oxygen at various coverages on the nonreconstructed and added row reconstructed Cu(110) surface. Calculations of electronic properties from first principles have been also performed for the (110) surface of Cu2O to use for comparison. The first-principles calculations in this work have been performed using DMOl3 code. The obtained theoretical results have been compared with available experimental data.

[1]This work was supported in part by the National Science Foundation grant #DMR-0907679 and the GAANN grant # P200A090284

19. *Space Station Twin Paradox*
FLORENTIN SMARANDACHE, University of New Mexico

Two twins T1 and T2 synchronize their clocks at the same location L. Then T2 travels at relativistic uniform speed to a space station S, where he stops. So far, each twin sees the other one younger, since in each twin inertial reference frame the other twin is moving. The time dilation and length contraction are respectively the same in both inertial reference frames. (There is a forth symmetry.) Then twin T2 return from the space station S to the Earth at the location L with a relativistic speed. Again there is a back symmetry since each twin sees the other twin traveling, and again the time dilation and length contraction are respectively the same in both inertial reference frames. But, when T2 returns to earth he finds out that he is younger than T1, sinceT2 was traveling while T1 didn't. (Now there is an asymmetry!)

20. *Effects of the surface plasmon excitations on photoluminescence by CdSe/ZnS quantum dots*
ANKIT SINGH, SURESH SHARMA, University of Texas at Arlington

We have studied the influence of localized surface plasmons (LSPs) and surface plasmon polaritons (SPPs) on the photoluminescence (PL) spectra of core/shell type CdSe/ZnS quantum dots. Thin film samples were deposited on glass slides, irradiated by 514-nm polarized beam from an Argon-ion laser, and PL spectra were measured by using a high-resolution 1.25-m JY-Horiba spectrometer equipped with liquid-nitrogen cooled CCD detector. In the first set of experiments, PL spectra were measured on QDs and QDs-Au NPs composites as functions of the intensity and polarization of the 514-nm laser beam. In the second set of experiments, PL spectra were measured by using the Kretschmann geometry, in which the SPPs are excited by p polarized 514-nm laser beam incident upon 40-nm Au film deposited on a high-index prism. The QDs were deposited over the Au film by dissolving them in chloroform. We describe the manner in which the experiments were carried out by using several different configurations and present results, which show clearly the effects of the localized and travelling surface plasmons on PL emission.

21. *Quark Propagator in a Theory of Massless Fermions with Super Fluidity*
SAJIB BARMAN, VIVIAN INCERA, The University of Texas at El Paso

A QCD inspired effective theory of fermions is considered to study superfluidity. We calculate the quark propagator in a theory with fermion-fermion condensate at finite density. In this theory color degrees of freedom are absent and the quark-quark interaction is modeled through a Yukawa interaction term. The final goal of the work is to find the polarization operator for the scalar field. Finding the quark propagator is needed to then calculate the polarization operator, so the results to be presented are still partial.

G3: Nanoscience and Solid State Physics (Friday 3:24-4:24)

Chair: Mirley Balasubramanya, Texas A&M University-San Antonio Science 112

1. *Electron transmission through a graphite crystal*[1]
CRISTIAN BAHRIM, ROBERT NICK LANNING, Department of Physics, Lamar University

The analysis of the diffraction pattern produced by electrons transmitted through crystals provides information about the length of the chemical bonds, the distance between the atomic layers, and the lattice constant of the crystal. Here we report experimental results for electron diffracted by a graphite crystal. From the Lorentzian profile of the central maximum of diffraction we calculate the characteristic time of interaction between the electron projectile and the Carbon atoms of graphite. The Carbon atom acts as a pinhole and Fourier transforms the incident electron beam into a broad diffraction pattern. This characteristic time is shorter than one femtosecond because of the Pauli Exclusion Principle which forbids the projectile electrons to inhabit the ground state atoms of graphite. Our apparatus can produce relativistic projectile electrons. Using a relativistic approach and the Heisenberg uncertainty principle, from the width of the central maximum of diffraction we extract the spreading, Δ, of the de Broglie wavelength of the projectile electron inside the crystal. We also calculate the relativistic values of the spreading in the linear momentum and kinetic energy while the electron is passing through the crystal.
[1]Project sponsored by the NSF-STEP program, award # DUE 0757057.

2. *Extraordinary Properties of Carbon Nanotubes and their Use in Technology and Medicine*[1]
MICHAEL DURAN, MICHAEL JACOBS, DANIEL BULLMORE, SAMINA MASOOD, University of Houston - Clear Lake

Single and multi-walled carbon nanotubes (CNTs) have remarkable thermal and electromagnetic properties that suggest a wide range of application. Here, we discuss some of the various properties of the tubes and how they are related to the method used to synthesize them. We focus on the electromagnetic and chemical properties, and use them to show the viability of discrete CNT based components. After considering various advantages that CNTs have over microstructures, we make a proposition for the advancement and development of electronics using nanotechnology. As for current applications, we discuss the use and functionality of CNTs in the development of cancer treatment. Whether these nanostructures of carbon are being used for chemotherapeutic drug delivery or photodynamic therapy, we show that their extraordinary properties of can be used in advantageous ways by many different industries. We discuss some new applications of existing results.

