2017 Fall Meeting of the APS New England Section
Kingston, Rhode Island
http://www.aps.org/meetings/meeting.cfm?name=NEF17
The use of Schrödinger equation has proved itself to help in finding new objects known as extrasolar planets. Too much baggage to accept the use of Schrödinger equation to describe also classical systems, including celestial quantization. After all, the equation exhibits fractal character, which implies that quantization could happen at any scale. Therefore, it seems that it should not impose.

One can expect to discuss an outline for how to derive Schrödinger equation from simplification of Ginzburg-Landau equation. It is known that Ginzburg-Landau the logarithmic nature of Schrödinger equation could be viewed as a support of its applicability to larger systems. As an alternative, one may use Schrödinger equation to describe quantization of celestial systems. While this notion of macroquantization is not widely accepted yet, it is known that it could provide a variety of fluxes. The reactor can be used for medical isotope production. The facility is performing research in the areas of nuclear materials, physics and detector development and it is also utilized by surrounding schools, including University of Rhode Island, Brown University, Providence College, Rhode Island College and Roger Williams University.

The Outfitting of Universes: The Secret of Reaching Absolute Zero

Kevin Harding, American Military University, Hyspot Collaboration — In dimensional physics, temperature is a function of time. This is true for any dimension higher than 1. This is why absolute zero is unachievable within our universe or any universe where time in linear. However, in a 0th dimension time in nonlinear, therefore heat cannot exist as a function of time in a 0th dimension: ergo the only place absolute zero must exist naturally in the universe, is in a 0th dimension. Attributes such as these natural laws evolve relative to the universes they’re in. But it doesn’t just end with absolute zero. I postulate laws like gravitons and even anti-gravitons exist in a natural state as a result of how their universes came to be. The total rate at which a collective group of strings of energy vibrate within a newton mass entity in linear time is equal too but can never exceed the total possible number of motions a Newtonian mass entity can move with respect to the common physical laws within their universes in the same linear time. At fix points in time that they do differ, it will be equal to the rate at which such a Newtonian mass entity is converting into energy. Therefore, all action is not an infinite choice, but rather an elaborate list of limited possible outcomes bounded by the physical laws of our universe.

Phase Change Memory and Thermoelectricity

Ali Gokirma, University of Connecticut — Ability to manufacture devices with < 20 nm critical features sizes is now enabling new technologies that compliment CMOS. Phase change memory (PCM) is a high-speed resistive non-volatile memory technology that has the prospect to be integrated on top of VLSI circuits, producing computer chips with large volume (~ 250 GB) of non-volatile memory in a single chip. This embedded storage will eliminate the need for additional computer memory (DRAM) or a motherboard, speeding up computer performance by ~1000x for data intensive applications. Phase change memory devices utilize glassy material which have a large resistivity contrast for their crystalline and amorphous phases. These materials can be rapidly and reversibly switched between the two phases by melting and freezing or by annealing above glass transition temperature using electric current (~ 1-10 MA/cm²). As the temperature of a small volume is increased rapidly while generating a large thermal gradient (~ 10 K/nm), thermoelectric effects play a significant role.

Can Schrödinger equation describe quantization of celestial systems?

Florentin Smarandache, University of New Mexico, Victor Christianto, Malang Institute of Agriculture — One can expect to use Schrödinger equation to describe quantization of celestial systems. While this notion of macroquantization is not widely accepted yet, the logarithmic nature of Schrödinger equation could be viewed as a support of its applicability to larger systems. As an alternative, one may discuss an outline for how to derive Schrödinger equation from simplification of Ginzburg-Landau equation. It is known that Ginzburg-Landau equation exhibits fractal character, which implies that quantization could happen at any scale. Therefore, it seems that it should not impose too much baggage to accept the use of Schrödinger equation to describe also classical systems, including celestial quantization. After all, the use of Schrödinger equation has proved itself to help in finding new objects known as extrasolar planets.
C1.00004 Stereoelectric and Thermodynamic Analysis of Biochemical Nanoparticles as Contrast Agents For Bio Imaging. SI YOUNG CHOI, Brooks School, ANDREW KYUNG, Northern Valley Regional High School at Demarest — Contrast agents are crucial in medical imaging, effectively improving the clarity and contrast of the targeted body part. Clear differentiation between the body structure and nearby tissue is necessary for accurate clinical examination and diagnosis. Through empirical and computational research, image contrast agents that are higher in stability and safety are examined. Magnetic resonance imaging, a major diagnostic method in modern medicine, is safe due to the absence of damaging ionizing radiation. Researchers have used electrochemical techniques to study aqueous fullerene nanoparticles as not only X-Ray contrast agents, but also MRI contrast agents. This paper uses computational simulations to examine the potential of nanomaterials such as fluorescent functionalized Gadolinium and metal oxides to be used as nano-scaled contrast agents in the detection of tumor cells. The paper presents the analysis and comparison of thermodynamic stability of various imaging contrast agents, such as derivatives of lanthanide element and metal oxides by assessing the optimized energy via chemical programs. The electron properties of contrast agents are examined by Density Functional Theory (DFT) and Universal Force Field (UFF) method which employ quantum physical and chemical method.

