H 1 Rebuilding the Crystal Ball Model and Detector-Related Hardware Projects at the Mainz Microtron

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The “Tagger” and the “Crystal Ball” are the main detectors used in the A2 hall of the Mainz Microtron. They are responsible for inferring photon energy, and providing energy and timing information about scattered particles, respectively. Due to advancements in technology and natural deterioration, these detectors, as well as a model were renovated in the summer of 2017. For the Tagger upgrade, a housing unit for individual scintillator and light guide pairs was assembled and a mounting device was designed for the scintillator towers. For the Crystal Ball, broken Photomultiplier tubes were identified and replacement parts were tested. In 2016, an LED model was constructed to display the reactions in the actual Crystal Ball detector. As it had greatly deteriorated by 2017, the model was deconstructed, re-designed and rebuilt to be safer and more durable than its original version.

H 2 Optimizing the Mu2e Straw Tracker through Machine Learning

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Mu2e is an experiment designed to detect neutrinoless muon-to-electron conversion. Discovery of this conversion would provide evidence for Beyond the Standard Model (BSM) theories. The tracker of the Mu2e detector takes measurements to reconstruct the tracks and measure the momentum of particles passing through. Neutrinoless muon-to-electron conversion produces an electron of 105 MeV/c momentum, providing a clear signal to search for. Thus, excellent reconstructed momentum resolution is essential to identify particles and achieve the goal of Mu2e. This paper explores the improvement of reconstructed momentum resolution through Machine Learning (ML) techniques and input variables. This study used data simulated by Geant4 and Mu2e simulations. Boosted Decision Trees (BDT) and Artificial Neural Networks (ANN) methods were the ML algorithms used.

References


The Large Hadron Collider (LHC) is the world’s largest particle accelerator, with a maximum possible center of mass energy of 14 TeV. The ATLAS experiment is a multi-purpose detector composed of an inner detector (SCT detector and transition radiation tracker), electromagnetic calorimeter, hadronic calorimeter, and muon spectrometer. High energy proton-proton collisions release particles such as quarks and gluons, but they quickly decay into parton showers, which create particle jets that can be measured by the detector. We use monte-carlo simulation data from the collider’s 13 TeV center of mass energy run to analyze differences between quark jets and gluon jets’ charged particle multiplicity as a function of jet momentum. Further research will seek additional variables that can help distinguish the properties of quark and gluon jets in order to create a quark-gluon jet tagger.

Reference


IceCube is a detector embedded deep in ice at the South Pole that is looking for high-energy extra-Galactic neutrinos; IceTop is a muon detector on the surface above IceCube that uses 162 6.7 m$^3$ tanks of equipment and ice to flag signals in IceCube’s data as possible muons. The current method IceTop uses is impractical for the proposed expansion because each tank is shipped to the South Pole as-is and the expansion will be 100 times larger. An alternative is envisioned as a bag which can be easily folded, shipped to the South Pole, and then filled with water there. We used a PVC pipe, wavelength-shifting fibers, a silicon photomultiplier, an Arduino, parts we designed and 3D-printed, and distilled water. While this method works, efficiency was only 0.24%, so it needs to be optimized in order to be a viable replacement. It could be that the detector is only detecting muons that go directly through the fibers.
H5 CEBAF Electron Gun Upgrade

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At Jefferson Lab, electrons are accelerated to near the speed of light using the Continuous Electron Beam Accelerator Facility (CEBAF). The electron beam is generated using an electron gun with an operating voltage of 130kV in an ultra-high vacuum with an internal pressure of approximately $10^{-12}$ torr. Our objective is to construct and install an upgraded electron gun capable of running at 200kV in an ultra-high vacuum with zero field emission. We started the design of the gun by focusing on a specific geometry of the electrode to prevent high voltage cable breakdown. Using the vacuum protocols, we achieved a vacuum of $10^{-12}$ torr. During our high voltage conditioning, we saw minimal field emission around the operating voltage of 200 kV. This can be improved with further conditioning at higher voltages. With this upgraded gun, we can give the accelerator higher beam quality and extended photocathode lifetime.