[1]TSGC Grant and FRSF Grant

3. *A Study of Dielectric Relaxation Using Microwave Technology*
JAMES ROBERTS, University of North Texas, JAI DAHIYA, Southeast Missouri State University, SANTEEL GHOSH, Southeast Missouri State University

An insulating material placed in an electric field is polarized. A material such as this when placed between two parallel plates of a capacitor changes the capacitance of the capacitor in accordance with the polarization behavior of the material. Because of this material behavior, the insulating material is known as a dielectric and this process of interaction is referred to as dielectric relaxation. The dielectric relaxation of a number of materials has been investigated using microwave technology at a fixed frequency and varying the temperature. The data show some interesting results for select materials which are presented in this paper.

4. *Improving Light-Emitting Electrochemical Cells with Ionic Additives*
JASON SLINKER, YULONG SHEN, The University of Texas at Dallas, BRAD HOLLIDAY, The University of Texas at Austin

Light Emitting Electrochemical Cells (LEECs) from ionic transition metal complexes (iTMCs) may serve as a new lighting technology candidate. These simple, cost effective devices are solution processable and compatible with low-temperature assembly and reel-to-reel fabrication under ambient conditions. However, these devices have yet to achieve the stringent operational benchmarks required for lighting. We used the archetypal iridium iTMC as the emissive material in LEECs and blended in alkaline additives to control ionic space charge effects and substantially improve performance. For lithium additives, turn-on time improved drastically and the maximum luminance was increased to practical lighting levels without substantially affecting device life-time. We have also studied other alkaline salts and justified their relative impact on device performance in view of double layer charging. These observations suggest that iTMCs from LEECs have the potential to serve as bright, long-lasting light sources.

5. *Ab Initio study of mechanical properties of n- and p-type doped PbTe and PbSe*
JOHN PETERSEN, LUISA SCOLFARO, THOMAS MYERS, Texas State University - San Marcos

PbTe and PbSe have become an active area of research due to their thermoelectric properties which enable them to convert waste heat into electricity, with possible applications being in engine exhaust and refrigeration. Recent efforts at doping PbTe and PbSe have shown an increase in thermoelectric efficiency. In practical applications, durability in high temperatures and variable conditions is a requirement, so it is necessary to consider the mechanical properties of the doped materials. Here, we present an ab initio study – using DFT GGA calculations – of Na and Tl (p-type) and In and Bi (n-type) doped PbTe and PbSe in the NaCl (rocksalt) structure of the materials. Supercells of 64 atoms were used to simulate the doped systems corresponding to carrier concentrations similar to those of experiment. Sodium and Indium in PbTe are calculated to have mechanical properties that agree with experiment, while the results of our Thallium and Bismuth doped systems are predictions. All of the above impurities when added to PbSe supercells show very promising mechanical properties: while not measured yet experimentally, our results can be used in future PbSe based thermoelectric studies.

K1: SPS Poster Session (Friday 4:00-5:00)

Chair: Chris Marble, Tarleton State University Science 2nd Floor

1. *Designing and Building a Tabletop Molecular Acoustics Experiment*
ASHLEY HICKS, WILLIAM SLATON, University of Central Arkansas

This work describes the design, construction, and testing a project investigating the molecular absorption of sound in certain gases, including the development of a capacitance transducer. The transducer is based on designs presented in the literature, modified to work optimally in our system which consists of 4-inch diameter steel pipe. The experiments will be conducted at atmospheric pressure, eliminating design constraints involved when using high pressure gas. However, work done by Bass & Shields shows that to work in these experiments at atmospheric pressure, the transducer must have a frequency range of 1 kHz { 100 kHz. [J. Acoust. Soc. Am. Vol 62, p. 346-353, 1977] The basic concept of our transducer depends upon creating a parallel plate capacitor from metal that is exible enough to move when a sound wave hits it. Our design utilizes 0.051 mm thickness aluminized Mylar film tensioned with a brass retaining ring over a brass backing plate with both secured to a Delrin plastic base for its electrically insulating properties. We will report on the transducer's performance and initial testing in a sound absorption experiment with carbon dioxide.

2. *Controlled Drug Delivery from Therapeutic Contact Lenses: the need for Accurate Release Studies*[1]
PAYAM POURJAVAD, Ouachita Baptist University

This work demonstrates the detrimental effects of inconsistency in release studies conducted in the field of controlled drug delivery via therapeutic contact lenses. It also express how certain condition can lead to false representation of a supposed controlled release. The lack of a standard in the field hinders the progression of effective methods and creates a distrust for all drug delivery systems from contact lenses. In vitro release condition variables include volume, mixing rate, temperature, solvent, and elapsed time between water exchange. The solubility of the drug being controlled is also a factor. Addressing solubility we created three different molecularly imprinted polymer networks that were designed to control three different drugs, Ketotifen Fumarate, Diclofenac Sodium, and Dexamethasone. It is clear that the different variables seen in the conditions have a huge impact on the release profiles, and that a condition is need to make valid comparisons amongst different drug delivery techniques.

[1]Special Thanks to the Auburn University REU Program

3. *An Analysis of the Texas Physics Teaching Certification from 2007-2011*
KRISTIN HOLZ, Abilene Christian University

I researched pathways to teaching certification under the advisement of Dr. Jess Dowdy of the Abilene Christian University Physics Department. His goal is to observe trends in the data from the state certification database providing information about physics teaching certification in Texas over the last four years. This research centers on the state certification database of information about teaching certification in Texas over the last four years. Within this database, I looked at various types of physics teaching certification tests taken by students from different universities during the years of 2007 through 2011 in order to focus on relationships between various aspects of the state data. I aided in coding this data to organize the information and quantitatively measure certain relationships. I also researched supplemental data to expand my analysis. My hypotheses were developed by searching the literature to incorporate other research performed on Texas physics teaching certification.

