2014 Annual Fall Meeting of the APS Ohio-Region Section
Portsmouth, Ohio
http://www.aps.org/meetings/meeting.cfm?name=OSF14
Friday, October 24, 2014 1:00PM - 1:15PM –
Session A1 Welcoming Remarks
University Center Ballroom - Tim Hamilton, Shawnee State University

1:00PM A1.00001 Welcoming Remarks –

Friday, October 24, 2014 1:30PM - 2:30PM –
Session B1 Quantum and Atomic Physics
University Center 215 - James Simmons, Shawnee State University

1:30PM B1.00001 Quantum Dynamics of Time-Dependent Optomechanical Systems
AMY KERST, Hillsdale College; JEAN-FRANCOIS S. VANHUELE, MANUEL BERRONDO, Brigham Young University —
Optomechanical quantum control theory is used in experimental research and various electronic technologies. The ability to construct apparatus on the mesoscopic scale and observe quantum effects has created a need for analytic methods that can accurately predict the time-evolution of these quantum systems. We present such a method, focusing on the time-evolution of driven optical and mechanical oscillators coupled through radiation pressure. We specify the circumstances under which the method yields exact results and propose a mean field theory for when it does not. We explore the behavior of the optomechanical systems as a function of their parameters and the form of the driving forces.

1:42PM B1.00002 Testing Lorentz and CPT symmetry in Penning traps
YUNHUA DING, ALAN KOSTELECKY, Indiana University-Bloomington, LOCAL LORENTZ AND GRAVITY TEAM — The Standard Model is phenomenologically successful in explaining particles and the complex nongravitational interactions between them. The CPT theorem, linking Lorentz and CPT symmetry, is a key property of this theory. However, some attempts to unify quantum physics with gravity suggest that tiny departures from Lorentz invariance could arise in nature and produce signals in high-precision experiments. In this talk, a theoretical analysis is performed of Penning-trap experiments confining a single charged particle or its antiparticle. Comparative measurements of cyclotron and anomaly frequencies in the electron-positron system are studied to determine the sensitivity to possible effects from CPT and Lorentz violation.

1:54PM B1.00003 Optical Switching Using Coherent Perfect Polarization Rotation in a One Dimensional Photonic Crystal
CHUANHONG ZHOU, JAMES ANDREWS, MICHAEL CRESCIMANNO, Youngstown State University — We report a high efficiency optical switch using coherent perfect polarization rotation effect (CPR) in a one dimensional photonic crystal (PC). The two-port device uses a counter-propagating control beam and is designed such that most light energy is located in the Faraday-active layers, significantly enhancing the polarization rotation and thus decreasing the size of the optical switch. CPR leads to high rotation efficiency in the optical switch due to the absence of reflected light. We show that more than 98% energy can be switched in direction and polarization by simply changing the phase of the control beam. This technique has promising applications in photonic circuits, computation, memory and photonic logic gates.

1:00PM A1.00001 Welcoming Remarks –

Friday, October 24, 2014 2:00PM - 3:00PM –
Session B2 Applied and Other Physics
Advanced Technology Center 124 (Planetarium) - Kyle Vick, Shawnee State University

2:06PM B1.00004 Lorentz-Violating Electromagnetostatics
JOSHUA FOSTER, V.A. KOSTELECKY, Indiana University Bloomington, RALF LEHNERT, Indiana University Center for Spacetime Symmetries — The Standard-Model Extension (SME) is a general effective field theory for Lorentz and CPT violation incorporating both the Standard Model and General Relativity. The SME provides a framework for experimental searches for Lorentz violation and for the investigation of new physics. In the static limit of Lorentz-violating electrodynamics, unusual mixing of electrostatic and magnetostatic effects occur. This talk investigates some aspects of Lorentz-violating electromagnetostatics, emphasizing modifications to multipole expansions of conventional electrodynamics.

1The authors are grateful to the National Science Foundation for financial support under grant number ECCS-1360725 and for financial support from the Science and Technology Center for Layered Polymeric Systems under grant number DMR 0423914.