H6 Data Analysis of JPARC Run to Test Current-Mode Detector for Use in NOPTREX Time Reversal Experiment

**Daniela Olivera**

Charge, Parity and Time reversal (CPT) conservation is one of the most fundamental assumptions in the Standard Model. One of the current problems in physics is the observed matter/antimatter asymmetry seen in the universe. In 1967, Sakharov proposed three conditions necessary for this asymmetry to occur, one of which is a need for processes that violate time reversal (T). The primary goal of the Neutron Optics Time Reversal Experiment (NOPTREX) Collaboration is to search for T-violation in polarized neutron transmission through a polarized nuclear target. This presentation will include an explanation of the NOPTREX experiment as well as preliminary measurements taken on indium and tantalum resonances at the NOBORU test beam at the Japan Proton Accelerator Research Complex (J-PARC) in June 2017 to test the functionality of the detector that will be used in the final experiment.

1. This work was supported by the Department of Energy under contract DE-SC0008107 and Berea College Office of Internships.

References

Schaper, Danielle: “NOPTREX: A Proposed Search for T Violation in Polarized Neutron Optics,” Qualifying Exam, University of Kentucky, Lexington, KY,
Astronomy

A 1 The Role of the Dynamic Plasmapause in Three-Belt Structure Formation and Electron Flux Enhancement

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The aim of this project was to provide a systematic study of the location and dynamics of the plasmapause compared to the MeV electrons in the outer radiation belt. We used spin-averaged electron flux data from the Relativistic Electron Proton Telescope (REPT) and density data derived from the EFW instrument on the Van Allen Probe satellites. We analyzed these data to determine the standoff distance of the location of peak electron flux of the outer belt MeV electrons from the plasmapause. We found that the location of peak flux was consistently outside but within ΔL=2.5 from the innermost location of the plasmapause at enhancement times, with an average standoff distance ΔL=1.0 +/- 0.5. This is consistent with previous observations of chorus activity. This study is significant to our understanding of how the plasmasphere under differing conditions can both shield Earth from or worsen the impacts of geomagnetic activity.

References


A 2 The Antikythera Mechanism

Amrit Dhillon, Dr. Brian Davis
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The purpose of this project is to identify and analyze the gear ratios of the Antikythera Mechanism to further understand the origins and purpose of the device. Analyzing the gear ratios will be done by creating an algorithm that
identifies the astronomical purpose of certain gear ratios, which will be done in Python.

A 3 Beta Cepheid Variable Stars: A Spectral Analysis

Sarah Hall, Lucian Undreiu
UVa-Wise

The purpose of this project was to evaluate the spectra of various Beta Cepheids with a concentration on the spectral evolution of the intriguing BW Vulpeculae. Beta Cepheids are a class of variable stars with short periods, large radial velocities, and small changes in magnitude. Studying such stars allows for determination of physical properties of the star that also can act as distance markers for other parts of the universe. An SBIG STT 8300 CCD camera, in conjunction with an LHIRES III High Resolution Spectrograph, was attached to the 16” SCT telescope of the UVa-Wise Observatory and used to record several spectral windows of some of the more accessible Beta Cephei stars according to magnitude. These stars include: ε Perseus, θ Ophiuchus, δ Cephei, γ Pegasus, and BW Vulpeculae. We primarily focused on BW Vulpeculae, which is the most interesting of the Beta Cepheids. BW Vul is of particular interest due to its large amplitude of pulsation (the fastest pulsator known) reflected in the variability in its spectrum with progression through its period. We followed the evolution through the star’s 4h 50m cycle. Multiple observation days secured enough data to assemble a picture describing the complex kinematics of the optical photosphere of BW Vul. Despite the scarcity of photometric observations available for the time frame of our project, we tried to correlate the spectroscopic line dynamics with the star’s light curve, which was done by extrapolating photometric data collected by the AAVSO. Spectral analysis of each Beta Cephei stars that were part of our study will be reported once the collected data has been reduced. With the spectral analysis data, a comparative study can be performed.