4. *Absorption Properties of NASA Flight Approved Materials and other Testable Samples*
MATTHEW SISSON, JUSTIN MANN, WILLIAM V. SLATON, University of Central Arkansas

The purpose of this project is to analyze the acoustic absorption properties of various flight approved materials currently and potentially used by NASA in its work with the International Space Station. These materials, consisting of manufactured felts and foams, were used in an experimental procedure utilizing an impedance tube. By simultaneously measuring the forward and backward components of generated plane waves within the tube, sound absorption coefficients were obtained for over 30 specific materials. Understanding these absorption properties can lead into the discussion of how to specifically arrange and utilize the materials to both maximize efficiency based upon a material's density and minimize excess ambient noise on manned space vehicles. These possible applications not only potentially affect astronauts on current and future missions for NASA but can also be directed in situations involving the choice of materials in auditoriums, concert halls, classrooms, etc.

5. *Electronic structure of dye attached fullerenes*
AMANDA GARNICA, RAJENDRA ZOPE, TUNNA BARUAH, University of Texas at El Paso

C60 fullerene and its derivatives are the most popular acceptors which are used in molecular/polymeric complexes used in organic photovoltaics. Recently, Chabynic et al. have synthesized a few functionalized C60 molecules with dye molecules for use as acceptors in solar cells. The functional units are diketopyrrolo-pyrrole and TBTDT pigments. Using density functional theory and large polarized all electron Gaussian basis, we optimized the structures of the C60-DPP and C60-TBTDT molecules. The inspections of molecular orbitals of these systems indicate that the HOMO level is localized on the dye whereas the LUMO is on the C60 molecule.

We have also calculated several lowest CT excited states where the charge transfer takes place from the HOMO on the dye to the LUMO on the C60 molecule. The electronic structure of the ground and the excited states will be presented.

6. *Design and Testing of a Custom Air Horn*
JERROD WARD, WILLIAM V. SLATON, University of Central Arkansas

Construction and testing of an air horn can provide insight into how certain design decisions can influence resulting acoustic properties. The unique sound of the air horn is produced when compressed air enters the main chamber through an inlet and builds up pressure against the diaphragm. As pressure builds, this diaphragm flexes to allow the air to leave the chamber through the outlet which is flush against it. This relieves the pressure in the chamber and the diaphragm returns to its original position, slamming against the outlet, creating the signature sound. We have designed and manufactured an air horn where it is possible to vary many different experimental parameters such as nozzle length, outlet diameter, diaphragm material, diaphragm thickness, diaphragm tension, etc. In this study, we have focused on the properties of the diaphragm and their relationship with the air pressure. By trying different permutations of diaphragms and seals with a range of pressures, it is possible to produce a desired tone over a very large range of frequencies. The system is very delicate and things like a good gasket seal for the diaphragm and solid, flush connections between the outlet and the diaphragm are absolutely necessary to ensure that pressure builds and relieves itself appropriately.

7. *Alternative Visualization Methods of Wine Glass Resonance*
SHELBY BURNS, WILLIAM SLATON, University of Central Arkansas

Breaking a wine glass with sound is a visually striking achievement and a great way to get potential students interested in Physics. The goal of this project is to not only break the wine glass but to build an apparatus that is portable and easily setup for lecture room demonstrations as well as outreach. The apparatus should also provide enough visibility for a room full of observers to easily see the resonance. Thus we constructed an enclosure using clear plexiglass, attached to two compression driver, hooked up to an amplifier and then hooked up to a signal generator. Until now our experiment has only been approached from one angle which is the utilization of a strobe light apparatus as the way to view the different modes of the wine glass. Moving forward with the experiment we began to explore different ways of viewing the modes of the wine glass. After receiving a generous loan from University of Mississippi in the form of a high speed camera, it is now possible to capture the modes without the use of a high speed strobe light. The apparatus should also provide even better visibility than previously achieved for a room full of observers to easily see the resonance. In a larger setting a camera could be used to relay the relatively small image of the wine glass to a projector for better visibility, only now there is a possibility to enhance the quality of those pictures and videos. From a more technical stand point, the project will provide an opportunity to experiment with resonance on a variety of different capture methods. In order to prepare for the final demonstration, many different wineglasses will be tested in the test chamber as well as different capture methods

8. *Analysis of Atomic Emission Spectra: a rened way to understand the photon concept*[1]
SARA-JEANNE VOGLER, KEELEY TOWNLEY-SMITH, CRISTIAN BAHRIM, Lamar University

Spectroscopic analysis of atoms and simple molecules reveals the atomic structure, the emission of photons, and the quantum interaction between light and matter. The optics equipment allows us to resolve the emission lines with a precision better than 1 nm. Pressure broadening effect enlarges the emission lines of our light sources to several nm at FWHM. From the relative intensity of the emission lines, de-convoluted using the Maxwell-Boltzmann distribution of atoms in a gaseous discharge at thermal equilibrium, we can find the effective temperature of the atoms and their average speed. Pressure broadening reveals the quantum characteristics of the photon emission by including the uncertainty principle. From the Lorentzian profile of each photon one can find the lifetime of the atomic states in given experimental conditions, and by comparison with their natural lifetime, the effect of the collisional de-excitation can be estimated. Because the photon emission obeys the selection rules for orbital angular momentum, spin, and parity, one can identify the characteristic wavelengths of the atomic constituents of light sources. We are going to present a brief progress report on the applications of the spectroscopic analysis in stellar measurements done under our 2013 Sigma Pi Sigma Undergraduate Research Award.

