SCIENTIFIC PASSION & PROGRESS
Meeting the Challenge
2018 CONFERENCE OF THE NATIONAL SOCIETY OF BLACK PHYSICISTS

NOVEMBER 4-7, 2018
Renaissance Columbus Downtown Hotel
Columbus, Ohio

# SCIENTIFIC SESSIONS AND WORKSHOPS

## SUNDAY, NOVEMBER 4

***MEETING ROOM: 33***
**SESSION TIME: 5:00pm – 7:00pm**
**NRAO – DATA INTENSIVE RESEARCH & EDUCATION - PARTNERSHIP OPPORTUNITIES**

**SESSION DESCRIPTION**
The VLASS Radio Astronomy Data Imaging & Analysis Lab (RADIAL) project is an early-state proposal that envisions a project composed of four “pillars,” or supporting programs, that, working together (at one or more institutions), will bring innovative data-intensive research and education opportunities to partner institutions. RADIAL is designed to enhance existing astronomy, physics, engineering, and computing programs, while simultaneously addressing a set of critical national needs: (a) a skilled data management and analysis workforce, and (b) a data center large enough, and sophisticated enough, to manage the many petabytes of astronomical data from the Very Large Array Sky Survey (VLASS) and other emerging massive astronomy datasets. The National Radio Astronomy Observatory (NRAO) is interested in meeting with potential institutional partners, along with interested researchers and faculty, to explore partnership opportunities. This session will introduce the overall concept of the RADIAL project and identify potential partners in the HBCU community. We plan to convene a meeting for potential interested institutions in December or early in 2019.

## MONDAY, NOVEMBER 5
**SESSION TIME: 8:00am – 8:30am**

**ONE-MINUTE POSTER REVIEW**
*Each morning from 8-8:30am there will be a 'Poster POP' session divided by topic area, where you can give a 1-minute elevator pitch for your poster. This is your opportunity to sell your audience on why they should review your work during the formal poster review sessions.*

| MEETING RM 21 | MEETING RM 22 | MEETING RM 30 | MEETING RM 31 | MEETING RM 32 | MEETING RM 33 |
|---|---|---|---|---|---|
| 1-MIN POSTER (CM) | 1-MIN POSTER (NPP) | 1-MIN POSTER (ASTRO) | 1-MIN POSTER (POP/AMO) | 1-MIN POSTER (MED/CBP) | 1-MIN POSTER (PER/EPSS) |

## MONDAY, NOVEMBER 5

### *MEETING ROOM 21*

**SESSION TIME: 11:30am – 12:00noon**

**EARTH AND PLANETARY SYSTEM SCIENCE (EPSS) – 1.A**

***11:30am - 12:00noon***

**AN IMPORTANT ROLE FOR PHYSICS IN CLIMATE AND AIR QUALITY RESEARCH**

*Belay Demoz, University of Maryland Baltimore*

**ABSTRACT**

Climate and air quality are among the primary environmental issues that will shape humanities future wellbeing. APS states that climate is a critical issue with significant risk to environment, economic, and social disruption not only here in the US but around the globe. The connection between the rising concentration of gases/pollutants and increasing warming is key, for APS, and urges sustained research in these areas. In 2015, after a heated debate of climate "skeptics" and advocates – it reiterated its commitment to climate research and the IPCC. This is contrary to some prominent Physicists belief that "a little extra carbon dioxide – might turn out to be good for the planet" – NYT-Magazine (03/25/2009). In my talk, I will echo the APS statement that physics and its techniques are fundamental elements to climate and air quality science. I will demonstrate and relate this with my preparation and current research work in climate and air quality. I will also comment on why physics graduate programs could use atmospheric research as a means to re-invigorate their programs.