A 4 Examining Ultra Luminous Infrared Galaxies with Integral Field Spectroscopy

Eleanor Hook and David Rupke

Integral Field Spectroscopy is an astronomical technique that allows for the collection of individual spectra across a field of view. Effectively, this means that extended objects need not be treated as point sources when examined using spectroscopy. This research focuses on Ultra Luminous Infrared Galaxies (ULIRGs), a class of galaxies undergoing collisions, using data collected from the VIMOS instrument on ESO’s Very Large Telescope. These galaxies are of interest because they are common at high redshift (that is, early in the universe’s history) and are typically characterized by high star formation and black hole accretion rates. To study these galaxies, it is necessary to use a series of data reduction software to eliminate or reduce various artifacts in the data due to the atmosphere, telescope, and instrument.
This research focuses on improving and expanding upon the data reduction process used for this project.

A 5  A Comparison of Galaxy Bulge + Disk Decomposition between Pan-STARRS and SDSS

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Measurements of the size and shape of bulges in galaxies provide key constraints for models of galaxy evolution. A comprehensive catalog of bulge measurements for Sloan Digital Sky Survey (SDSS) galaxies is currently available to the public. However, the Pan-STARRS1 (PS1) 3π survey now covers the same region with higher image quality. To test how much improvement in galaxy parameter measurements (e.g. bulge + disk) can be achieved using the new PS1 data, we make use of ultra-deep imaging from Hyper Suprime-Cam (HSC) on Subaru Telescope. We fit bulge+disk models to images of 372 bright galaxies detected in all three surveys. Comparison of galaxy parameters derived from SDSS and PS1 images with those measured from HSC images shows a tighter correlation between PS1 and HSC bulge and disk results. Therefore, we plan to use the PS1 data to produce an updated catalog of bulge+disk decomposition measurements.

A 6  Cosmic Ray Telescope Design

K. Schumacher, Dr. E. Dukes and Dr. R. Ehrlich
University of Virginia

The Cosmic Ray Veto group at the University of Virginia is designing and constructing the Cosmic Ray Veto (CRV), a device which will detect incoming cosmic ray muons and use this information to reduce the background noise of the mu2e experiment. In order to ensure the success of the CRV we want to measure the cosmic ray muon flux at the experiment site to confirm previous simulations and to add to our understanding of flux at angles close to the horizon. Therefore we need a cosmic ray telescope large enough to collect a substantial amount of data in a short time, small enough to be portable for ease of transportation, and with sufficient resolution to distinguish between angles close to the horizon. Using a computer simulation and tests of possible data acquisition systems, we designed a telescope that we believe to be the most efficient and inexpensive possible.

A 7  Our Magnetic Moon

Dany Waller and Dhananjay Ravat
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Lunar swirls are optical structures on the surface of the Moon with highly divergent patterns of albedo from the surrounding regolith. They occur in both mare
and highland terrain, and are correlated with crustal magnetic anomalies. Recent research has strongly suggested the formation of lunar swirls is related to solar wind shielding via these magnetic anomalies. We are using dipole source modeling to examine this theory, as anomalies must satisfy nominal conditions to stand off solar wind through an electric field generated above the lunar surface. Our research explores a possible relationship between swirl location and complexity, and will produce a detailed global map of magnetic anomalies on the surface of the moon.

References


A 8 Searching for Flares in the MAXI Lightcurves

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Galactic X-ray transient sources such as neutron stars or black holes sometimes undergo an outburst in X-rays. Ring structures have been observed around three such sources, produced by the X-ray photons being scattered by interstellar dust grains along our line of sight. Light echoes provide a useful tool for measuring and constraining Galactic distances, mapping the dust structure of the Milky Way, and determining the dust composition in the clouds producing the echo. Using data from the Monitor of All-Sky X-ray Image (MAXI), we ran a continuous wavelet transform peak-finding algorithm in Python to look for characteristic outburst flare events. Each flare was characterized by its fluence, the integrated flux of the outburst over time. We measured the distribution of flare fluences to show how many observably bright flares were recorded by MAXI. These results provide a parent set for dust echo searches in archival X-ray data and will inform observing strategies with current and future X-ray missions such as Athena and Lynx. This work was done as part of the 2017 NSF REU program at the University of Wisconsin-Madison.