1This research was supported by Columbia University, College of Physicians and Surgeons, and Choice Research Group in New Jersey. The authors gratefully acknowledge the use of the facilities at the Center for Clinical Radiology in Columbia University.

C1.00005 Femtosecond micromachining of optical elements. JIN-TAE KIM, Chosun Univ., HUN KOOK CHOI, IK BU SOHN, GIST — and microlens array (MLA) fabricated directly using a femtosecond laser have been done. Lithography processing with a femtosecond laser without a phase mask has been applied to fabricate a FZP on silica surface and optical characteristics of the FZP are compared to those of FZP on the silica surface fabricated conventional femtosecond technology using laser ablation processes. Diffraction gratings with higher diffraction efficiency due to CO₂ laser surface treatment processing have been fabricated on the surface of silica surface using a femtosecond laser. MLA on silica surface has been fabricated using a femtosecond and CO₂ lasers and optical characteristics have been compared with a commercial MLA.

C1.00006 Enhancing the conductivity of graphitic thin films using silver nano wires. MILES ST JOHN, MEDINI PADMANABHAN, Rhode Island College, DEPARTMENT OF PHYSICAL SCIENCES, RIC TEAM — Graphitic thin films are widely researched as potential candidates for use as transparent conducting electrodes in solar cells. Starting with commercial graphite powder, we fabricate thin films using the technique of interface exfoliation. We find that these films typically exhibit high electrical resistance. In this work we attempt to increase the conductivity of our thin films by adding silver nano wires.

C1.00007 Study on the Dielectrics in the Piezoelectric Element to Convert Mechanical Energy to Electrical Energy. WOO JAE KIM, RICHARD KYUNG, Choice Research Group — Renewable, green energy is an important field of research amidst the 21st century energy crisis. Many of the researches around the world have been consistently looking for new energy source. Applying repetitive mechanical forces to mono or multi layered ceramics element generate electrical energy. It depends on the direction of the stress, polarization, and the geometrical shape of the individual layers. The research focuses on increasing efficiency of the piezoelectric module utilizing the geometry of the ceramics layers and material properties. Different combinations of ceramic slabs were numerically and computationally studied in order to determine the factors affecting the capacitances in the piezoelectric module. To harvest higher energy using piezoelectric vibration, multiple layered metal oxides such as metal tantalum oxide and metal titanium oxides were considered to calculate the energy in the module. Computational software such as Matlab has been employed to calculate the distributions of electric fields and charges within the piezoelectric module in order to measure the maximum energy possible to obtain between each electrodes. Electromagnetics principles and modeling tools were used to construct the models considered in this paper.

C1.00008 Electrochemical Characterization of MnO₂ for Supercapacitor Applications. AMIR OMIDWAR, SETH GAGNON, PETER K. LEMAIRE, RAHUL SINGHAL, Central Conn State Univ — Manganese dioxide (MnO₂) has been found to be useful in applications involving supercapacitors, due to its high theoretical capacity, environmental compatibility, safety, low environmental toxicity, and cost effectiveness. We have synthesized MnO₂ using hydrothermal method. The precursor materials manganese (II) sulfate (MnSO₄), potassium permanganate (KMnO₄) were dissolved in water and then placed in Teflon lined stainless steel autoclave at 160°C. The resultant precipitate was washed with distilled water and dried at 80°C to obtain MnO₂ powder. The phase purity of resulting MnO₂ powder were studied using X-ray diffraction and thermal characterizations were carried out using differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). Electrochemical characterization were carried out by studying charge – discharge and cyclic behavior of MnO₂ cathode materials. The electrodes were prepared by coating a slurry of 80% of active materials, 15% carbon black and 5% PVDF binder, onto a Ni mesh. The detailed results and analysis will be presented and discussed during the APS-NES Fall 2017 meeting.

1Financial support received from CCSU’s faculty student research grant (Banner Id AFLEMK) is highly acknowledged.

C1.00009 Synthesis and characterization of Fe doped HfO₂. RILIND ABAZI, AMIR OMIDWAR, PETER K. LEMAIRE, Central Conn State Univ, RAM S. KATIYAR, University of Puerto Rico, San Juan, PR, RAHUL SINGHAL, Central Conn State Univ — Hafnium oxide (HfO₂) materials were found to be useful for various applications such as in dielectric barriers, capacitors, oxygen detectors etc. We have synthesized Hf₁₋ₓFeₓO₂ (0 < x ≤ 0.05) materials by precipitation method using hafnium tetrachloride (HfCl₄), iron chloride, and sodium hydroxide. The synthesis method was followed as reported earlier [1] with some modifications. The obtained precipitate of Hf₁₋ₓFeₓ(OH)₄ was dried overnight at 80°C. The dried materials were ground with a pestle and mortar and the powders were finally calcined at 600°C for 3 hrs, resulting in Hf₁₋ₓFeₓO₂ nanoparticles. The synthesized nanoparticles were characterized using X-ray diffraction and micro-Raman spectroscopy. Thermal characterizations were carried out using DSC and TGA studies. The detailed results and analysis will be presented and discussed during the APS NE October 2017 meeting.