**SESSION TIME: 2:00pm – 3:00pm**

**EARTH AND PLANETARY SYSTEM SCIENCE (EPSS) – 1.B**

***2:00pm - 2:30pm***

**HEAT PIPE PLANETS – PHYSICS REVEALS A NEW ERA IN EARTH'S HISTORY**

*William Moore, Hampton University*

**ABSTRACT**

Early in its history, the Earth's mantle experienced far greater internal heating due to radioactive decay, tidal heating, and loss of accretional heat. While there has been considerable debate on the viability of plate tectonics over Earth's history, little attention has been paid to the role of volcanic heat transport. A wide range of geological evidence shows that the Earth experienced a phase in which volcanism dominated heat transport for roughly a billion years prior to the initiation of plate tectonics. Diverse studies show that, prior to about 3.2 Ga, Earth's crust consisted of very thick (10s of km) and stable (spanning hundreds of Myr) sequences of volcanic rocks. These observations match the predictions for a planet in the heat-pipe mode, in which near-global volcanism results in a downgoing crustal conveyor belt moving cold surface materials to great depth producing a cold and thick lithosphere that does not participate in the flow of the mantle. Although there are plate tectonic explanations for these observations, distinctive plate tectonic features with high preservation potential such as paired metamorphic belts and passive margins are absent from the geologic record. Numerical models of heat transport in the Earth's mantle including volcanism reveal that volcanic heat pipes reduce stress in the lithosphere by removing buoyancy from the mantle, but as internal heating wanes, stresses increase leading naturally to a plate-tectonic regime. Heat-pipe Earth provides a coherent dynamic framework for the understanding of planetary evolution from initial crystallization of the lithosphere atop the magma ocean to the onset of plate tectonics.

***2:30pm - 2:45pm***

**ICE–DRIVEN VOLCANIC ERUPTIONS AND HABITABILITY ON MARS**

*Alex Evans, Brown University*

**ABSTRACT**

Water – an essential requirement for known life – was once abundant on Mars. Yet despite the substantial evidence for the existence of surface water, early Mars may have been too cold for liquid water to have been continuously stable across most of the Martian surface. However, continuously habitable environments on Mars may have existed for much of its history resulting from the interplay of long-lived magmatism and ice (glaciers) deposited at the peaks of Martian volcanoes. We use a finite-element model to explore how ice deposited within the caldera of the largest volcano within the Solar System, Olympus Mons at Mars, likely served as a mechanism to systematically replenish water within the Martian near-surface environment, enabling previous periods of long-term habitability. We consider a viscoelastic lithosphere that extends 900 km from the center of Olympus Mons. We load the lithosphere with the radially-averaged topographic profile of Olympus Mons and include a 1270-K pressurized spherical magma chamber beneath Olympus Mons that is initially at equilibrium with the average pressure of the surrounding lithosphere. By varying the magma chamber depths and radii within expected ranges, we find that the ice deposited within Martian calderas likely resulted in the melting of ice, generating significant volumes of water (up to 1.5✕10^12 km^3 within a 120-kyr interval). Additionally, we find that ice deposition within volcanic calderas would have likely affected the eruptibility of magma, possibly modulating the timing of volcanic activity. Such modulations could explain the periodic bedding observed within volcanic deposits at the Martian surface.

***2:45pm - 3:00pm***

**GROUND PENETRATING RADAR AND 2D ELECTRICAL RESISTIVITY MODELING ANALYSIS OF THE LOTSANE DAM, BOTSWANA**

*Julian Gordon, North Carolina A&T State University*

**ABSTRACT**

Lotsane Dam built in 2012 was created off the Lostane River in the Tswapong area of Botswana. In this study, Ground Penetrating RADAR (GPR) and Electrical Resistivity Imaging (ERI) measurements were conducted to determine the underground materials across the length of the dam at different depths. The ERI method was only used over 470 meters of the dam, while the GPR went across the total length of the dam. These types of measurements can be used to determine different aspects of the subsurface. Factors that can affect resistivity are clay content, water/porous, dissolved salts, temperature, material, and density. ERI and GPR models could show us a small glimpse of what was happening underneath the surface of the dam. Additional Comments:

We acknowledge the support by a grant from the National Science Foundation NSF-OISE-IRES # 1559308 to travel to Botswana in the summer of 2018.

**SESSION TIME: 4:00pm – 6:00pm**

**EARTH AND PLANETARY SYSTEM SCIENCE (EPSS) – 1.C**

***4:00pm – 4:25pm***

**SMALL NEXT-GENERATION ATMOSPHERIC PROBE (SNAP): A NASA MISSION CONCEPT STUDY**

*Kunio M. Sayanagi, Hampton University*

**ABSTRACT**

I present the latest design of the Small Next-generation Atmospheric Probe (SNAP), which is a future atmospheric probe to conduct in-situ measurements of Saturn, Uranus and Neptune. I was selected by NASA to lead the design of the probe, which could be added to a future NASA mission to Uranus to be launched in the 2030s, and orbit Uranus in the 2040s. If realized, the SNAP probe would be carried from Earth to Uranus onboard the Uranus Orbiter. Upon arriving Uranus, SNAP would be released from the orbiter and enter the atmosphere, where the probe would descend under a parachute down to the target depth of at least 5-bar pressure level.

The scientific measurements to be performed by SNAP will reveal the thermal stratification, wind speed, and atmospheric composition at the probe descent site. The thermal stratification will be measured using temperature and pressure sensors in combination with the accelerometer; the accelerometer senses the atmospheric turbulence as well as changes in the atmospheric density. The background wind speeds are measured using the Doppler shift in the radio signal to be transmitted by the descent probe. The atmospheric compositions are measured using a sensor that incorporates an innovative carbon-nanotube technology.