[1]Project done under the NSF DUE 0757057 grant and the 2013 Sigma Pi Sigma Undergraduate Research Award.

9. *Dynamic Optimization on the Eigenvalue Problems*
KATHERINE OH, Stuyvesant HS, RICHARD KYUNG, CRG

In many fields of mathematical and physical science, the concept of optimization has been used to make better decisions for complicated dynamic and mathematical problems. In practice, an objective value to measure the quality of the decision is first defined, and then followed by the selection of a defining numerical algorithm for optimization. In this paper, the main focus will be on numerical optimization algorithms on the eigenvalue problems in the modal analysis. In general, one cannot obtain exact closed-form solutions using classical mathematics for the desired optimal eigenvalues in the case of generalized eigenvalue problems. Therefore, to find the desired dynamic characteristics, using a numerical iteration method for optimization is the only practical alternative. In this paper, we have developed a numerical optimization algorithms. The proposed algorithm shows practical usefulness and can solve the problems using much less degrees of freedom of a system.

10. *Understanding the Dielectric Response of Polar Organic Solvent in an Artificial Photosynthetic System*

FRANCIS DE DIOS, University of Texas

The artificial photosynthetic analogue of interest is the triad molecule composed of an organic material in fullerene (C60), and two naturally occurring compounds: porphyrin and carotene. The components of the triad are abundant in nature and the cost of its synthesis is very small relative to the expense of fabrication of inorganic solar cells. Combining the economic advantages of the triad with its ability to mimic the natural photosynthetic process, the triad promises to be a feasible basis for highly cost-effective solar energy conversion. The present work focused on the behavior of solvent molecules in the presence of both a ground state and excited state triad molecule. The solvent significantly influences the structural fluctuations of the triad and increases the lifetime of the photo-induced charge- separated state of the triad by providing an electrostatic-screening effect. The two types of organic solvents that were investigated were Tetrahydrofuran (THF), which is a polar molecule, and Toluene, which is non-polar. Reduced radial shells of the solvent were taken to observe significant large-scale variations in the dielectric constant.The results from the dielectric constant evaluation suggest a much stronger interaction between the THF solvent and the triad compared to the interaction between Toluene and the triad due to the significantly larger dipole moment of THF relative to that of Toluene. Furthermore, the interaction is very large between THF and the charge-separated excited state of the triad, meaning that the magnitude of interaction between the solvent and the triad is largely dependent on the electronic state of the triad and the dipole strength of the solvent molecules. The spatial correlations between selected solvent molecules were also analyzed to gain further insight on the solvent fluctuations.

M1: Plenary Session II (Saturday 8:15-10:15)

Chair: Daniel K. Marble, Tarleton State University Science 102

1. *ADS Fission in a Molten Salt Core - how to safely close the Nuclear Fuel Cycle*
PETER MCINTYRE, Texas A&M University

The transuranic elements in spent nuclear fuel are the most enduring hazard of nuclear power. They have immense radiotoxicity, enough to jeopardize all life on Earth if they entered the biosphere, each reactor produces half a ton per year of them, and they have half-lives of hundreds of thousands of years. Innovations in accelerator physics and core neutronics make it possible to make accelerator-driven subcritical fission in a molten salt core (ADSMS) with which the transuranics can be safely destroyed by fission at the same rate they are produced in conventional power reactors. In ADSMS intense proton beams are produced by strong focusing cyclotrons and delivered into a molten salt core. The core operates with a criticality of 0.96 - 4% of the neutrons needed to sustain fission. The protons produce fast neutrons in the core by spallation and drive fission. The core is designed with ultrafast neutronics, needed to fission the transuranics. The fuel salt is prepared by extracting the contents of spent nuclear fuel assemblies into molten salt using a non-aqueous pyroprocessing technology. Two designs of the ADSMS core have been developed: an Isoburner fueled only with transuranics for wasteburning, and an Isobreeder, fueled with a mixture of transuranics and depleted uranium from the spent fuel. The Isobreeder breeds fresh transuranics from the depleted uranium and burns them at the same rate, so that it can operate indefinitely by refueling periodically only with more depleted uranium and removing fission products. The Isobreeder opens the possibility to safely recover the entire energy content of uranium and thorium, and provide safe, abundant nuclear power for the next 2,000 years.

2. *Research-based Tools and Tips for Teaching Quantum Mechanics*
CHANDRALEKHA SINGH, University of Pittsburgh

Despite our best and most sincere efforts, there is an alarming disconnect between what we teach and what students learn and understand. Learning quantum mechanics is especially challenging, in part due to the abstract nature of the subject. We have been conducting investigations of the difficulties that students have in learning quantum mechanics. To help improve student understanding of quantum concepts, we are developing quantum interactive learning tutorials (QuILTs) as well as tools for peer-instruction. The goal of QuILTs and peer-instruction tools is to actively engage students in the learning process and to help them build links between the formalism and the conceptual aspects of quantum physics without compromising the technical content. They focus on helping students integrate qualitative and quantitative understanding, confront and resolve their misconceptions and difficulties, and discriminate between concepts that are often confused. In this talk, I will give examples from my research in physics education of how students' prior knowledge relevant for quantum mechanics can be assessed, and how learning tools can be designed to help students develop a robust knowledge structure and critical thinking skills.