1Financial support received from AAUP Faculty research grant (Banner Id. ARSINJ) is highly acknowledged.

¹Heartfelt Gratitudes to HE. Mr. Prof. Ir. HANDOJO/PT. PINDAD[persero]., Bandung 40284

C1.00011 Expanding General Relativity’s Space by S-Denying. LARISSA BORISSOVA, Independent Researcher, FLORENTIN SMARANDACHE, University of New Mexico — Following neutrosophy, we claim: Aside for observed positively mass-charged (i.e. massbearing) particles and neutrally mass-charged (light-like) particles, there should be a third class of “negatively” mass-charged particles unknown in today’s experimental physics. We aim to establish such a class of particles by the methods of General Relativity. Any four-dimensional proper vector has two observable projections onto time line, attributed to our world and the mirror world (for a mass-bearing particle, the projections are attributed to positive and negative mass-charges). There should be a class of neutrally mass-charged particles that inhabit neither our world nor the mirror world. Inside the space-time area (membrane) the space rotates at the light speed, and all particles move at as well the light speed. So, the predicted particles of the neutrally mass-charged class should seem as light-like vortices.

C1.00012 Relative emissivity measurement through photoacoustic effect¹, YAQI ZHANG, GERALD DIEBOLD, Brown Univ — Determination of emissivity with great accuracy is significant for temperature measurement by pyrometry, radiation heat transfer and so on. Normally, emissivity is determined directly by measuring the ratio of radiation of the sample to the blackbody or indirectly through measurement of reflectance. Here, a new method employing the photoacoustic effect is introduced for emissivity measurement. Radiation of two different samples goes into an acoustic cell alternately by rotating two chopping wheels out of phase. The radiation difference will result in the generation of acoustic waves which are recorded by a lock-in amplifier. Raising the temperature of one sample while keeping the other at constant temperature will eventually result in a balanced state where radiation from two samples at different temperatures is equalized. By recording the amplitude and phase of the acoustic signal and the temperature difference simultaneously, the balanced null point could be accurately determined, thus resulting in an accurate measurement of emissivity. Emissivities of teflon, PVC, polystyrene sheet and aerogel Z306 are given.

¹U.S. Department of Energy

C1.00013 Is US Industry losing carbon-free energy to China?¹, PAUL H CARR, AF Research Laboratory Emeritus — In 1995, the US had 43% of the solar manufacturing market with China at 1%. Now the US market share of this exponentially increasing market has declined to 10%, as compared to China’s 30%. China now dominates wind turbines with 27% of the market share with the US at 9%. Solar energy is available only 26% of the time and wind 33%. Nuclear is 24/7. The energy returned divided by the energy invested (EROI) in manufacturing for nuclear is 8 times that of solar and 19 times that of wind. Fear of nuclear reactors is hurting our environment. We are decommissioning them faster than the increase in wind and solar. To make up for this net decrease, we are increasing our burning of fossil fuels, raising carbon dioxide emissions which warm our planet. Westinghouse’s nuclear reactors being built in S. Carolina and in Georgia have gone bankrupt. China has 23 nuclear plants being built and 33 planned. Bill Gates’ TerraPower nuclear pilot plant is being built in China with the Chinese National Nuclear Corp. This traveling wave reactor converts depleted uranium, a byproduct of the nuclear-fission process, into usable fuel, solving the nuclear waste storage problem.

C1.00014 Investigation of High Altitude, Long-term Aerosol Features Using Laser Radar and Wind Measurements. JALAL BUTT, CHRIS OVILLE, NIMMI SHARMA, Department of Physics and Engineering Physics, Central Connecticut State University, JOHN BARNES, Cooperative Institute for Research in Environmental Sciences, CU Boulder, NOAA Earth System Research Laboratory, Global Monitoring Division — Measurements of the atmosphere were taken over several years using a CCD camera Lidar with wide angle optics and laser line filter on Mauna Loa Observatory, a world premier atmospheric baseline station. A 532-nm laser was vertically transmitted and the scatter off clouds, aerosols, and air molecules was detected using the CCD camera. The received signal was normalized to a molecular scattering model and corrected for transmission using an AERONET derived phase-function. Long-term measurements of high altitude aerosols were compiled and the scatter off clouds, aerosols, and air molecules was detected using the CCD camera. A distinct aerosol feature in the long-term aerosol extinction average was observed and studied further with nearby radiosonde wind-direction measurements.