2:18PM B1.00005 Model Independent Analysis of the Proton Magnetic Radius
JOYDEEP ROY, Wayne State Univ — The Proton is a fundamental constituent of matter. In contrast to other fundamental particles like the electron, it is an extended object and has a finite size that can be inferred with some degree of accuracy from several measurements. The electric radius can be extracted from electron-proton scattering experiments, \( r_E^p = 0.871 \pm 0.009 \text{ fm} \) and Lamb shift in Muonic Hydrogen \( r_E^p = 0.84184 \pm 0.00006 \text{ fm} \). The reason of this discrepancy between these values is still unknown and an open issue till date. In the literature there also exist several values of the proton magnetic radius extracted using several model-dependent methods. We use constraints from the analytic behavior of form factors to determine the proton magnetic radius in a model-independent way. Using existing datasets of electron-proton scattering we find \( r_M^p = 0.91 \pm 0.03 \pm 0.06 \text{ fm} \). When we include electron-neutron scattering data and \( \pi \pi \rightarrow N\bar{N} \) data, we find \( r_M^p = 0.87 \pm 0.04 \pm 0.05 \text{ fm} \) and \( r_M^n = 0.87 \pm 0.02 \text{ fm} \) respectively. We also extracted the neutron magnetic radius as \( r_M^n = 0.89 \pm 0.03 \text{ fm} \) combining all three datasets.

Friday, October 24, 2014 1:30PM - 2:30PM –
Session B2 Applied and Other Physics
Advanced Technology Center 124 (Planetarium) - Kyle Vick, Shawnee State University
1:30PM B2.00001 The Measurement of the Radioactivity in an Outcrop of Ohio Shale. IGNACIO BIRRIEL, LACEE PYLES, Morehead State University — Ohio Shale is a fragmented rock that is part of the black organic shale family that is found all over Kentucky. An outcrop of Ohio Shale, found in the northern part of Cave Run Lake, was used for this study. The outcrop can be split into two parts, the first consisting of only Ohio Shale while the second part consisting of the bottom most layer being the Ohio Shale covered by a non-radioactive Three-Lick bed. Along the bottom of the outcrop measurements were made of only Ohio Shale while along the surface of the outcrop measurements consisted of both the uncovered Ohio Shale and the Ohio Shale covered by a layer of Three-Lick bed were made. A GAMMA-SCOUT radioactive detector was used to measure the radioactivity. It is standard radiation detector with a halogen filled Geiger-Müller counter tube. This talk will discuss the radioactivity measured of this outcrop.

1:42PM B2.00002 Mechanics of the Battery in Baseball. AARON GOE, IGNACIO BIRRIEL, Morehead State University — The term “battery” in baseball refers to both the pitcher and catcher as a unit. They work together but have very specific and different defined roles. This study investigates the properties needed to throw out a runner trying to steal second base. The role of a pitcher is to disrupt the timing of the runner while also trying to get the hitter out. The catcher has many roles, one of which is to throw out runners stealing a base. A pitcher is typically trying to throw the ball with as much force as he can because he has as much time as he wants to deliver the ball to home plate. The catcher on the other hand does not have much time to throw out a base runner and therefore must have a quick throw to second. This study analyzes these different throwing mechanics and the timing required to get the baseball to second base. This will lead to a further investigation of understanding everything that goes on during a stolen base from the pitcher, to the catcher throwing to second, and the runner trying to steal the base.

1:54PM B2.00003 Multicopter Based Small Format Aerial Photography to Free and Open Source Open Source Photogrammetry. ROBERT DAVIS, None — A process is described to convert multicopter based small format aerial photography from flat images to 3 dimensional point clouds and then rasterized into height maps to be used as pseudo digital elevation models for surface modeling. All software used in the process is either free or open source. The process uses Canon Point and Shoot cameras with Canon Hacker’s Development Kit installed as the image collection platform. One camera is unaltered, and the other camera is modified to remove the near infrared filter. A DJI Phantom FC-40 multicopter is used as the aerial platform to carry the cameras. Multiple paths are described to convert from still images (or video to still images) to N-view matches, followed by sparse point clouds then dense point clouds. The dense point clouds can be converted into 3D models for viewing and analysis. A height map is extracted from the pointcloud and rasters are created and then used in QGIS or ArcMap as pseudo digital elevation models for surface modeling.