3. *High Energy Focused Ion Beams: Technology and Applications*
GARY GLASS, University of North Texas

Understanding the physical, chemical and mechanical properties of materials on a nano- dimensional scale, and the ability to alter those properties in a controlled manner, is a necessary precursor to developing useful technological applications of nanomaterials. Consequently, there is a continuing and critical need for novel instrumentation with which nanomaterials properties can be observed, measured, altered and utilized. High energy ions can penetrate well below surfaces of materials and, as a result, can offer a means by which sub-surface regions can be studied and/or manipulated. By focusing these ion beams to nanometer-sized regions and developing associated specialized techniques, unique analyses and manipulations of the nano-world are possible. High energy focused ion beam (HEFIB) technology has undergone significant evolutionary changes since the first operational system was utilized, but advances in computing, component technology and focusing systems theory have enabled the development of new applications and opened doors to potentially revolutionary possibilities. HEFIB microprobe systems operate very similar to scanning electron microprobes when utilized for materials analysis: A focused ion beam is scanned over a sample surface to generate images using emitted signals produced by ion-solid interactions. These signals can consist of detected electrons, ions, or photons along with corresponding emission angles, energies, or other pertinent identifying parameters. HEFIB microprobes can also be used to modify surface or near surface

regions in predetermined patterns in a process defined as microlithography. This presentation will describe the background and history of HEFIB systems, the current and developing focusing technologies and some examples of applications.

N1: Astrophysics II (Saturday 10:30-11:54)

Chair: Michael Hibbs, Tarleton State University Science 102

1. *Estimating the viscous potential value using SuperDARN data*
MICHAEL MISHLER, KYLE VAN ZUIDEN, DENVER SCOTT, AARON BACA, SHREE BHATTARAI, RAMON LOPEZ, University of Texas of Arlington

The solar wind owing around the magnetosphere causes tail-ward dragging of the magnetospheric plasma, which in turn causes a return flow deeper inside the magnetosphere, thus producing a
circulation pattern called the viscous circulation pattern. This plasma circulation pattern gets mapped into the ionosphere via magnetic field lines, thus imposing an electric field in the ionosphere. This field can be measured in terms of an electric potential which is known as the viscous potential. In this paper, we will use the electric potential values obtained from SuperDARN (Super Dual Auroral Network) during weak IMF (Interplanetary Magnetic Field) conditions (j By j <1 , and -0.5< Bz<0) to estimate the viscous potential value.

2. *Interaction of space, time, mass relation constant of LIZI*
YONGQUAN HAN, 13241375685

One, definition 1, LIZI: the material which is reasonable to exist, from the basic to the universe 2, the universe, the outer space and is a constant size of space, is the foundation of space; space including non-vacuum part (the internal space) and the vacuum part (the universe outer space), non-vacuum part as far as possible to occupy the whole vacuum part into non vacuum. 3, LIZI space: refers to the visible, not visible management sub can radiate to the field. 4, feeling space: in addition to the LIZI space outside the space. 5, if and only if the universe (LIZI) mass will not change Two, LIZI constant The product of the mass of LIZI, time, feeling space is a constant, we can express it by a math equation, N=(V-v)MT, N is the LIZI constant, V refers to the summation of the inside and outside universe is a constant, v is the space which LIZI takes, (V-v)is the feeling space, M is the mass of the LIZI, T refers to time.

3. *Analyzing the Parameters of Corotating Interaction Regions and Their Relationships with Geomagnetic Storms*
PHU NGUYEN, SOHASLAM, KYLE VAN ZUIDEN, KEVIN PHAM, RAMON LOPEZ, University of Texas at Arlington

A corotating interaction region (CIR) forms when a low speed solar wind stream is compressed by a high speed solar wind stream (HSS) behind it, creating a region of higher pressure and density. This interaction region rotates along with the Sun, hence the name “corotating interaction region.” It is observed that HSSs occur after CIRs. CIRs and the following HSSs are often associated with geomagnetic storms. We have collected CIRs followed by HSSs from the period of the years 2000-2005. We will analyze the relationship between the average parameters of CIRs and HSSs to determine which parameters affect the size of geomagnetic storms.

4. *Evaluation of Two Transit Algorithms*
MATT HEUSER, RICHARD OLENICK, ARTHUR SWEENEY, JAMES MEIER, JEFF SCHNEIDERJAN, University of Dallas, STEXTS TEAM

Crucial in the data pipeline for transit searches are dependable algorithms which hunt for transits in accumulated light curves. We used C++ versions of EEBLS (Edge Enhanced Box Least Squares) and QATS (Quasi Automated Transit Search) algorithms to search for possible transits in the STExT group database of light curves of approximately 2500 stars. The outputs of these two programs were compared and a list of potential binary candidates was determined. We will compare the algorithms and discuss possible candidates for transits.

5. *Big Bang Nucleosynthesis with a non-Maxwellian distribution*
JOHN FUQUA, CARLOS BERTULANI, Texas A&M University-Commerce, MAHIR HUSSEIN, Instituto de Fisica, Universidade de Sao Paulo

I will present results on the abundances of light elements based on the big bang nucleosynthesis model calculated using the Tsallis non-extensive statistics. The impact of the variation of the non-extensive parameter q from the unity value is compared to observations and to the abundance yields from the standard big bang model. We find large differences between the reaction rates and the abundance of light elements calculated with the extensive and the non-extensive statistics. We found that the observations are consistent with a non-extensive parameter q = 1+0.05-0.12, indicating that a large deviation from the Boltzmann-Gibbs statistics (q = 1) is highly unlikely.