C1.00015 Machine Vision System for Characterizing the Electric Field for the $_{225}$Ra EDM Experiment. ANDREW SANCHEZ, Univ of Connecticut - Storrs — If an atom or fundamental particle possesses an electric dipole moment (EDM), that would imply time-reversal violation. At our current capability, if an EDM is detected in such a particle, that would suggest the discovery of beyond the standard model (BSM) physics. The unique structure of $_{225}$Ra makes its atomic EDM favorable in the BSM search. An upgraded Ra-EDM apparatus will increase experimental sensitivity and the target electric field of 150kV/cm will more than double the electric field used in previous experiments. To determine the electric field, the potential difference and electrode separation distance must be known. The optical method I have developed is a high-precision, non-invasive technique to measure electrode separation without making contact with the sensitive electrode surfaces. A digital camera utilizes a bi-telecentric lens to reduce parallax error and produce constant magnification throughout the optical system, regardless of object distance. A monochrome LED backlight enhances sharpness of the electrode profile, reducing uncertainty in edge determination and gap width. A program utilizing an edge detection algorithm allows precise, repeatable measurement of the gap width to within 1% and measurement of the relative angle of the electrodes.

C1.00017 Vertical Axis Wind Turbine Induction Generator Subsystem¹, AMANDA PRESCOTT, Univ of Mass - Dartmouth — This novel approach to an atypical sail-driven wind turbine is primarily distinguishable by the vertical axis structure as well as the induction generator. The generator subsystem for this vertical axis wind turbine is being designed and constructed to maximize the power output through variable wind speeds at ground-level. The goal is to produce 2.3kW of power through a 3-phase AC system, making use of Neodymium magnets and specially designed coils to fit the production needs. The generator is being designed with modular properties to fit power needs of the consumer. The design is currently in progress and undergoing significant testing and reconfiguration on a full-scale prototype structure. Preliminary designs and results from testing will be shown.

¹Allard Engineering
C1.00018 Efficiencies of the Amino Acid Derivatives for Fat Burning and Thermodynamic Analysis of the Molecules, SEONG HO SHIN, RICHARD KYUNG, Choice Research Group — Studies by scientists substantiate that digesting fat burning supplements increases fat oxidation of fatty acids from adipocytes and speeds up mobilization of cells. By coupling supplementation of fat burning drugs with a reduced-calorie diet, a decrease in body fat and increase in muscle mass is possible. Weight loss is affected by several factors such as amino acids, hormones, and minerals. The systematic supplementation of specific amino acids instigates the body to naturally produce fat-burning hormones. When sufficient amounts of amino acids such as arginine, glutamine, and methionine are taken at night, there is an increase in the production of fat-burning hormones. This research uses Chemcraft and Avogadro, which are softwares that are capable of determining the theoretical and chemical properties of the molecules as well as the efficiencies of the fat burning abilities. The theoretical structure of each feasible amine molecule is studied by using the stability of each compound to predict the efficiency of the molecule in assessing the physical stability and measuring the fat burning ability. The stereochemistry of Rauwolscine, L-carnitine and other compounds is examined to assess the chemical properties including thermodynamic activity.

Friday, October 20, 2017 6:45PM - 7:30PM —
Session D1

6:45PM D1.00001 So you have a degree in physics. Now what? , RUDOLF TRUMP, IBM T.J. Watson research Center — Physics students (undergraduate and graduate), as well as postdoctoral researchers, are usually embedded in an academic environment, working with or for a professor with extensive research experience. This professor will naturally be a role model, and many students aspire to also become a university professor and spend their careers in academia. But reality is different: the vast majority of physics students will not end up in academia, and will not end up spending their careers doing research. Even more, physics research in industry has sharply declined over the last 20 years. So what is a fresh physics graduate to expect, and what career options are available to her? In this (hopefully interactive) talk I will discuss how a degree in physics provides a starting point for addressing a variety of societal grand challenges in a broad range of professional settings.

Saturday, October 21, 2017 8:30AM - 9:45AM —
Session E1

8:30AM E1.00001 Anderson Localization in Time-Dependent Hamiltonians1, ELIZABETH (NOELLE) BLOSE, Middlebury College, NATASHA PROCTOR, California Polytechnic State University, RAJIV SINGH, RICHARD CALETTAR, UC Davis — We study a generalization of Anderson localization to show that different forms of time-dependence of onsite energies cause the system to behave in qualitatively different ways. Our results confirm the known result that random time dependence causes a disordered system to delocalize completely. However, we find that periodic time dependence causes an increase in localization length, but not complete delocalization.

8:45AM E1.00002 Distribution independence of statistics of symmetric random walks: an intuitive proof, ROBERT CORDERY, Fairfield Univ, CLAUDE ZELLER, C. Zeller Consulting LLC — Random walks on the real line are used to approximate diffuse light reflection, logarithm of stock prices, Brownian motion, and other stochastic processes. First passage statistics and time distribution of the order statistics of one-dimensional symmetric continuous random walks have important applications such as diffuse reflectance. These statistics are surprisingly independent of the step size distribution. Further, the statistics of finite walks constructed from permutations of a finite set of real step lengths are also independent of the set of lengths. Many of these independence results were known from the fluctuation theory of partial sums developed by Andersen, Baxter, Darling and others between 1940 and 1960. We present simple proofs of several fluctuation theory results by examining certain pairs of walks. Our approach reveals the mechanism behind these remarkable results and the ubiquity of combinatoric formulas and Catalan numbers even in the continuous case.