2:06PM B2.00004 Fluorescence of Laser Pointer Light by “Neon” Pigments. CLARISSA ROE, JENNIFER BIRRIEL, Morehead State University — In a short paper to the Physics Teacher, Matt Lowry reports on a serendipitous discovery that a green laser pointer will appear yellow when incident upon a neon pink plastic clipboard. After a cursory examination of the spectrum of the reflected yellow dot, Lowry concludes that the green laser causes fluorescent emission in the pink plastic. The dot appears yellow as a result of the combined spectrum of the fluorescent emission. Here we explore the fluorescence of green and violet lasers incident on a variety of “neon” clipboards and “neon” papers. We find that the reflected light can range in color from yellow to orange to magenta. We examine the spectra of these reflected dots using an RSPEC Explorer Spectrometer. We explain the observed reflected colors and find that the general shape of the fluorescence spectrum is independent of the excitation wavelength, so long as the given object absorbs those wavelengths. We discuss this investigation in the context of similar investigations of fluorescence due to laser pointer light and discuss the use of such experiments in an educational setting.

2:18PM B2.00005 The challenges of working with middle school teachers. GORDON AUBRECHT, Ohio State University at Marion — There are multiple challenges in working with middle school teachers. Content knowledge is problematic. Basically, middle school teachers should have a master’s in geology, biology, physics, and chemistry—and be able to work effectively with adolescents. Obviously, this is far from reality. Colleges of education fail to prepare teachers for the reality of the administrative-driven classroom. Inquiry is lectured about but not practiced. The granting agencies want quantitative data, but how does one provide these data? The talk will discuss these issues and some possible solutions we developed.

1This work supported in part by grants from the Ohio Department of Education C1457-OSCI-09-49 (2006-2009), C1667-MSP-10-410 (2009-2010), EDU01- 000006141 (2010-2011), EDU01-0000007902 (2011-2012), GRT0029161 (2012-2013), ODE-MSP-10673 (2013-2014), and ED

2:30PM - 2:30PM —
Session C1 Poster Session — University Center Ballroom — Tim Hamilton, Shawnee State University

C1.00001 The black hole mass in NGC 4258 from gas kinematics. DAVID DECOLIBUS, JASON PINKNEY, Ohio Northern University — NGC 4258 (or M106) is an important galaxy for the demographics of supermassive black holes (SMBH). Radio (VLBA) observations of its nuclear disk of water masers has allowed a very precise estimate of the mass of the central SMBH (3.82 ± 0.01 × 10^7 M☉), and the distance to the galaxy (7.2 Mpc). Hubble Space Telescope (HST) archival data allow the measurement of the BH mass in two additional, independent ways: stellar and gas kinematics, thus providing a crucial test of these more widely-used methods. Here we report on progress in a re-analysis of the archival data allowing gas kinematics. These data consist of HST long-slit spectroscopy from two programs, a total of 6 slit positions. We have fitted the Hα + [NII] and [SII] lines in order to determine radial velocities and velocity dispersions as a function of distance from the BH. The gas only shows organized rotation out to r ≠ 0.4″. The Hα emission shows a broad-line (BL) component from the central AGN, and regions outside of the BL region show greater line widths than expected for a kinematically “cold” gas disk. We report initial results of modeling the kinematics as resulting from a thin, inclined disk of line-emitting gas orbiting under the influence of gravity only.

1Based on observations made with the NASA/ESA Hubble Space Telescope operated by the AURA under NASA contract NAS 5-26555.

C1.00002 Investigation of Use of Calcein Dye for the Purpose of Studying Membrane Fusion. MATTHEW TENORIO, LAURA WESSELS, University of NE-Keamy — Calcein dye was to be used as the detection fluorophor while fusing an enveloped virus particle with a liposome. Dye was encapsulated into the liposome and membrane dye was incorporated into a virion. Calcein dye is quenched and water soluble making it easy to encapsulate into liposomes. There are several lipid dyes that will incorporate directly into a lipid bilayer that are also quenched. The properties, specifically the osmolality, of calcein dye was studied in order to determine the feasibility of this dye for membrane fusion experiments that require different signals to distinguish between a hemifusion state and fusion pore creation. Attempts to balance the osmolality of calcein dye included using high salt and high sucrose buffers, as well as trying different lipid compositions.
C1.00003 Solution Processed SERS Substrates, NARAYAN SHARMA, Bowling Green State University — Surface enhanced Raman spectroscopy (SERS) is a great analytical tool to obtain information on molecular composition. This technique has gained a reputation as one of the most sensitive spectroscopic methods available for the detection of a wide range of adsorbate molecules down to a single molecule detection limit. The most investigated metals for SERS substrates are gold (Au) and silver (Ag). Unfortunately, the fabrication of such devises poses a significant challenge due to an expensive deposition technology including, vapor deposition, electron-beam lithography, focused ion-beam lithography, and nano-transfer printing. Herein, we introduce a simple and low-cost approach to fabricate SERS substrates using roll-to-roll printing of matrix encapsulated gold nanoparticle arrays. The enhancement of Raman signals obtained using these materials was found to be comparable to commercially available SERS substrates. We expect that an on-going optimization of the film morphology should yield further enhancement of the demonstrated SERS architecture.