6. *Comparisons between observations and simulations of solar wind magnetic field reversals*

BRETT SCHOCK, SPENCER DURRENBERGER, ROBERT BRUNTZ, RAMON LOPEZ, University of Texas at Arlington

Computer simulations are essential to our pursuit of a greater understanding of the space that surrounds our planet, including the interaction of the solar wind and the Earth's magnetic field – the magnetosphere. These simulations incorporate years of knowledge obtained by physicists on the nature of the solar wind, a plasma of particles streaming from the sun that can greatly affect the satellites and power grids that we depend on for much of modern life. Testing of the simulations with observed data helps to validate existing theories and refine the computer models to better simulate reality and provide physicists, commercial and governmental satellite operators with critical information on the potential negative effects of "space weather." Several quick and significant reversals in the predominant direction of the magnetic field carried by the solar wind, events that can cause dramatic changes in the magnetosphere which satellite operators must be aware of, were identified in otherwise steady observational data. These data were compared to simulations of the same events, using the Lyon-Fedder-Mobarry (LFM) magnetohydrodynamic
(MHD) simulation. The ionospheric states during periods of steady conditions were also compared to simulation results to determine correspondence.

7. *The Effects of Modifying the Solar Wind Input into an MHD Simulation of the Whole Heliosphere Interval*
KEVIN PHAM, RAMON LOPEZ, University of Texas at Arlington

As high speed solar wind catches up to slower solar wind, it compresses the slower solar wind. This compressed region, called a corotating interaction region (CIR), has higher density, magnetic field magnitude, and temperature. CIRs interact with the Earth's magnetosphere and can cause geomagnetic storms. It has been suggested that the fluctuation in the magnetic field of the CIR and the following high speed stream play a large role in geomagnetic storm strength. We will be using the Lyon-Fedder-Mobarry global 3D magnetohy-drodynamic(MHD) simulation to simulate the Whole Heliosphere Interval (March 20 – April 16, 2008) which contains two CIRs. Various modifications will be done to the solar wind input to determine the relative geoeffectiveness due to the average magnetic field and due to the fluctuation in the magnetic field.

N2: High Energy Physics II (Saturday 10:30-12:18)

Chair: Jimmy J. McCoy, Tarleton State University Science 109

1. The Unification of Symmetry and Conservation
SERGIO PISSANETZKY, UHCL

The partial order in a causal set model of a dynamical system breaks the symmetry of the original set. A law of conservation must exist. The corresponding conserved quantity must be invariant for all least-action trajectories in state space. An action functional for causal sets is postulated. It defines a metric over causal sets. Its minimization is equivalent to minimizing the free energy and entropy in the system. The result is a grupoid of least-action trajectories, where a block system B can be constructed. B is the unique conserved quantity. In turn, B is a causal set, with its own symmetry and conserved quantities. Iteration yields a unique hierarchy of conserved quantities. This is a new fundamental theory of Physics derived directly from fundamental principles of causality, symmetry, least-action, laws of Thermodynamics, and the postulated action functional.
Unlike statistical or differential methods, it allows the dynamics of a system to be described in detail. See: http://www.degruyter.com/view/j/jagi.2012.3.issue-3/issue-files/jagi.2012.3.issue-3.xml

2. *QuantumVacuumEnergyTorqueAnomoly*
HAMILTON CARTER, Texas A&M University

Fulling et al. have found an apparent violation of the relationship between torque and total vacuum energy based on the expectation values of the energy density and pressure of a quantum field inside a conducting wedge as a function of angle. The basic physics underlying the Casimir effect will be presented followed by a brief description of the eigenfunction expansions used to solve Casimir boundary value problems. Finally, details of the torque anomaly will be reviewed.

3. *Study of Long Term Stability of Gas Electron Multiplier Radiation Detector*
YING WUN YVONNE NG, JAEHOON YU, SEONGTAE PARK, SAMANTHA LACOMBE, TIMOTHY BLAKE WATSON, AMIT BASHYAL, University of Texas at Arlington

The Gaseous electron Multiplier (GEM) technology is one of the many radiation detector technologies that use ionization in gaseous medium to detect electrically charged and neutral particles from various radiations. University of Texas at Arlington's advanced detector group has been working on GEM technology to develop a new, precision detector for future particle accelerator, such as the International Linear Collider. During the course of the past severalyears, data has been taken continuously to characterize 30cmx30cm prototype detector. Statistical method has been developed to study device's long term behavior. The effect of atmospheric pressure to the detector amplification has been compensated by a correction algorithm. In this talk, I will present the final result of the long term stability study of the prototype detector and its ramification to future use.

4. *Induced Anomalous Magnetic Moment in a Magnetized Quark System*
MATTHEW QUIROZ, EFRAIN FERRER, VIVIAN DE LA INCERA, The University of Texas at El Paso

It is well known that the magnetic field is a strong catalyst of chiral symmetry breaking. We show in the context of the one-flavor Nambu-Jona-Lasinio model that the magnetic catalysis is also responsible for the generation of a dynamical anomalous magnetic moment, which is directly proportional to the chiral condensate. The effect of the induced anomalous magnetic moment on the critical temperature of the chiral phase transition will be discussed. We point out possible implications for highly magnetized systems such as compact neutron stars and heavy-ion collisions.