9:00AM E1.00003 Binding Mechanism of Exotic Heavy Quark Systems1, SADHANA SURESH, PETER SCHWEITZER, Univ of Connecticut - Storrs, SCHWEITZER GROUP TEAM — This project seeks to shed light on how charmonium states can bind with the nucleon. The results of this calculation will be applied to the new pentaquark states which have been observed recently by LHCb at CERN. These new states, P_c(4380) and P_c(4450), are observed to decay in J/Ψ and the proton and can be interpreted as pentaquark states with hidden charm. The P_c(4450) state can be described as a bound state of a nucleon and Ψ(2S).

9:15AM E1.00004 The Map of Physics and Missing Phase Equations of Quantum Mechanics, DOUGLAS SWEETSER, quatemions.com of Acton, MA — Minkowski’s vision was that we would — someday — never think of space without time, nor correspondingly, energy without momentum. One way to enforce the vision is to write physics equations using quaternions that require 4 slots to be filled even if they are zeros. Do this for a number of physics equations, and patterns appear: if a quaternion physics equation has zeros or constants, then that equation is classical. If all the space and time terms are on equal footing, then the equation is relativistic. This rule clarifies why the Schrödinger equation belongs to classical quantum mechanics, but the Klein-Gordon equation is relativistic quantum mechanics. The need to take a norm is what distinguishes an equation is quantum versus non-quantum. The uncertainty principle derivation uses the Cauchy-Schwarz inequality which requires taking a norm. Applied consistently to the Klein-Gordon equation, a quaternion physics expression insist there should be three more equations that are not part of the canon of modern physics. I have yet to put such equations to productive use, but am willing to point them out.

1 NSF Award No. 1406298 to P.S.
9:30AM E1.00005 Why the Vortex Electron’s Internal Revolving Charge Does Not Radiate. ERNST WALL, The Institute for Basic Research, Palm Harbor, FL — The electron is a tiny charge (≈20 pb) that revolves at light speed in a Compton Wavelength orbit. This revolving charge produces the Bohr magneton, identically, as well as its mass-energy and angular momentum, $\hbar/c/2$. An impulse, observed just outside the orbit, is caused by the passing charge as it generates wavelets that spiral outward from the orbit at the speed of light with a Compton wavelength spacing, thus forming an electrical field vortex. The synchronous interaction of these wavelets from two electrons gives rise to de Broglie waves. When the electron is accelerated, the wavelets in front of it are increasingly compressed while those behind are increasingly decompressed, thus causing an increasing potential difference with an attendant increasing electric field across the finite extent of the electron. That generates radiation. However, the tiny revolving charge itself is not surrounded internally by tiny wavelets, so it has no means of generating a field across itself as it accelerates inward. In addition, it is too tiny to have any reasonable spatial extent across which to form a field. Hence, it cannot radiate the electron’s mass-energy away. References provided in website, tachyonmodel.com.

Saturday, October 21, 2017 8:30AM - 10:00AM — Session E2 Optics and Astrophysics The 95 Club -

8:30AM E2.00001 Magneto-Optical Trap Thermometry Using a Triggered Electro-Optic Modulator*, S.A. ENTNER, University of Connecticut; Wentworth Institute of Technology, J. M. KWOLEK, University of Connecticut, D.S. GOODMAN, University of Connecticut; Wentworth Institute of Technology, W.W. SMITH, University of Connecticut — Magneto-optical trapping and cooling is fundamental to the study of ultra-cold gases, often serving as the workhorse for many cutting-edge, cold-atomic-physics applications. The magneto-optical trap creates a cold (~100 μK) localized cloud of neutral atoms, therefore, characterizing the temperature of the cloud is an essential task. Our poster will describe the implementation of a modified release-and-recapture technique that measures a trapped sodium clouds temperature via spatiotemporal fluorescence imaging (STFI). The technique uses a triggered electro-optic modulator and CCD camera to release, recapture, and image the ballistic expansion of the atom-cloud. Ultimately, tracking the clouds expansion allows us to determine the temperature of the trapped atom-cloud.

8:45AM E2.00002 Testing Parameterized Theories of General Relativity using Gravitational Waves†, RADHA MASTANDEA, Massachusetts Inst of Tech-MIT, ALAN WEINSTEIN, Caltech, LIGO SCIENTIFIC COLLABORATION — The recent detections of gravitational waves (GWs) by the Laser Interferometer Gravitational-Wave Observatory (LIGO) have provided researchers with the first opportunities to test general relativity (GR) in the strong-field and highly-dynamical limit. Qualitative tests of the agreement between LIGO’s GW observations and classical GR have already been done; we have carried out more quantitative tests in terms of controlled, parameterized deviations from GR. In this project, we simulate a number of binary black hole (BBH) merger waveforms with known amplitude and phase deviations from those predicted by GR that are governed by the real and imaginary parts, respectively, of a complex parameter λ. We use Bayesian analysis to recover the deviation. We then provide an estimate of the number of GW detections from BBH mergers that are necessary to establish a given deviation from classical GR, notably finding that under 80 events are necessary to determine λ to a precision of 0.025 (a fractional precision of 5% for λ = 0.5).