C1.00004 Exciton Generation in Semiconductor Nanocrystals via Near-Field Plasmon Coupling, AMIT ACHARYA, Bowling Green State University — We demonstrate that contrary to the classical electrodynamics standpoint, the phonon–driven decay of surface plasmons (SP) in small-diameter metal nanoparticles can be suppressed through efficient coupling of SP modes to excitons in the external environment. Such near-field energy exchange was manifested here through the generation of excitons in CdSe nanocrystals (NCs) that were coupled to 5-nm Au nanoparticles. A unique signature of the energy transfer process was observed in photoluminescence measurements that unambiguously correlated the increase in the CdSe exciton population with the excitation of SP modes in Au. To enhance the efficiency of plasmon to exciton energy transfer, the backwards flow of photoinduced charges into metal was suppressed by embedding Au and CdSe nanoparticles into insulating matrices. The observed generation of semiconductor excitons through near-field energy transfer from small-diameter Au nanoparticles presents an excellent opportunity for converting the energy of strongly confined (near field) radiation into long-lived excitations, which could be utilized by photovoltaic or photocatalytic applications.

C1.00005 Shreedhar Raj Kandel, Zhoufeng Jiang, Simeen Khan, Sailendra Chiluwal, Liangfeng Sun, SHREEHAR KANDEL, ZHOUFENG JIANG, SIMEEN KHAN, SAILENDRA CHILUWAL, LIANGFENG SUN, BGSU — Colloidal nanocrystal-based materials are promising for applications in optoelectronic devices. Beyond size-tuning as in quantum dots, shape-tuning of the material at the nanometer scale also results in novel optical and electronic properties. For instance, the multiple exciton generation (which is critical for high-efficient photovoltaic devices) is significantly enhanced in one-dimensional PbSe nanorods as contrast to the zero-dimensional quantum dots. The applications demand high quality and structure-well-controlled materials, which are still greatly underdeveloped. We report a method of catalyst-free, one-pot synthesis of colloidal PbSe nanorods with a well-controlled structure. This method is based on a typical synthesis of PbSe quantum-dot, but a chloroalkane cosolvent is added during the synthesis to drive the one-dimensional growth of the crystal. The synthesized nanorods have a uniform diameter of 6 nm and a length of 40 to 50 nm. Photoluminescence from these nanorods shows a peak at around 2000 nm, exhibiting a strong quantum confinement on the excitons in the nanorods.

C1.00006 Synchronization of Huygens’ clocks: An elementary treatment, ULRICH ZURCHER, LAURA KÄRLE, Physics Dept, Cleveland State University, ANDREW SLIFKIN, Psychology Department, Cleveland State University — We discuss a Huygens’ model in the “language” for someone with a background in algebra-based physics. The system consists of two pendulums mounted on a cart. We show how the movement of the cart removes the degeneracy of the two bobs, and use the conservation of linear momentum to describe the necessary escapement mechanism. We present results from an Excel calculation for the decay of the symmetric and antisymmetric modes.

C1.00007 An introductory physics laboratory that uses magnetic interactions to aid student understanding of the Coulomb and gravitational interactions, ANTHONY ROY DAY, John Carroll Univ — Introductory physics students often have difficulty interpreting energy curves and force curves for the 1/r potentials of the Coulomb and the gravitational interaction. It has not been possible to give students direct experience with these potentials in the laboratory but with the readily availability of powerful rare earth magnets laboratory studies of a dynamical system where the force increases rapidly with decreasing separation and tends to zero at large separation, qualitatively similar to the Coulomb and the gravitational interaction, are now possible. We present a series of experiments that allow students to infer the existence of magnetic potential energy from changes in the kinetic energy of the system, plot the potential energy as a function of separation, and confirm the relationship between the gradient of the magnetic potential energy and the magnetic force. Additional activities allow students to include the effect of magnetic friction and velocity dependent dissipative forces.