References

For a sample of collisional ring galaxies, we used archival Hubble Space Telescope images to compare individual star clusters and kpc-sized clumps of star formation to each other in a variety of ways. For each galaxy, instrument, and filter, we compared the magnitude of the brightest cluster in a clump with the magnitude of the entire clump, calculated the fraction of the flux of the clusters in a clump over the flux of the entire clump, and compared to star formation rates. In addition, we derived a cluster luminosity function for each galaxy.

How electromagnetic waves are affected by the geometry around a black hole can tell us important information about the black hole itself. By taking different variables that affect the geometry of the space around it, and how light is affected by said geometry, or the potential of the black hole, we get the frequency and damping of the wave after interacting with the black hole, shown as $\omega_r$ and $\omega_i$. We can calculate these frequencies for different values of mass and charge. Also, we can see how temperature is related to the frequencies of the electromagnetic waves. The properties of the black hole determine how it will affect the electromagnetic waves, so by understanding how each property affects them, we can see how changes in the electromagnetic waves indicate the specific properties of the black hole.

The nucleosynthesis which occurs in core-collapse supernovae (CCSN) is one of the most important sources of elements in the universe. Elements from Oxygen through Iron come predominantly from supernovae, and contributions of heavier elements are also possible through processes like the weak $r$-process, the gamma process and the light element primary process. The composition of the ejecta depends in detail on the mechanism of the explosion, thus simulations of high physical fidelity are needed to explore exactly what elements and isotopes CCSN can contribute to Galactic Chemical Evolution. We will analyze the nucleosynthesis results from self-consistent CCSN simulations performed with CHIMERA, a multi-dimension-
al neutrino radiation-hydrodynamics code. Much of our understanding of CCSN nucleosynthesis comes from parameterized models, but these fail to address essential physics, including turbulent flow/instability and neutrino-matter interaction, which are addressed by CHIMERA. We will present nucleosynthesis predictions for the explosion of a 9.6 solar mass first generation star, relying both on results of the 160 species nuclear reaction network used in CHIMERA within this model and on post-processing with a more extensive network. The lowest mass iron core-collapse supernovae, like this 9.6 solar mass model, are distinct from their more massive brethren, with their explosion mechanism and resulting nucleosynthesis being more like electron capture supernovae resulting from Oxygen-Neon white dwarves. We will highlight the differences between the nucleosynthesis in this model and more massive supernovae. The inline 160 species network is a feature unique to CHIMERA, making this the most sophisticated model to date for a star of this type. We will discuss the need and mechanism to extrapolate the post-processing to times after the end of the simulation and analyze the uncertainties this introduces for supernova nucleosynthesis. We will also compare the results from the inline 160 species network to the post-processing results to study further uncertainties introduced by post-processing. This work is supported by the U.S. Department of Energy, Office of Nuclear Physics, and the National Science Foundation Nuclear Theory Program (PHY-1516197).

A 12 Monitoring the H-αlpha Emission of Cygnus X-1 and X Perseus

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Building off the previously established H-αlpha index (Joner & Hintz 2015), we used differential photometry to study High Mass X-ray Binaries and Be stars, focusing on Cygnus X-1 and X Perseus. The H-αlpha index is used to define their level of activity, an increase or decrease in interaction, or sharing of material, between the two bodies. Data was obtained for both systems to monitor their long and short term activity. For long-term, we compared newly collected photometric data to previous spectroscopic values obtained at the Dominion Astrophysical Observatory. All data was analyzed using IRAF. Data taken using differential photometry was merged with previously collected spectroscopic data to show a seamless flow of results between techniques. We also established the H-αlpha values of 10 stars in the frame of Cygnus X-1. Further examination shows two variable star and emission object candidates.