As the Principle Investigator, I am responsible for the overall project management including the design of the scientific measurements, choosing orbital trajectories, and engineering design of the descent probe. As a conclusion, I will discuss how my training, including a Ph.D. in physics, helped me prepare for the role.

## *CONTRIBUTED TALKS*

***4:25pm -4:40pm***

**AN OVERVIEW OF WINTERTIME SO2 OXIDATION FROM POWER STATIONS AND URBAN SOURCES EMISSIONS OVER THE EASTERN UNITED STATES**

*Jaime Green, North Carolina A&T State University*

**ABSTRACT**

The oxidation and transport of atmospheric sulfur emissions from coal-burning power plants and urban sources during wintertime conditions over the Eastern United States is presented. SO2 emissions from power stations have been shown to affect human and plant health through the deposition of acidic aerosols, acid rain and gaseous exposure. In wintertime conditions in the Eastern United States there are fewer reactant sinks for gaseous SO2. The Wintertime INvestigation of Transport, Emission and Reactivity (WINTER - 2015) campaign estimated the factors that influence the wintertime removal and oxidation based on observational data of atmospheric SO2. Data was obtained from a series of survey night and day flights on a C-130 aircraft that occurred from Feb 3 to Mar 13, 2015 over the Eastern United States Atmospheric lifetimes of SO2 ranged 8.5 – 27 days, using the range of mean oxidation rates during the day and 10.5 hours of daylight. Correlations to the SO42- measured in the region allowed for numerical estimates of the oxidized sulfur compounds due to transported $SO_2$, and evidence of direct power station emissions of compounds containing $SO_4^{2-}$.

***4:40pm -4:55pm***

**DEVELOPING AND NON-DEVELOPING AFRICAN EASTERLY WAVES AND THE LARGE-SCALE ENVIRONMENT OVER THE TROPICAL ATLANTIC**

*Bantwale Enyew, North Carolina A&T State University*

**ABSTRACT**

Many previous studies show that African easterly waves (AEWs) serve as seeding for Atlantic tropical cyclones (TCs). About 50 -60 % of all TCs and about 85% of major hurricanes have originated from African Easterly waves. On average, about 50-60 AEWs per year develop and cross the western coast of the continent. While AEWs are important precursors for TC-genesis, the great majority of AEWs that develop over Africa and crosses the continent do not develop into TCs. Examining the environmental conditions under which AEWs can develop into tropical TC and decays can help improve predictability of tropical cyclogenesis. Our analysis is based on the European Centre for Medium-Range Weather Forecasts Interim analysis dataset for the period between 1984 and 2009. The Hurricane Best Track datasets report were used to identify tropical cyclones that are their origins from AEWs. We employed objective tracking algorithm to track and identify African easterly waves that are associated with TCs and that are not. Composite analysis of large-scale environmental variables were used to study structure of AEWs. Preliminary analysis shows, about 27 % of AEWs that cross Africa coast between July and October have developed into tropical cyclones. The composite analysis shows that, the developing AEWs are characterized by high moisture anomaly over West Africa coast and eastern Atlantic, while non-developing AEWs have characterized by negative moisture anomaly over eastern Atlantic close to the coast of West Africa.

***4:55pm - 5:10pm***

**PHOTOMETRY OF GIANT PROPELLERS IN SATURN'S RINGS FROM CLOSE-RANGE CASSINI IMAGES**

*Jakayla Robinson, University of Alabama Birmingham*

**ABSTRACT**

"Propellers" are eponymously-shaped disturbances in Saturn's rings centered on embedded moons (see [1] and references therein). In particular, a handful of "giant propellers," created by km-size embedded moons [2], have predominantly keplerian orbits that have been shown to contain clear but enigmatic patterns of change as they have been tracked for over 10 years by frequent Cassini images [1]. During its Ring Grazing Orbits (RGO) and Grand Finale (GF), the Cassini spacecraft passed very close to the outer and inner edges (respectively) of Saturn's main rings. During these maneuvers, the Cassini ISS camera executed a series of very high-resolution images of the main rings [3]. Among other priority science targets, several giant propellers were imaged at resolutions better than 0.4 km/pixel and high S/N. The propeller "Santos-Dumont" was imaged in this way during a single Cassini pass on both the lit and unlit sides of the rings (see images at https://photojournal.jpl.nasa.gov/catalog/PIA21433), revealing detailed structure of the propeller-disturbance in two very different photometric regimes [3]. The photometry of

propellers has previously been found difficult to interpret [4,5]. We use the lit/unlit pair of Santos-Dumont images as a "Rosetta Stone" to determine how the propeller's photometry follows or deviates from classic Chandrasekhar theory. We will present details and will discuss the implications.