C1.00008 Using CFAs and observations to measure growth in inquiry-based middle school science teaching, GORDON AUBRECHT, Ohio State University at Marion, BILL SCHMITT, Science Center of Inquiry, JENNIFER ESSWEIN, Education Northwest, JESSICA CREAMER, Education Specialist — We work with inservice middle-school and high-school teachers in two high-needs urban school districts in Ohio. We estimate that new teachers who attend the summer institutes received at least 188 hours of professional development involvement. We expect to see changes in teacher practice as a result. We first look at publicly available information to observe changes. In addition, we analyzed common formative assessments (CFAs) administered to middle and high school students across a broad range of science subjects including biology, geology, physics, etc. For the analysis of CFAs, we established a rubric with four defining parameters: reasoning, clarity, analysis, and correctness. Teachers worked with PER faculty to improve their teaching methodology and CFAs were used to analyze and quantify changes in student learning across the four rubric parameters that resulted from the intervention. We also explain our attempt to quantify changes in teacher practice by using staff observations and self-reported measures such as RTOP and other self-assessments to quantify changes in teachers and teaching practice.


C1.00009 Dealing with more climate myths, GORDON AUBRECHT, Ohio State University at Marion — Many scientists understand that climate change has a sociopolitical aspect, but some scientists are unwilling to address the issue lest they be perceived as political themselves. Nevertheless, when we scientists find climate myths, I think it is our duty as scientists to be willing to debunk them. A poster at YSU on this topic was well received (Myths 1—7). This poster exhibits some more climate myths and contrasts them with the science.
Preliminary study of relaxation mechanisms for dusty plasma clusters

Andrew Kurtz, William Theisen, Terrance Sheridan, Ohio Northern Univ — Dusty plasma particles in a confining potential well regularly form into single layer plasma clusters under certain experimental conditions. The time evolution of these particles from random thermal motion to regular lattice structures is being investigated. The strongly coupled particles shift and rotate in a two-dimensional plane in order to achieve an equilibrium position. Each slip stick adjustment in the structure results in less overall systemic energy. In the process of shifting, changes in the height and width of the clusters were found and are seen to be inversely proportional.

Some results on metastable states of two-dimensional dusty plasma

Austin R. Howell, T.E. Sheridan, Ohio Northern University — In dusty (complex) plasma, charged microscopic dust particles are confined inside a regular electron-ion plasma. Small clusters of identical dust particles can be confined to two dimensions at the edge of the plasma sheath, and will take the overall shape of the confining potential well. For strongly-coupled systems, clusters with more than a few particles may be trapped in metastable arrangements due to potential barriers that block rearrangement. We have experimentally characterized the arrangements of clusters with \( n = 14 \) to 30 dust particles confined in a two-dimensional biharmonic potential well. Ensembles of particle arrangements are created by applying a step increase to the plasma density, which briefly melts the cluster to create a new arrangement state. For \( n = 14 \) dust particles we find a single arrangement state without interior particles. When \( n \) is increased to 15, we observe a number of different arrangement states with interior particles. Most of these states must be metastable. We suggest that particles in the interior of the cluster cannot easily move, thereby preventing rearrangement into the minimum energy state.

Effect of ion collisions on the plasma presheath

T.E. Sheridan, Ohio Northern University — We investigate solutions of a collisional Tonks-Langmuir model for a bounded plasma discharge using a particle-in-cell simulation. This is a one-dimensional model where ions are created uniformly throughout the volume and experience constant mean-free-time collisions. Results for the time-averaged potential as a function of collisionality will be presented.

Plasma sheath measurement using two dust particles

Nicholas R. Weiner, T.E. Sheridan, Ohio Northern University — Plasma is a gas of charged particles that interact through electromagnetic forces. Because of the long-range particle-particle interaction, plasma displays collective behavior such as the sheath. The plasma sheath is the boundary layer that separates plasma from a material wall. The large sheath electric field confines high-speed electrons and accelerates positive ions out of the plasma. Charged, microscopic dust particles may float near the sheath-plasma interface. As a consequence, dust particle motions can be used to characterize the sheath. A conducting rectangular confining well was placed on a negative electrode, and two dust particles were trapped in resulting plasma sheath. Natural frequencies of the oscillation modes of the two-particle clusters have been measured, allowing us to determine the ellipticity of the potential energy well parallel to the electrode, the dust particle charge, and the plasma Debye length.