References

Biological Physics

B 1 Structural and Functional Studies of trPHD2

P. Gallo

Prolyl-hydroxylase domain (PHD)-containing proteins are the primary oxygen sensors in the cell and have been identified as important potential targets for treatment of ischemic events. There are three known PHD isoforms that differ significantly in size and activity. Initial efforts for this project focused on PHD-3 (27.3 kDa) and the catalytic domain of PHD-2 (27.5 kDa). These two isoforms are the most active in maintaining cellular oxygen levels. The catalytic activity of trPHD2 is measured by fluorescence assay. The structural changes of these proteins are assessed using solution nuclear magnetic resonance (NMR). Because the known structure of trPHD2 shows that the catalytic center is buried, an important role for protein dynamics in enzymatic turnover has been proposed. Molecular dynamics simulations of the trPHD2 protein in various ligand-bound forms are being used to investigate the functional relevance of internal motions.

References


B 2 Collective Gradient Sensing in Fish Schools

Aawaz R. Pokhrel, Julia A. Giannini, Nicole Linard, and James G. Puckett

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Throughout the animal kingdom, animals frequently benefit from living in groups. Models for collective animal behavior show that group morphologies (swarms, flocks, and mills) found in nature can be generated via local social interactions. However, individuals also interact with their environment. In this work, we experimentally study group performance in two species of schooling fish, golden shiners (Notemigonus crysoleucas) and rummy nose tetra (Hemigrammus bleheri). Using numerical simulations, we examine how group performance depends on the relative weights of social and environmental information in determining individual locomotion. Our results highlight the importance of individuals weighing various information to promote optimal performance.

References

in Vertebrates


B 3 Design and Implementation of Microfluidic Devices by the Foil-Embossed Method for the Analytical Isolation of Yeast Cells and Sortation of Microspheres

C. Lemus, S. Rezanejad and K. McBride, PhD

Microfluidic devices are channel networks with cross-sectional dimensions beneath 1 millimeter that allow fluid flow through pressure gradients. These devices have gained scientific interest for numerous applications because researchers can tightly control the microenvironment with minimal reagent/sample. The majority of research conducted within the field of microfluidics consists of expensive and extensive methodology, thus limiting exposure to the scientific population and potential advancements within the field. Through foil-embossed methods, we were able to develop multiple designs to separate beads by physical size (53-63 μm and 10-27 μm) and isolate single-cell yeast cells for analysis. Such altered methods demonstrate laminar flow and microorganism growth at little expense using microfluidic devices.

References


B 4 Structured Illumination to Spatially Map Chromatin Motions

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We describe a simple optical method that creates structured illumination of a photoactivatable probe and apply this method to characterize chromatin motions
in the nuclei of live cells. A laser beam coupled to a diffractive optical element at the back focal plane of an excitation objective generates an array of near diffraction-limited beamlets with FWHM of 340±30 nm, which simultaneously photoactivate a 7x7 matrix pattern of GFP-labeled histones, with spots 1.70 µm apart. From the movements of the photoactivated spots, we map chromatin diffusion coefficients at multiple microdomains of the cell nucleus. The results show correlated motions of nearest chromatin microdomain neighbors, whereas chromatin movements are uncorrelated at the global scale of the nucleus. The method also reveals a DNA damage-dependent decrease in chromatin diffusion. The DOE instrumentation can be easily and cheaply implemented on commercial inverted fluorescence microscopes to analyze adherent cell culture models. A protocol to measure chromatin motions in non-adherent human hematopoietic stem and progenitor cells is also described. We anticipate that the method will contribute to the identification of the mechanisms regulating chromatin mobility, which influences most genomic processes and may underlie the biogenesis of genomic translocations associated with hematologic malignancies.

B 5 Backscatter Signal Decay Analysis of Micro-Structural Integrity of Cancellous Bone

Brent K. Hoffmeister, Phoebe C. Sharp, Jordan P. Ankersen, Joseph A. McPherson and Ann M. Viano

Background: Ultrasonic backscatter techniques are being developed to detect changes in bone caused by osteoporosis. Most techniques analyze backscatter signals in the frequency domain by measuring quantities related to the power spectrum. Goal: Investigate the correlation between the backscatter amplitude decay constant (BADC) and microstructure of specimen (μ CT). Methods: A 3.5 MHz transducer was used to acquire backscatter signals from 54 cube-shaped specimens of bone prepared from the proximal end of 14 human femurs. BADC was determined by measuring the exponential decay in the amplitude of a backscatter signal. Results: BADC demonstrated highly significant (p < 0.001) linear correlations with micro-structural integrity density. Conclusions: Parameters based on a time domain analysis of backscatter signals from bone may be sensitive to changes in the microstructure of bone caused by osteoporosis. Funding: NIH/NIAMS R15AR066900.