## MONDAY, NOVEMBER 5
## *MEETING ROOM HAYES ABC*

### SESSION TIME: 4:00pm – 6:00pm
### COSOMOLOGY, GRAVITATION AND RELATIVITY

***4:00pm – 4:20pm***

**FROM 2D GRAVITY TO 4D DARK MATTER AND ENERGY**

*Jahmour Givens, Ohio State University*

**ABSTRACT**

In 2D, Einstein's theory of general relativity becomes trivial. Yet when one studies the symmetries of 2D, new features arise from the gravitational anomaly. We show that this 2D structure has meaning in higher dimensions through projective geometry. By using the Thomas-Whitehead connection and the projective Gauss-Bonnet Theory we are able to describe a theory for gravitating matter that might be the essence of dark energy and dark matter in 4D.

***4:20pm – 4:40pm***

**PHENOTYPIC REDSHIFTS: A NOVEL TECHNIQUE FOR ESTIMATING GALAXY PHOTOMETRIC REDSHIFTS**

*Justin Myles, Stanford University*

**ABSTRACT**

Understanding how the large-scale structure of the Universe has evolved over time is an essential probe for constraining cosmological models. Mapping galaxies in space for this purpose relies primarily on two observational strategies: wide-field imaging surveys that yield 2-D maps of the sky and corresponding spectroscopic surveys that measure galaxy redshifts. Measuring redshifts from spectroscopy of all galaxies observed by wide-field imaging surveys is infeasible, thus motivating the development of techniques for estimating galaxy redshifts from their broadband photometry. In this work we use the newly developed phenotypic redshift (pheno-z) calibration method to assign galaxies in the weak lensing source catalog from the Year 3 data of the Dark Energy Survey to four tomographic bins. The method leverages the 'deep-drilling' supernova observing fields that have additional flux filters to act as an intermediary between securely known redshifts and wide field fluxes. By assigning galaxies in this field to distinct phenotypes based on their wide and deep field fluxes, we break degeneracies in the wide-field color to redshift relation, achieving ~60% improvement over the Year 1 analysis. As the first application of this method to data, we validate that the assumptions made during the development of the pheno-z method apply to the Y3 weak lensing source galaxies. This work uses the COSMOS 2015 catalog and corresponding DES deep field fluxes as its secure redshift and deep samples and the DES Y3 weak lensing catalog as the wide-field sample.

***4:40pm – 5:00pm***

*Annika Peter, The Ohio State University*

***5:00pm – 5:20pm***

**IMPROVING LIGO SENSITIVITY TO ECCENTRIC SEARCHES**

*Amber Lenon, West Virginia University*

**ABSTRACT**

The gravitational waves from binary systems on eccentric orbits do not have the same form as gravitational waves from the Laser Interferometer Gravitational Wave Observatory's (LIGO) previous detections. Past detections have a steadily increasing amplitude and frequency while eccentric systems do not. This makes generating accurate models difficult as the systems are more sensitive to minute changes. We describe our work to develop an approach for the detection of eccentric binaries that searches for the eccentric signal in the data using a waveform model. We

compare two available eccentric waveform models to determine if there is a systematic discrepancy as you increase the eccentricity. Understanding the differences will allow us to integrate these waveforms into the standard LIGO analysis in order to increase sensitivity to these sources.

*5:20pm – 6:00pm*

**MAKING A UNIVERSITY WITH AXIONS**

*Chanda Prescod-Weinstein, University of Washington & University of New Hampshire*

**ABSTRACT**

The discovery of the Higgs boson reinforces the possibility that other similar, scalar particles may exist in nature. In this talk, I will begin by discussing one such dark matter and sometime inflaton candidate, the axion. I will describe the claim that dark matter axions form an exotic state of matter called a Bose-Einstein condensate and my work on this exciting prospect, including connections with pending X-ray space telescopes.

## MONDAY, NOVEMBER 5

*MEETING ROOM 22*

**SESSION TIME: 11:30am – 12:00noon**

**CONDENSED MATTER AND MATERIALS PHYSICS (CMMP) – 1.A**

*11:30am - 12:00noon*

**TRENDS IN CMMP THEORY**

*Trevor Rhone, Harvard University*

**ABSTRACT**

What does a condensed matter theorist do? What topics and techniques are relevant to this area? This talk will give a basic overview of topics, techniques, and trends in current condensed matter theory research.