5. *The MSRT, The Interpretation of The Lorentz Transformation Equations, Faster Than Light, The Cherenkov Radiation, Wormholes and The Pioneer Anomaly*
AZZAM ALMOSALLAMI, The science center for studies and research

In this paper, I'll give an interpretation for the Lorentz transformation equations depending on my Modified Special Relativity Theory MSRT [23]. My interpretation illustrates, the Lorentz factor is equivalent to the refractive index in optics. Also, according to my MSRT, it is possible measuring speeds of particles or electromagnetic waves to be greater than light speed in vacuum, but in this case, there is no violation for the Lorentz transformation or causality, and thus it is keeping on the laws of physics to be the same in all inertial frames of reference. From that I refute the proposed claim by Cohen and Glashow in their paper [33] refuting the OPERA experiment, depending on the analogy of Cherenkov radiation, where this proposed claim is based on a wrong concept to the superluminal speeds, and this wrong concept is based on a flaw that is existed in the special relativity theory of Einstein. Also, in this paper I'll illustrate how the Modified general Relativity must be modified according to MSRT, and then the worm holes and the Pioneer anomaly will be solved according to that.

6. *Measurements of the Structure of the Nucleon*
RUSTY TOWELL, Abilene Christian University, ACU NUCLEAR PHYSICS RESEARCH GROUP TEAM

The Abilene Christian University Nuclear Physics Research Group has a long history of studying the structure of the nucleon. Our research has focused on measurements that will improve our understanding of the anti-quark and spin structure of the proton. More recently we have also joined an effort to improve our understanding of the fission process of heavy nuclei. All of these measurements study the charged particles that are produced by a nucleon beam. The physics goals and current status of the PHENIX, SeaQuest, and NIFFTE collaborations will be reviewed.

7. *Investigation of Electric Sparks on the Failure of GEM Radiation Detector Prototype*
AMIT BASHYAL, JAEHOON YU, SEONGTAE PARK, YING WUN YVONNE NG, SAMANTHA LACOMBE, TIMOTHY BLAKE WATSON, University of Texas At Arlington

High energy physics (HEP) looks for the fundamental particles of the universe and the forces between these particles. HEP often uses high energy particle accelerators and massive detectors for these. Experiments in the future particle accelerator, precision measurement of clusters of particles is very important. UTA High Energy Physics (HEP) group has been working on the development and testing of Gas Electron Multiplier (GEM) based calorimeter, an energy measuring device for the past several years. Several prototypes up to 30cmx30cm have been built and exposed to particle beams and cosmic rays. During data taking, however, several electronics channels stopped functioning. Electric discharges in the prototype detector were suspected to be the most probable cause. Understanding the behavior of spark is essential for the reliability of this technology and help mitigating future damage to expensive electronics. In this talk, I will present results from data analysis using statistical methods to understand the behavior of the high voltage sparks in the prototype and the impact to the neighboring channels

8. *Long-Term Stability Gas Electron Multiplier Radiation Detector with One-Bit Digital Readout*
SAMANTHA LACOMBE, SEONGTAE PARK, AMIT BASHYAL, BLAKE WATSON, YVONNE NG, University of Texas at Arlington, CALICE COLLABORATION

High Energy Physics (HEP) is the field which investigates the most fundamental particles in the universe using high-energy particle accelerators in an attempt to understand the forces between them. Thus far, the Standard Model describes many of the interactions we observe; however, it is not a complete theory and there is a push to further accurately characterize these particles. For this, future particle accelerator experiments require very precision energy measurement device, the calorimeter. The University of Texas at Arlington's (UTA) HEP group developed and tested three 30cmx30cm prototype Gas Electron Multiplier detectors (GEM) as a viable instrument to carry out such measurements. Two cascaded GEM foils amplify electrons stripped from the Ar-CO2 gas in the chamber while the voltage across the chamber directs the signal to a readout board. The detector provides a high rate of particle detection and can withstand high radiation environments. Determining GEM detectors operational behavior and stability over a long time period is critical to implement the technology. The GEM detector has been exposed to various radiation sources during testing, but to accurately depict the long-term behavior it is important to consider experiments done only under similar conditions. In this talk, we present a long-term analysis to understand the stability of the GEM detector using the statistical method on cosmic ray data.

9. *Detector Design Studies for High Precision Particle Physics Experiment*
TIMOTHY WATSON, SAMANTHA LACOMBE, AMIT BASHYAL, YVONNE YING, University of Texas Arlington

High-energy physics is the field of physics utilizing powerful high-energy particle accelerators to probe and understand the fundamental particles of nature and the forces between them. Among the great accomplishments of the field of particle physics is a theoretical model that explains many of the phenomena we see in our universe: the Standard Model. While the Standard Model has been very successful in describing nature, it is necessary to push the limits of this model in an effort to truly understand its predictability. This search for new physics beyond the Standard Model requires the construction of next generation particle detectors capable of extreme high-precision measurements. The ORKA experiment, currently in the proposal stage, will search for rare kaon decays that may contradict Standard Model predictions and presents a paradigm changing new physics. In this talk, I will outline in detail design studies for the range stack, an essential detector component UTA is responsible for, incorporating novel components, specifically silicon photomultipliers (SiPMs) in place of photomultiplier tubes (PMTs) and the Gas Electron Multiplier (GEM) technology.