B 6 Mathematical Modeling of a Stochastic Genetic Switch in Heat Shock Response

E. Wu

Gene networks involve interactions between molecules that are nonlinear and stochastic. In order to understand and predict the behavior of such complex biological networks, quantitative models are needed. We developed a stochastic mathematical model to describe heat shock response, a phenomenon where cells exposed to too high (and thus damaging) temperatures upregulate the expression of
certain repair proteins. We used the chemical Master Equation and analytical methods to arrive at time dependent equations for the means and variances of the model variables, and compared these solutions with computer simulated data. Both predict that a stochastic switch, acting as a heat stress sensor, can lead to three distinct outcomes with respect to the response duration, intensity and variability, which has important biological consequences.

**Materials/Condensed Matter/Energy**

**M+E 1 Electrospun Membranes; Properties and Parameters vs. Liquid Entry Pressure**

**Dea Santi Alqurwani, James T. McLeskey, Jr**

*Randolph-Macon College, Schapiro Undergraduate Research Fellowship (SURF) 2017*

Electrospinning is a method of creating fibers using electrostatic forces. A high voltage is applied between a syringe and a grounded electrode (a collector drum). The charge difference draws a polymer solution out of the syringe, forming a stream. The solvent evaporates as the stream moves to the collector drum, forming a fiber that later creates a hydrophobic membrane. The pore diameter and fiber size of the resulting membranes are functions of the electrospinning parameters.

The critical pressure or Liquid Entry Pressure (LEP) was correlated against pore size and fiber diameter. Membranes were placed in the LEP testing device with water inside and pressure (nitrogen gas or hydrostatic pressure) was applied until a water droplet leaked through the membrane. Determining the relation between the electrospinning parameters, the physical properties, and the critical pressure of the membranes can help optimize the Direct Contact Membrane Desalination (DCMD) process.

**M+E 2 Investigation of Energy Transfer in Photon Harvesting Pendant Assemblies within Solvents of Differing Viscosities using Coarse-Grained Modeling**

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The study of energy transfer within photon harvesting assemblies is essential to building more efficient photovoltaics. Polyfluorene (PF) – RuOs is a photon harvesting pendant assembly with an exceptionally high energy transfer efficiency given its low packing density. Through this study, the impact of the polymer backbone’s flexibility on energy transfer is studied to determine why the assembly attains such a high efficiency. Using coarse-grained modeling in Materials Studio, PF-RuOs is modeled in three solvents of varying viscosities: acetonitrile, dimethylacetamide, and benzenesulfonamide. The position of the assembly’s pendants, where energy
transfer occurs, is recorded over a 200ns trajectory and used to generate kinetics for each model. These kinetics will be investigated to determine how the energy transfer rate and efficiency compare among solvents, which will aid in generating a better understanding of energy transfer within the assembly.

References


M+E 3 Tunable CdS Quantum Dots Synthesized by Microemulsion Method

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CdS quantum dots have been prepared at ambient temperature via reverse micelle methods. Tunable quantum dots of various sizes were synthesized by AOT/hexanol and CTAB/hexanol microemulsions using varied molar ratios of water to surfactant. The nanoparticles have been characterized using UV-Vis, fluorescence spectroscopy, and DLS techniques. Comparisons between the size and quality of QDs synthesized are correlated with surfactant film rigidity and intermicellar exchange rates of the different surfactant systems.1