**SESSION TIME: 2:00pm – 3:00pm**

**CONDENSED MATTER AND MATERIALS PHYSICS (CMMP) – 1.B**

*2:00pm - 2:24pm*

**MATERIALS INFORMATICS STUDY OF TWO-DIMENSIONAL MAGNETIC MATERIALS**

*Trevor Rhone, Harvard University*

**ABSTRACT**

When the dimensionality of an electron system is reduced from three-dimensions to two-dimensions, new behavior emerges. This has been demonstrated in gallium arsenide quantum Hall systems since the 1980's, and more recently in van der Waals (vdW) materials, such as graphene. This talk will discuss the behavior of electrons in reduced dimensions with a focus on their spin properties. We highlight our recent study of vdW materials with intrinsic magnetic order. These materials are at the forefront of condensed matter physics research. We use a materials informatics (machine learning applied to materials research) approach to study the magnetic and thermodynamic properties of vdW materials. Crystal structures based on monolayer Cr2Ge2Te6, of the form A2B2X6, are studied using density functional theory (DFT) calculations and machine learning methods. Magnetic properties, such as the magnetic moment are determined. The formation energies are also calculated and used to estimate the chemical stability. We show that machine learning methods, combined with DFT, can provide a computationally efficient means to predict properties of two-dimensional (2D) magnetic systems. In addition, data analytics provides novel insights into the microscopic origins of magnetic ordering in two dimensions. Analysis of DFT data highlights that the X site strongly affects the magnetic coupling between neighboring A sites - driving magnetic ordering. This novel approach to materials research paves the way for the rapid discovery of magnetic vdW materials that are chemically stable.

***2:24pm - 2:42pm***

**2D TOPOLOGICAL PHOTONIC CRYSTAL BAND STRUCTURES**

*Dewan Woods, Purdue University*

**ABSTRACT**

The understanding of the nature of light and matter interactions at the interface of novel, exotic materials such as Metamaterials (MMs), Topological Insulators (TIs), and photonic crystals are essential for the continued growth of condensed matter physics and quantum photonics. Much research effort is being made to engineer and have the ability to tune the optical parameters of such materials, which in turn will tailor their electromagnetic response and thus allow for a better understanding of the photon, giving rise to interesting optical phenomena in the process. In this theory-based talk, 2D photonic bandstructure-engineering will be emphasized. Topological effects in these materials will also be discussed.

***2:42pm – 3:00pm***

**NOVEL QUANTUM MATERIALS BEYOND GRAPHENE: GERMANENE NANOFLAKES**

*Steven Richardson, Howard University and MIT*

**ABSTRACT**

An example of one such new quantum material is germanene, which is the germanium analog of graphene. Germanene is an atomically thin two-dimensional quantum material which theory predicts will possess unique transport and optoelectronic properties because of its band gap. Unlike graphene, which is a semi-metal with a planar honeycomb structure, germanene is a semiconductor with a buckled two-dimensional geometry because of pseudo Jahn-Teller distortions. Recently, there have been many experimental efforts to successfully grow two-dimensional films of germanene on noble metal substrates using molecular beam epitaxy (MBE). In addition to this top-down approach of using MBE to synthesize large scale films of germanene, it is important to pursue a bottom-up approach in which germanene nanoflakes could be used as molecular seeds or precursors in chemical vapor-phase experiments to grow large films of two-dimensional germanene.

**SESSION TIME: 4:00pm – 6:00pm**

**CONDENSED MATTER AND MATERIALS PHYSICS (CMMP) – 1.C**

***4:00pm – 4:24pm***

**A STUDY OF THE ENERGY CAPACITY OF LITHIUM IRON PHOSPHATE BATTERIES VERSUS THE ADDITION OF VARIED WEIGHT PERCENTAGES OF GRAPHENE OXIDE**

*Sharah Yasharahla, Howard University*

**ABSTRACT**

Research has shown that adding graphene(G) to Lithium Iron Phosphate(LFP) batteries can improve performance. This improvement has been demonstrated with LFP/G composites delivering an initial discharge capacity of 160mAhg-1 at 0.2C, which is comparable to pristine LFP capacity of 170 mAhg-1. Our research is focused on exploring the addition of low weight percentages (0.25 - 5wt%) of graphene to LFP cathodes. Initial results show slightly larger specific capacity in batteries where 2wt% of graphene is added to LFP cathode material. In contrast, batteries with 0.25 wt% and 0.5 wt% of graphene added to the LFP cathode material had similar specific capacities in comparison with batteries made with pristine cathode material. Currently, our experimental investigations are focused on LFP battery specific capacity versus the addition of low wt% of graphene oxide within the range of 2 - 5wt%.