N3: Solid State Physics II (Saturday 10:30-11:30)

Chair: Daniel Vrinceanu, Texas Southern University Nursing 108

1. *Engineering the band gap of α-Fe2O3 by isovalent surfur doping*[1]
QIMING ZHANG, CONGXIN XIA, University of Texas at Arlington

Hematite α-Fe2O3 is one of the potential materials for solar energy conversion due to its nontoxic, abundant, low-cost and environment-friendly characters. But its indirect band gap of the value of 2.1 eV causes the low efficiency in the optical absorption and hence the solar energy conversion. We study the isovalent substitutional doping of sulfur on oxygen sites in α-Fe2O3 by means of the first-principles calculations based on DFT. Our results show that the band gap of α-Fe2O3xSx decreases monotonically with increasing the sulfur concentration x, resulting in an obvious increase of the optical absorption edge in the visible range. Most intriguingly, unlike the pure α-Fe2O3 material, the α-Fe2O3xSx with x 0.17 exhibits a direct band gap of an ideal value (1.45 eV), together with high optical absorption (10'5 cm^{-1}) and lower carriers effective masses. These results indicate that α-Fe2O3xSx, with a proper concentration of sulfur, may serve as a promising candidate for low-cost solar-cell materials.

[1]This research was supported by the U.S. Department of Energy, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering under Award No. DE-SC0002062.

2. *Using Resonant Microwave Cavities for Material Properties*
JAMES ROBERTS, University of North Texas, JAI DAHIYA, S GHOSH, Southeast Missouri State University, JOINT COLLABORATION

The resonant microwave cavity is a very sensitive device operating very much like a high Q parallel RLC resonant network. In this paper we discuss some of the results obtained on plasmas, phase change in liquids and in gas-substrate interactions using microwave cavities. Results on the nature of the hydrogen bond will be discussed in the light of phase transition studies made on hydrogen and deuterium during phase transition from liquid to solid and solid to liquid. The macroscopic quantities frequency shift and width change at half-power-maxima of the resonance prole will be related to the microscopic quantities real and imaginary dielectric response of the material loading the resonant cavity. Slater's perturbation equations for perturbed resonant cavities will be used for analysis of the data. The apparatus used in this investigation is briefly y discussed.

3. *New Sensitivity Regimes in Nuclear Magnetic Resonance*
DANIEL TENNANT, ISAAC MANZANERA, JEREMY PASTER, JOHN MARKERT, University of Texas at Austin, MARKERT LAB TEAM

Conventional NMR experiments using inductive techniques require a sample size of approximately 10^{12} nuclear spins. This limitation can be overcome by utilizing cantilevers, traditionally used for Atomic Force Microscopy, as the measuring tool. This technique has the potential to image individual nuclear spins and has already shown itself to be successful in capturing single electron spins. In this talk, I will outline the details of this procedure, present preliminary data from a trial sample of Ammonia Sulfate, and discuss future experiments.

4. *Experimental search for Bremsstrahlung radiation predicted by the hole theory of superconductivity*[1]
HAMILTON CARTER, Texas A&M University

The theory of hole superconductivity modifies BCS theory to propose that the paired charge carriers are \undressed" holes instead of electrons. As a consequence of this modification, the theory further states that electrons are expelled from the interior of the superconductor and exist as an excess charge density contained within the London penetration depth at the surface of the material. The theory predicts several experimentally testable consequences. Of these, arguably the most interesting, and the most easily tested

prediction is the emission of Bremsstrahlung radiation by the expelled electrons as they redistribute in the superconductor when the superconducting state is quenched. An experimental design to detect the predicted ionizing radiation will be presented. The experiment will utilize a Pb sample cooled to its superconducting state in a liquid helium cryostat. The sample will be quenched using a superconducting magnet contained in the same cryostat. A NaI(Tl) scintillator will be used as the radiation detector. The maximum energy of the Bremsstrahlung spectrum predicted by the theory is 308.22 keV using a Pb sample with a radius of 3.8 cm.

[1]Supported by a student research award from the Texas Academy of Science

5. *DNA in Nanoscale Electronics*

JASON SLINKER, CHRIS WOHLGAMUTH, MARC MCWILLIAMS, ALON ORODETSKY, The University of Texas at Dallas

DNA, the quintessential molecule of life, possesses a number of attractive properties for use in nanoscale circuits. Charge transport (CT) through DNA itself is of both fundamental and practical interest. Fundamentally, DNA has a unique configuration of stacked bases in a well ordered, double helical structure. Given its unparalleled importance to life processes and its arrangement of conjugated subunits, DNA has been a compelling target of conductivity studies. In addition, further understanding of DNA CT will elucidate the biological implications of this process and advance its use in sensing technologies. We have investigated the fundamentals of DNA CT by measuring the electrochemistry of DNA monolayers under biologically-relevant conditions. We have uncovered both fundamental kinetic parameters to distinguish between competing models of operation as well as the practical implications of DNA CT for sensing. Furthermore, we are leveraging our studies of DNA conductivity for the manufacture of nanoscale circuits. We are investigating the electrical properties and self-assembly of DNA nanowires containing artificial base pair surrogates, which can be prepared through low cost and high throughput automated DNA synthesis. This unique and economically viable approach will establish a new paradigm for the scalable manufacture of nanoscale semiconductor devices.