9:30AM G1.00001 Magnetic Phase Diagram of a 2D XY Model with Random Easy Axis Orientation

Donald Priour, Youngstown State University — Using Monte Carlo simulations, we examine the bulk magnetic behavior of classical XY models with an inherently random anisotropy manifested as a randomly oriented easy axis for each pair of interacting spins in the 2D square lattice with magnetic interactions among nearest neighbor spins. Whereas thermally excited spin waves destroy ferromagnetic order in the isotropic XY model, any finite temperature, long-range spin alignment is effectively stabilized by XY models with collinear easy axes. We examine the extent to which ferromagnetic order is supported for the disordered counterpart with randomly oriented easy axis directions. With Binder cumulants and finite size scaling analyses, we determine the phase diagram for a variety of values of the anisotropy parameter \( \gamma \), directly related to the relative energetic favorability of alignment along the direction of preferred spin orientation. We consider the possibility of ferromagnetic order for values of \( \gamma \) in the intermediate regime, in principle strong enough to imbue spin waves with a finite energy yet weak enough to avoid a non-ferromagnetic ground state.
9:42AM G1.00002 Revisiting the RKKY interaction with a polarized electron gas

CHRISTOPHER PORTER, The Ohio State University — The RKKY interaction is a well-known itinerant interaction that can account for long-range magnetic interaction, and does not require overall polarization of the electron gas through which the interaction occurs. In fact, very few authors have considered the effects of the polarization of the electron gas. We revisit the general form of the pairwise RKKY interaction, including the possibility of a polarized electron gas. A few special cases in bulk materials are considered, in which the effect of electron gas polarization on magnetic interactions is analytically calculable. We also present preliminary results of classical Monte Carlo calculations. Such calculations are appropriate for disordered distributions of large-spin ions in a nonmagnetic lattice such as the heavy doping of Mn in GaAs diluted magnetic semiconductors.

9:54AM G1.00003 Thickness-Controlled Synthesis of Colloidal PbS Nanosheets and Their Thickness-Dependent Energy Gaps.

ZHOUFENG JIANG, KAMAL SUBEDI, GHADENDRA BHANDARI, YUFAN HE, MATTHIEW LEOPOLD, NICK REILLY, H. PETER LU, ALEXEY ZAYAK, LIANGFENG SUN, Bowling Green State University, BOWLING GREEN STATE UNIVERSITY TEAM — Ultrathin colloidal PbS nanosheets are synthesized using organometallic precursors with chloralkane cosolvents, resulting in tunable thicknesses ranging from 1.2 nm to 4.6 nm. Corresponding photoluminescence peaks are tuned from 1470 nm to 2175 nm. The one-dimensional confinement energy of these quasi-two-dimensional nanosheets is found to be proportional to 1/L instead of 1/L² (L is the thickness of the nanosheet), which is consistent with results calculated using density functional theory.

10:06AM G1.00004 Spinodal Field and Surface Free Energy of the Ising Model on the {5,4} Tiling of the Hyperbolic Plane

HOWARD L. RICHARDS, Physics Dept, Cleveland State University, LUKE BAKER, Math Dept, Cleveland State University — Consider the ferromagnetic Ising model on a two-dimensional lattice, with all the spins initially up but with a weak down magnetic field, evolving under a single-spin-flip Metropolis dynamics. If the lattice lies in the Euclidean plane — for example, if it is the square lattice — a droplet of down spins (appearing as a thermal excitation) can decrease the free energy of the system by growing if it is larger than a finite critical size. In the hyperbolic plane, however, beneath a spinodal field $H_{sp}$, it is impossible to nucleate a critical droplet. Monte Carlo simulations for finite regions of the {5,4} tiling with mean-field boundary conditions show that $H_{sp}^{3/2}$ is approximately a linear function of temperature, which should be expected at least in the neighborhood of the critical temperature. Assuming that the droplets are circular, a first estimate of the surface free energy can be made.

1This research was supported by NSF grant OCI-1005117.