***4:24pm – 4:36pm***

**LIFEPO4/CARBON NANOFIBER COMPOSITE CATHODES FOR HIGH-RATE LI-ION BATTERIES**

*Adewale Adepoju, Howard University*

**ABSTRACT**

Olivine lithium iron phosphate (LiFePO4) is a promising cathode material for high power application such as in hybrid electric vehicle (HEV) and plug-in hybrid electric vehicle (PHEV). However, LiFePO4 is faced with the problem of low electrical conductivity and sluggish Li+ diffusion dynamics. Therefore, in this work, carbon

nanofibers (CNFs) was used as conductive additives to the $LiFePO_4$ cathode due to its excellent electronic conductivity (via reactive its inner and outer surface structure), mechanical stability, and high aspect ratio. A mixing of different percentages of CNFs on the composite cathode was investigated to enhance the overall performance of $LiFePO_4$. Electrochemical properties were evaluated by charge/discharge profile, rate performance, and cycling stability. Practically, the composite cathode $LiFePO_4$/5%CNFs exhibited an excellent rate performance at high charging rates and a modest improvement in cycling stability.

*4:36pm - 4:48pm*

**ROOM TEMPERATURE INTRINSIC FERROMAGNETISM IN EPITAXIAL MANGANESE SELENIDE FILMS IN THE MONOLAYER LIMIT**

*Dante O'Hara, University of California Riverside*

**ABSTRACT**

Monolayer van der Waals (vdW) magnets provide an exciting opportunity for exploring two-dimensional (2D) magnetism for scientific and technological advances, but the intrinsic ferromagnetism has only been observed at low temperatures. Here, we report the observation of room temperature ferromagnetism in manganese selenide ($MnSe_x$) films grown by molecular beam epitaxy (MBE). Magnetic and structural characterization provides strong evidence that, in the monolayer limit, the ferromagnetism originates from a vdW manganese diselenide ($MnSe_2$) monolayer, while for thicker films it could originate from a combination of vdW $MnSe_2$ and/or interfacial magnetism of α-MnSe(111). Magnetization measurements of monolayer $MnSe_x$ films on GaSe and $SnSe_2$ epilayers show ferromagnetic ordering with a large saturation magnetization of ∼4 Bohr magnetons per Mn, which is consistent with the density functional theory calculations predicting ferromagnetism in monolayer 1T-$MnSe_2$. Growing $MnSe_x$ films on GaSe up to a high thickness (∼40 nm) produces α-MnSe(111) and an enhanced magnetic moment (∼2×) compared to the monolayer $MnSe_x$ samples. Detailed structural characterization by scanning transmission electron microscopy (STEM), scanning tunneling microscopy (STM), and reflection high energy electron diffraction (RHEED) reveals an abrupt and clean interface between GaSe(0001) and α-MnSe(111). In particular, the structure measured by STEM is consistent with the presence of a $MnSe_2$ monolayer at the interface. These results hold promise for potential applications in energy efficient information storage and processing.

*4:48pm - 5:00pm*

**THE MAGNETIC PERFORMANCE OF FEPT/FE2O3 AND FEPT/CU AFTER HEAT TREATMENT**

*Deidre Henderson, Grambling State University*

**ABSTRACT**

The magnetic performance of FePt/$Fe_2O_3$ and FePt/Cu following heat treatment was studied to determine the parameters for phase transformation which is required for high magnetic storage media. A self-assembled layer of FePt nanoparticles was placed between two layers of $Fe_2O_3$ nanoparticles using surfactants on Si and Cu substrates to minimize aggregation during heat treatment. Following, a sample was made, eliminating the surfactants, by simply mixing FePt and Cu nanoparticles in hexane. The samples were deposited on a Cu substrate and annealed using a vacuum furnace at 600°C (1 hour) or heated by laser at 20-80 W at a speed of 1-1.5 m/s. The coercivity of FePt/$Fe_2O_3$ layered samples increased from 148 Oe to 366 Oe and 246 Oe for furnace annealed samples on Si and Cu substrates, respectively. However, it remained almost unchanged in laser heat treated samples on Cu-substrate. The magnetization is slightly higher for samples which were treated by laser at 40 W than 20 W, on Si-substrate. The FePt/Cu nanoparticles mixed layer on Cu-substrate was subjected to laser heat treatment at 40 and 80 W. The coercivity at both laser powers did not show any significant change. The results indicate that the furnace annealing at 600 °C brings the desired magnetic phase transformation in all cases, while the laser heat treatment even at high power does not bring the phase transformation. Further studies are needed to confirm any structural changes and determine possible misinterpretations after laser heat treatment due to the superparamagnetic nature of the nanoparticles. Additional Comments: This work is funded by the NSF EPSCoR CIMM project under award #OIA-1541079.