Reference


M+E 4 Explosives Detection via Halogen Bonding Interactions

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The development of gas-phase sensors for the detection of explosives remains a critical challenge in improving homeland safety. Our work explores the development of a molecular detection device that targets non-aromatic explosives such as HMX, RDX, and PETN through the use of halogen bonding. Based on the non-covalent interaction between regions of positive and negative electrostatic potential, halogen bonding is highly directional and influenced by the electron-withdrawing properties of surrounding electronegative groups. We determined ideal “selector” molecules with halogen bonding abilities using computational methods and incorporated these into carbon nanotube (CNT) networks deposited onto an interdigitated array of electrodes (IDA) to construct our sensor. Electronic conductivity measurements were made upon exposure to gas-phase analytes and explosive mimics.
M+E 5 Sub-Angstrom Resolution X-Ray Imaging of Correlated Disorder in Crystals

Victoria Kovalchuk, Jacob Ruff, and Joosep Lee

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We implemented a new method, called 3D ∆-PDF for analyzing X-ray diffraction data, and modeled some two-dimensional systems to evaluate the strengths and weaknesses of this method in describing different systems with correlated disorder. We found that our current implementation of the code would require for very large reciprocal spaces in order to give accurate and interesting information about a system. Such sizes of a reciprocal space are not common or easy to attain using current X-ray diffraction methods, and this poses a problem when trying to apply this method to real data sets.

Reference


M+E 6 Frustrated Breathing Pyrochlores: Tuning the Underlying Interactions

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Frustrated quantum magnets are systems in which the exchange interactions governing the interacting spins cannot be simultaneously satisfied, leading to a highly degenerate ground state and new states of matter. In particular, geometrically frustrated systems exhibit competitions between neighboring spin interactions due to the geometry of the lattice, and have been of high interest for their potential applications in spin based electronics (spintronics). Recently a new class of geometrically frustrated magnets has been discovered, namely the Breathing Pyrochlore (BP) family. Here, we present the successful growth and characterization of high quality single crystals of BP compound Ba₃Yb₂Zn₅O₁₁ (BYZO) for the first time, as well as the x-ray and neutron scattering data collected. Furthermore, the effect of applying external magnetic field on the underlying spin interactions in BYZO is discussed, revealing the exotic physics in BP systems.

References

M+E 7  Properties of Thin Cylinder Surface Corrugations During Buckling

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The ability to manipulate surface elastic instabilities finds many applications in engineering smart interfaces, e.g. in fluid-structure interaction and micro-fabrication. We study the buckling phenomena of a thin cylindrical shell under axial compression that is constrained to slide onto an inner non-deformable pipe. There are multiple variables that affect how the surface patterns form, and we are specifically exploring the relationship between the force needed to induce buckling, the sound created during the buckling process, and the actual pattern formed. Surface buckling is induced by immobilizing one end of our cylindrical apparatus and applying a known amount of force to the other end. We have found that there is a direct relationship between altering the thickness of the thin shell and the applied force needed to induce corrugations. Future work will focus on observation and analysis of the dynamics of pattern formation on non-cylindrical shells and investigation of the hydrodynamic properties of corrugated surfaces.

M+E 8  Optical Properties of Mn$_3$O$_4$ Thin Film Metal Oxides

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Thin film metal oxides (MOs) present a variety of applications including: displays, photovoltaics, and sensors. The combination of a wide bandgap, mechanical flexibility, optical transparency, and high carrier mobility are unique properties of these materials. In this work, we propose to optically characterize Mn$_3$O$_4$ thin films through ellipsometry in the near-IR range of the electromagnetic spectrum. Ellipsometry is a method to measure material properties through light-matter interaction. By measuring the difference in light polarization from the incident and the reflected light we obtain $\Psi$ and $\Delta$, where $\Psi$ is related to the amplitude and $\Delta$ to the phase shift of the electromagnetic wave. From these two parameters, we acquire the refractive index of the material, $N = n + ik$. Therefore, we could better evaluate if the material under investigation would be a good candidate for applications in telecommunication, sensing, or detection.
APS Conferences for Undergraduate Women in Physics (CUWiP) are regional conferences for physics majors. January 12-14, 2018, the University of Virginia will be one of twelve universities hosting regional CUWiP conferences.

The goal of CUWiP is to help undergraduate women continue in physics by providing them with the opportunity to experience a professional conference, information about graduate school and professions in physics, and access to other women in physics of all ages with whom they can share experiences, advice, and ideas.