10:18AM G1.00005 Approximate Solution of the Time-Independent Schrödinger Equation for the Quartic Oscillator

ULRICH ZURCHER, Physics Dept, Cleveland State University, LUKE BAKER, Physic Dept, Cleveland State University — Exact solutions to the quantum quartic oscillator are not known. We equip the set of Hamiltonian operators with a metric, thereby providing a notion of distance between these operators. This metric is a generalization of the $L^2$ metric on the space of Lebesgue measurable functions. We determine Hamiltonian operators with known solutions (to the Schrödinger equation), and then use the generalized metric to find a unique Hamiltonian with known solution that is minimal in distance to the quartic Hamiltonian. The Hamiltonian that we seek is, in fact, the Hamiltonian of the harmonic oscillator. Minimizing the distance will correspondingly suggest a harmonic frequency. The approximate solutions to the quartic oscillator will thus be the solutions of the harmonic oscillator with the suggested frequency.

10:30AM G1.00006 Estakhr Permutation Amplitude, (String Theory)

AHMAD REZA ESTAKHR, Researcher — Permutation $P(n, m) = \frac{1}{n! m! (n - m)!}$, when interpreted as a scattering amplitude, has many of the features needed to explain the physical properties of strongly interacting mesons, such as symmetry and duality. The formula is the following: $P\left(\frac{1}{3} (k_1 + k_2)^2 - 2, \frac{1}{3} (k_1 + k_2)^2 + 1\right) P\left(\frac{1}{3} (k_2 + k_3)^2 - 2, \frac{1}{3} (k_2 + k_3)^2 + 2\right)$, k^n is a vector (such as a four- vector) referring to the momentum of the n^th particle. The relationship between Euler beta function and Permutation: $B(n, m) = P(n - 1, -m) P(m - 1, -m - 1)$, Relationship between the Veneziano amplitude and Estakhr Permutation Amplitude: $B\left(\frac{1}{3} (k_1 + k_2)^2 - 1, \frac{1}{3} (k_2 + k_3)^2 - 1\right) = P\left(\frac{1}{3} (k_1 + k_2)^2 - 2, \frac{1}{3} (k_2 + k_3)^2 + 2\right) P\left(\frac{1}{3} (k_2 + k_3)^2 - 2, \frac{1}{3} (k_2 + k_3)^2 + 2\right)$ (The notion of permutation relates to act of permuting or rearranging members of a set into a particular sequence or order).

Saturday, October 25, 2014 9:30AM - 10:42AM — Session G2 Astronomy and Gravitation Advanced Technology Center 124 (Planetarium) - Tim Hamilton, Shawnee State University

9:30AM G2.00001 Short-Range Tests of the Gravity Sector in the Standard-Model Extension

RUI XU, Indiana University Bloomington, QUENTIN G. BAILEY, Embry-Riddle Aeronautical University, V. ALAN KOST-ELECKY, Indiana University Bloomington — Lorentz symmetry is an essential property of modern physics. However, some attempts to unify quantum theory and general relativity suggest tiny violations of Lorentz symmetry could appear in nature. The Standard-Model Extension is a general framework to describe Lorentz violation within our existing physics using effective field theory. It gives many interesting corrections to existing physical phenomena, including corrections to the properties of elementary particles and the fundamental forces. Many of these corrections can be tested with current high-precision experiments. This talk will discuss corrections to the Newtonian potential and their implications for experimental tests of gravity at short ranges.