*5:00pm - 5:12pm*

**ELECTRON TRANSPORT IN THIN FILM OXIDES**

*Daniel Mukasa, Oberlin College*

**ABSTRACT**

Correlated materials, being materials in which electron-electron interactions significantly affect electron transport, have gained much attention due to their potential applications within electronics. Landau's Fermi liquid model attempts to describe the effects of these interactions, but parameters including strain, carrier concentration, and defect concentration cause deviations from this model. Molecular beam epitaxy (MBE) is therefore ideal for testing this model, as these parameters can be controlled with great precision. In this study various correlated materials have been made via MBE and their electric properties are investigated. X-ray diffraction is used to verify the structure and lack of defects in each thin film and electric properties including carrier concentration, mobility and resistivity are obtained via Hall effect measurements. Each parameter is investigated to understand how they affect deviations from Fermi liquid theory and shed light onto the true mechanisms behind electron transport within correlated materials.

## MONDAY, NOVEMBER 5

### *MEETING ROOM 30*

**SESSION TIME: 11:30am – 12:00noon**

**ASTRONOMY (ASTRO) – 1.A**

*11:30am – 12:00noon*

**THE INTERGALACTIC MEDIUM AND WHY IT MATTERS**

*Eric Wilcots, University of Wisconsin, Madison*

**ABSTRACT**

We now understand that a significant amount, if not most, of the baryonic matter in the Universe resides in what is broadly considered to be the intergalactic medium (IGM). While some of this matter likely exists in the immediate environment of individual galaxies in what is known as the circumgalactic medium (CGM), much of it is thought to fill a "cosmic web" that forms the large-scale structure of the Universe. Given that a large portion of the CGM and IGM is very diffuse and thus difficult to measure in emission at any wavelength, many observational studies have focused primarily on detecting this gas in absorption, using absorption lines of a variety of ions to probe different gas regimes in the ultraviolet part of the spectrum. We are taking a different approach, probing this important component of the baryonic content of the Universe using radio telescopes. In this talk I will show how we can use observations of radio galaxies to derive densities of the intergalactic medium of $10^{-4}$ - $10^{-3}$ cm $^{-3}$; high enough to account for the missing baryons in these systems and have a dramatic impact on the evolution of resident galaxies. We are also using deep radio continuum observations to detect the presence of large-scale intergalactic magnetic fields. Lastly, I will discuss how the new generation of radio observations with sufficiently long integration times and high sensitivities offer the ability to probe neutral hydrogen in absorption in the intergalactic medium.

**SESSION TIME: 2:00pm – 3:00pm**

**ASTRONOMY (ASTRO) – 1.B**

*2:00pm – 2:15pm*

**ASTRO POSTER POPS**

### *2:15pm – 2:30pm*

### A NEW HIGH SENSITIVITY POLARIZATION STUDY OF CYGNUS A: DEPOLARIZATION AND MAGNETIC FIELDS

*Makhuduga L. Sebokolodi, Rhodes University, NRAO and SKA SA*

**ABSTRACT**

Cygnus A is one of the ultra-luminous radio galaxies, and by far the closest. It has played an important role in the radio-loud active galaxy research field. Previous polarization studies of Cygnus A have shown that it has unusually large Faraday Rotation Measures (RM) of up to ~5500 rad/m/m. Although these studies have shown that the RMs come from the ambient dense X-ray cluster gas, they haven't been able to qualitatively rule out any possible contribution from the compressed gas around the radio lobes or mixed gas inside the lobes. My work conducts a high sensitivity polarization study of Cygnus A using the new 2-18 GHz JVLA data. These data show significant depolarization and complicated polarization structures -- none of which could be seen with a narrow bandwidth of the old VLA. Our preliminary analysis indicate the presence of complex multi-scale B-fields with scales > 120 kpc and < 300 pc. We show that the dominant RMs are a result of large-scale B-fields associated with the cluster, while the small-scale fields, of unknown location, are responsible for the observed depolarization. This research project have taught me that nothing in science is ever too well-known to be re-studied -- in fact, it is important to continually test accepted ideas. I now confidently question and re-evaluate concepts that intrigue me. My project has revealed new things -- challenging the well-believed ideas but more importantly, seeing my advisors flexible to unlearn and relearn what the new data present have greatly influenced how I perceive scientific research.