†LIGO SURF, NSF

9:00AM E2.00003 By Parallax to the Moon: An exercise with online data, CHARLES H. HOLBROW, Colgate Univ & MIT — On May 23, 2007 at 16:09:31 UTC, Peter Lawrence at Selsey, UK (50.73502° N, 0.78977° W), and Anthony Ayiomamitis at Athens, Greece (37° 59’ 2.3” N, 23° 43’ 40.1” E), photographed the Moon as it passed close to the bright star Regulus (α-Leonis).†Their two pictures show the Moon at different angular separations from Regulus because of parallax of the Moon relative to this much more distant star. You can extract from the pictures the parallax angle of 118° and use it to find the distance from Earth to Moon. However, you cannot use the simplifying assumptions that are standard in astronomy texts because the triangle formed by the locations of Selsey, Athens, and the Moon is oblique; no two of its sides are equal; and it lies in a plane tilted relative to the horizontal planes of the observers in a way not easy to visualize. I will show how a student can set up the problem in terms of vectors, evade difficulties of three dimensional visualization, and obtain a value of the Earth-Moon distance on that day and at that time of 373,000 ± 4,000 km in good agreement with its actual value.

†http://www.etwright.org/astro/moonpar.html

9:15AM E2.00004 Two-dimensional (2D) semiconductor: Probing by femtosecond broadband continuum second harmonic generation (SHG) measurement, MOHAMMAD MOKIM, FERUZ GANIKHANOY, Univ of Rhode Island — After the remarkable success of graphene, two-dimensional (2D) semiconductors have recently become the focus of fundamental research due to their novel electronic and optical properties, making for very promising applications in nano- and optoelectronic devices. We demonstrate an effective microspectroscopy technique by tracing the dispersion of second order nonlinear susceptibility $\chi^{(2)}$ to characterize the monolayer tungsten diselenide (WSe$_2$) within the photon energy range of 2.4-3.2 eV. We then retrieve, with reasonable precision, the fundamental bandgap and exciton binding energy of this semiconductor. To perform the experiment, ultra-broadband continuum pulses served as the fundamental beam while its second harmonic spectrum in visible and ultraviolet (UV) was detected and analyzed with better than 0.3 nm spectral resolution (<2 meV). In this presentation, I will discuss our recently obtained experimental results that can be crucial to refining the theoretical calculations.
9:30AM E2.00005 Sensitive photoacoustic trace gas detection with a moving optical grating. WENYU BAI, LIAN XIONG, Brown Univ, FEIFEI CHEN, FAPENG YU, XIAN ZHAO, Shandong Univ, GERALD DIEBOLD, Brown Univ — Examination of the wave equation for the photoacoustic effect shows that photoacoustic waves can be excited by steady motion of a heating source. Compared with the traditional excitation methods such as the pulsed or amplitude-modulated laser excitation, photoacoustic waves launched by moving sources permits greater sound controllability, higher input radiation energy, and most importantly, the possibility of achieving optimal optical to acoustic energy conversion efficiency. In this talk, we first show that in the linear acoustic regime when a laser source moves at the sound speed in a one-dimensional geometry, the amplitude of the acoustic wave grows linearly in time without bound. Second, use of this principle is described for trace detection of gases using two frequency shifted beams from a CO$_2$ laser directed at an angle to each other to give optical fringes that move at the sound speed in a cavity with a longitudinal resonance. The photoacoustic signal is detected with a high Q, piezoelectric crystal with a resonance on the order of 443 kHz. As the grating frequency, the length of the resonator, and the crystal must all have matched frequencies, three resonances are used to advantage to produce sensitivity that extends to the parts-per-quadrillion level.

The authors are grateful to the US Department of Energy under Grant DE-SC0001082 for the support of this research.

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9:45AM E2.00006 Sub-picometer Laser Distance Gauge for Gravitational and Astronomical Instruments. JAMES D. PHILLIPS, DAN KAPLAN, Illinois Institute of Technology, ROBERT D. REASENBERG, UCSD and Harvard-Smithsonian Center for Astrophysics, TOM ROBERTS, Illinois Institute of Technology — The Tracking Frequency laser Gauge (TFG) can measure distances in the range 0.01-1000 m. We have demonstrated accuracy of 2 picometers (pm, 10^-12 m) in 1 s, and 40 femtometers (fm, 10^-15 m) in 30 s when using a resonant measurement interferometer with a finesse of 130. It is the world’s most accurate laser distance gauge. The TFG can be the sensor for new tests of the equivalence principle, including a test with antimuons; and for optical trusses in demanding spaceborne astronomical instruments, such as telescopes with exoplanet coronagraphs and others using segmented or distributed apertures. The TFG locks a laser to the measurement interferometer. This architecture gives it substantial advantages over the traditional precision instrument, the heterodyne phase gauge (HPG). The TFG is free of an important source of cyclic bias that limits the HPG accuracy. The TFG’s readout is a radio frequency derived from an optical heterodyne, not an RF phase as in the HPG. The TFG measures absolute distance (to pm precision) with little or no additional hardware. The TFG is now operating at the Illinois Institute of Technology (IIT), where we are refining and testing error models to increase reliability and improve accuracy.