9:42AM G2.00002 Statistics of Swift detected Gamma Ray Bursts

DIRK GRUPE, Morehead State University — Over the last 9 and a half years the NASA Swift Gamma-Ray Burst Explorer Mission has discovered more than 900 Gamma-Ray Bursts (GRBs). This unique data set allows for the first time a detailed statistical analysis of GRBs. In my talk I will present new relations between the prompt and the X-ray afterglow emission that will show that the prompt emission already dictates the fate of the GRB afterglow. I will also present multi-variate statistical analysis of the data set employing a Principal Component Analysis (PCA) and Cluster analysis. The PCA shows that the properties of GRBs are primarily driven by energetics. The Cluster Analysis allows to easily separate between three groups of GRBs - short and long duration GRBs and X-ray Flashes (XRFs).
9:54AM G2.00003 Spatially Resolved Spectral Analysis of Galactic Supernova Remnant W28 with the Chandra X-ray Observatory, ALEKZANDER KOSAKOWSKI, THOMAS PANNUTI, Morehead State University — We present a spatially resolved spectral analysis of the Galactic mixed-morphology supernova remnant (MM SNR) W28 (G6.4-0.1) using data collected from a pointed observation made by the Chandra X-ray Observatory (CXO). Like most MM SNRs, W28 appears to be interacting with a nearby molecular cloud, as evidenced by numerous OH masers seen along the interface between the SNR and adjacent molecular clouds. We extracted spectra from numerous regions toward the center of the SNR and fit these spectra with a two VPSHOCK component model: the VPSHOCK plasma model describes a plane-parallel shock with variable elemental abundances (specifically, the abundance of iron has allowed to be a free parameter). Consistent with previous spectral analysis we have obtained acceptable fits with the two-component model for almost all regions. The averages of the fit parameters are $NH = (0.37^{+0.06/-0.06})E^{22} \text{cm}^{-2}$, $kT_1 = 1.94^{+0.72/-0.72} \text{keV}$, $kT_2 = 0.59^{+0.03/-0.03} \text{keV}$, iron abundance (allowed to vary) = 0.52$^{+0.11/-0.11}$, ionization timescales $\text{Tau}_1 = (3.70^{+1.98/-1.98})E^{13} \text{cm}^{-3} \text{s}$, and $\text{Tau}_2 = (3.70^{+2.17/-2.17})E^{13} \text{cm}^{-3} \text{s}$. The presence of two thermal components in the X-ray emission from W28 makes this object more unique amongst MM SNRs: it indicates complex plasma conditions as the SNR interacts with adjacent molecular clouds.

10:06AM G2.00004 What Triggers Active Galaxies? (Plus, an Unexpected Find), TIMOTHY HAMILTON, Shawnee State — Active galaxies (AGN), whose central black holes are actively pulling in gas and radiating light from the core, cover a wide range of luminosities and types of host galaxies. What triggers this behavior, turning a normal galaxy active? It is often assumed that galaxy mergers are responsible for the most powerful AGN, like quasars, while the weaker examples have some other cause. This can be tested by looking at the shapes of the host galaxies to seek signs of mergers. I will show the results of our Hubble imaging campaign, as well as an unexpected (and so far unexplained) find in one field.

10:18AM G2.00005 An analysis of the gravitational waves null memory, MARIA BABIUC, Marshall University — A direct detection of gravitational waves will happen when a permanent change is induced in the detector, which is well known as a memory effect. Recently, an addition memory effect was proved possible, due to the energy of the gravitational radiation escaping to null infinity. Electromagnetic waves contribute to this memory effect, by coupling with the gravitational waves. This new type of memory was called “null memory,” because both gravitational and electromagnetic radiation travel on principal null directions (light rays), which are characteristic surfaces of Einstein and Maxwell equations. In order to understand better this type of memory and it’s significance to the direct detection of the gravitational waves, we present an analysis of the electromagnetic and gravitational radiation energy in the fully nonlinear Einstein-Maxwell theory, in a characteristic space-time described by the Bondi-Sachs metric. In this characteristic framework, we deduce expressions describing the gravitational and electromagnetic radiation polarization patterns at null infinity, as well as the nonlinear effects of the interaction between them, that could in principle be detected as a “null” memory in the Cosmic Microwave Background.

10:30AM G2.00006 The Young Solar Analogs Project, JON SAKEN, Marshall University, RICHARD GRAY, Appalachian State University, CHRISTOPHER CORBALLY, Vatican Observatory, MICHAEL BRILEY, Appalachian State University — Since 2007 we have been conducting spectroscopic monitoring, in Ca II H & K and the G-band, of a sample of 31 YSAs in order to better understand their activity cycles and variations, as well as the effects of young stars on their solar systems. The targets cover the spectral range of stars most likely to contain Earth analogs, F8-K2, and a broad enough range of ages, 0.3 Gyr - 1.5 Gyr, to investigate how activity level changes with stellar age. In 2011 we began monitoring these stars photometrically in Stromgren-v, Johnson-Cousins B, V, and R, and narrow-band H$\alpha$. To complement these efforts we recently started high-cadence, high-S/N spectroscopy of our program stars with the Vatican Advanced Technology Telescope, along with high-cadence photometry in order to detect and characterize flare activity. In this talk I will briefly describe our observational methods and present some early results from the project.

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Saturday, October 25, 2014 11:00AM - 11:36AM —
Session H1 Invited Session III University Center Ballroom - Time Hamilton, Shawnee State University

11:00AM H1.00001 TBD, IVAN HORVATH, University of Kentucky —