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Saturday, October 21, 2017 8:30AM - 10:00AM — Session E3 Energy and Biological Physics The 95 Club -

8:30AM E3.00001 Nanophysics for improving industrial oil extraction. NANCY BURNHAM, Worcester Polytechnic Institute, SHANNON EICHMANN, Aramco Services Company — Oil powers modern economies. Yet only 30% of oil is recovered from a typical reservoir. The reservoirs of Saudi Arabia provide over 10% of the world’s oil. They are highly saline, with concentrations of up to 120,000 ppm total dissolved solids (TDS), and the oil and brine is dispersed within small fissures in carbonate rock. These conditions are challenging for the unhindered diffusion of the nanoparticle tracers that could be used to map an oil field from one well to the next. In this study, bare and carboxyl-terminated atomic-force microscope tips and calcite surfaces acted as surrogates for nanoparticle tracers and carbonate rocks, respectively. They were immersed in three fluids: brine (120K ppm TDS), seawater (60K ppm TDS), and calcium-doped seawater (60K ppm TDS). Surprisingly, the amount of TDS was not a good predictor of the tip-sample adhesion. Rather, adding calcium to seawater brought the adhesion down to the levels of brine. The addition of calcium to seawater should mitigate nanoparticle-rock adhesion and allow more efficient diffusion of nanoparticle tracers through a reservoir, which could help ensure a stable supply of an essential global resource.

8:45AM E3.00002 Novel borate additives for lithium-ion battery cathode passivation investigated with hard x-ray photoelectron spectroscopy. STEPHANIE RIVARD, BENJAMIN YOUNG, Rhode Island College, DAVID HESKETT, YINGNAN DONG, University of Rhode Island, YONGFENG HU, Canadian Light Source, BRETT LUCHT, University of Rhode Island — Cathodes presently used in industry-standard graphite-based Li-ion batteries will limit capacity improvements made on the anode side due to electrochemical limitations. The high voltage spinel cathode, LiNi0.5Mn1.5O4, may permit a higher 4.7 V operating potential and represents a significant step in the journey to developing higher capacity rechargeable batteries. Successful employment of the high voltage cathode will require attention paid to formation of the cathode electrolyte interphase (CEI), a passivation layer that grows on the electrode surface to prevent decomposition of the electrolyte material. Herein we present an investigation of three novel borate additives to the standard electrolyte (ethylene carbonate/ethyl methyl carbonate solvent with LiPF6 salt) using Hard X-Ray Photoelectron Spectroscopy (HAXPES). Electrochemical cycling data reveal that the standard electrolyte is significantly outperformed by batteries with these additives at elevated temperature. The HAXPES data suggest that this may be due, in part, to the thickness of the CEI layer developed on each cathode, which we have approximated for each battery. Furthermore, we see evidence of additive decomposition on the better-performing batteries, which likely leads to more effective electrode passivation.

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8:00AM E3.00003 Sucralose Interaction with Protein Structures. NIMESH SHUKLA, Wesleyan University, ENRICO POMARICO, MAJED CHERGUI, Ecole Polytechnique Federale de Lausanne, J.S. CODY, ERika TAYLOR, CHRISTINa OTHON, Wesleyan University — Sucralose is an artificial sweetener that appears to destabilize protein native structures in contrast to its natural counterpart, sucrose, which enhances the stability of biomolecules against environmental stress. We explored the molecular interactions of sucralose as compared to sucrose to illuminate the origin of the differences in their bio-preservative efficacy. We show that the mode of interactions of sucralose and sucrose in bulk solution differ subtly using hydration dynamics measurement and computational simulation. At high concentrations (>0.2M) or in the thermally stressed state, sucralose appears to differ in its interactions with proteins leading to the reduction of native state stability. We explored the difference in the preferential exclusion model using time-resolved spectroscopic techniques and observed that both molecules appear to be effective reducers of bulk hydration dynamics. However, the chlorination of sucralose appears to slightly enhance its hydrophobicity, which reduces the preferential exclusion of sucralose from the protein-water interface. We propose this as a possible origin for the difference in their bio-preservative properties.

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1DOE EPSCoR DE-SC0007074 and RI College Faculty Research Fund
9:15AM E3.00004 Gene expression as a bio indicator for the radiation exposure in Drosophila Melanogaster, SAMANAH SHRESTHA, ADAM VANASSE, Univ of Rhode Island, LEON N COOPER, Brown University, MICHAEL P ANTOSH, Univ of Rhode Island and Brown University — This work reports a set of genes which could serve as a biomarker in irradiated Drosophila Melanogaster (fruit flies) on the basis of gene expression analysis. These radiation responsive panel of genes have human homologs and could potentially be used in the radiation dosimetry for human exposure to radiation. Gene expression analysis was done on the data obtained from an RNA sequencing gene expression experiment on 15222 genes of drosophila melanogaster at days 2, 10, 20 post irradiation. The fruit flies were exposed to x-rays of 10, 1000, 5000, 10000, 20000 roentgens. The analysis of these data showed that 6 genes showed a linear response at all time points post irradiation with dose. One of them, Dmp, was a novel gene. This gene is a DNA repair gene and has a human homolog (XRCC6). Ignoring the lowest dose of 10R, a set of 13 genes of which 4 having human homologs and 8 having the known functions showed a linear response with dose at all the time points. 5 of 6 genes with all radiation doses included are found in this set of 13 genes. This suggests that these genes with human homologs could be used for the biodosimetry application to determine the radiation health risks.

9:30AM E3.00005 Global warming impact on low frequency sound transmission in the ocean - Jurassic acoustics here we come, DAVID BROWNING, PETER HERSTEIN, Browning Biotech, PETER SCHIFTELE, Fetch Lab, Univ. of Cincinnati — Amazingly, 2.4 MILLION pounds of carbon dioxide are ejected into the atmosphere every SECOND, about a quarter of which is absorbed into the oceans of the world. This results in ocean acidification, which negatively impacts the boron chemical reaction principally responsible for low frequency sound absorption in seawater, hence low frequency sound transmission improves. Already there is a measurable decrease in ocean surface pH and if this continues and migrates throughout the water column it is projected that the sound transmission will eventually become similar to that in the high CO2 Jurassic Age of the distant past.

9:45AM E3.00006 Thermviscous analysis of open photoacoustic cells¹, MADHUSOODANAN MANNOOR, SANGMO KANG, Dong-A University — Open photoacoustic cells, apart from the conventional spectroscopic applications, are increasingly useful in bio medical applications such as in vivo blood sugar measurement. Maximising the acoustic pressure amplitude and the quality factor are major design considerations associated with open cells. Conventionally, resonant photoacoustic cells are analyzed by either transmission line analogy or Eigen mode expansion. In this study, we conducted a more comprehensive thermo viscous analysis of open photoacoustic cells. A Helmholtz cell and a T-shaped cell, which are acoustically different, are considered for analysis. Effect of geometrical dimensions on the acoustic pressure, quality factor and the intrusion of noise are analyzed and compared between these cells. Specific attention is given to the sizing of the opening and fixtures on it to minimize the radiational losses and the intrusion of noise. Our results are useful for proper selection of the type of open photoacoustic cells for in vivo blood sugar measurement and the optimization of geometric variables of such cells.

¹This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and future planning (2017R1A2B4005006)

Saturday, October 21, 2017 10:15AM - 11:15AM –
Session F1: Facilitating Li-Ion Battery Advancement With Hard X-ray Photoelectron Spectroscopy
The 95 Club -

10:15AM F1.00001 Facilitating Li-Ion Battery Advancement With Hard X-ray Photoelectron Spectroscopy, BENJAMIN YOUNG, Rhode Island College — Portable electronic devices and the robust research effort to improve batteries supplying power to them have increased each others popularity for more than 30 years. This has furnished batteries that work acceptably well for handheld electronics, but are insufficient for more demanding applications like electric vehicles. Greater energy density and power output, as well as reduced charging time and cost, for instance, are desirable facets next-generation batteries ought to have in order to facilitate industrial conversion to hybrid and all-electric vehicles. Researchers across industry and academia are presently attempting to improve battery technology to meet these goals.

Many attempts to improve battery technology, both successful and unsuccessful, may be characterized by analysis of a passivation layer that grows on battery electrodes during regular charge/discharge cycling. X-ray photoelectron spectroscopy (XPS) is a popular tool for this analysis but the higher energy version of this technique, HAXPES, can offer additional information, including depth-sensitive profiling of the chemical environment using synchrotron radiation. Some of the most pressing challenges to development of superior Li-ion rechargeable battery solutions for demanding applications are presented, as well as proposed solutions and lessons learned about them from HAXPES analysis performed at Brookhaven National Laboratory and at the Canadian Light Source.

Saturday, October 21, 2017 11:15AM - 12:15PM –
Session G1: Physics, industry, and electronic materials at NIST NSLS beamlines
The 95 Club -

11:15AM G1.00001 Physics, industry, and electronic materials at NIST NSLS beamlines, JOSEPH WOICIK, NIST — "NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life." In this lecture I will discuss three industrial collaborations that highlight this paradigm: Local-structure determination in strained-layer semiconductors, ferroelectric strontium-titinate thin films on silicon, and hard x-ray photoelectron-spectroscopy measurements of semiconductor gate stacks. A common theme to each is the strain engineering of atomic and electronic structure and synchrotron measurement science.