### *2:30pm -2:45pm*

### RADIO MORPHOLOGIES OF DUST OBSCURED STARBURSTS IN THE SUPERCLASS FIELD

*Sinclaire Manning, University of Texas, Austin*

**ABSTRACT**

The SuperCLASS (Super-Cluster Assisted Shear Survey) is a deep, wide-area (~2 square degrees) extragalactic field with high resolution (0."1) radio continuum coverage from e-MERLIN (the upgraded Multi-Element Radio Linked Interferometer Network.) The combination of sensitivity and spatial resolution makes e-MERLIN an ideal tool to trace spatially resolved star-formation in heavily obscured, dusty star-forming galaxies (DSFGs). Additionally, thanks to the tight relationship between radio continuum and far-IR observations, we have an observationally inexpensive and accurate method of mapping star formation density in distant galaxies. We present a case study of radio bright DSFGs in the SuperCLASS field, their photometric redshifts, and comparison of radio and optical morphologies. We aim to conduct the first large sample morphological analysis of z~1-3 obscured galaxies and plan to address two important questions: 1) Are most obscured SFR>50 M_solar/yr galaxies driven by major collisions? and 2) do luminous active galactic nuclei (AGN) play a crucial role in the quenching of highly obscured star-formation?

### *2:45pm – 3:00pm*

### COMPUTATIONAL METHODS IN ASTROPHYSICS AND TWO-WAVE INTERACTION IN IDEAL MAGNETOHYDRODYNAMICS

*Marvin Jones, Indiana University*

**ABSTRACT**

Numerical methods and computing power are essential for understanding the behavior of the universe. We examine various numerical techniques that are useful in solving astrophysical problems. In particular, we explore problems related to magnetohydrodynamics (MHD) and fluid dynamics for astrophysical problems and fluids. In the first part of this work, the methods are explored from a general perspective looking at things such as limitations, challenges with implementation, as well as the uses of the methods. The second part of this work explores MHD through methods explored by J.M. Stone using ATHENA, which is a higher-order Godunov scheme for astrophysical MHD. These problems typically center around Interstellar shocks, MHD Turbulence in Molecular Clouds, Accretion Disks, and for the purposes of this work, interactions between sound and Alfvén waves in plasma. The ATHENA higher-order scheme demonstrated the dissipative nature of sound waves coupling energy with Alfvén waves in ideal MHD, which opposed the opposite hypothesis that the coupled energy would not be dissipative in the plasma. This result is specific to the conditions of this MHD problem, but provides insight into the nature of electromagnetic wave interactions in plasma, particularly astrophysical MHD.

**SESSION TIME: 4:00pm – 6:00pm**
**ASTRONOMY (ASTRO) – 1.C**

***4:00pm – 4:15pm***

**THE MINIATURE X-RAY SOLAR SPECTROMETER (MINXSS) CUBESATS: INSTRUMENT CAPABILITIES AND EARLY SCIENCE ANALYSIS ON THE QUIET SUN, ACTIVE REGIONS, AND FLARES.**

*Christopher Moore, Harvard-Smithsonian Center for Astrophysics - Invited*

**ABSTRACT**

Detection of soft X-rays (sxr) from the Sun provide direct information on coronal plasma at temperatures in excess of ~1 MK, but there have been relatively few solar spectrally resolved measurements from 0.5 – 10. keV. CubeSats can be a low-cost alternative to rapidly fill astrophysical observations gaps, that large missions are currently missing. The Miniature X-ray Solar Spectrometer (MinXSS) CubeSat is the first solar science oriented CubeSat mission flown for the NASA Science Mission Directorate, and has provided measurements from 0.8 -12 keV, with resolving power ~40 at 5.9 keV, at a nominal ~10 second time cadence. MinXSS design and development has involved over 40 graduate students supervised by professors and professionals at the University of Colorado at Boulder. Instrument radiometric calibration was performed at the National Institute for Standard and Technology (NIST) Synchrotron Ultraviolet Radiation Facility (SURF) and spectral resolution determined from radioactive X-ray sources. The MinXSS spectra allow for determining coronal abundance variations for Fe, Mg, Ni, Ca, Si, S, and Ar in active regions and during flares. Measurements from the first of the twin CubeSats, MinXSS-1, have proven to be consistent with the Geostationary Operational Environmental Satellite (GOES) 0.1 – 0.8 nm energy flux. Simultaneous MinXSS-1 and Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) observations have provided the most complete sxr spectral coverage of flares in recent years. These combined measurements are vital in estimating the heating flare loops by non-thermal accelerated electrons. MinXSS-1 measurements have been combined with the Hinode X-ray Telescope (XRT) and Solar Dynamics Observatory Atmospheric Imaging Assembly (SDO-AIA) to further constrain the coronal temperature distribution during quiescent times. The structure of the temperature distribution (especially for T > 5 MK) is important for deducing heating processes in the solar atmosphere. MinXSS-1 observations yield some of the tightest constraints on the high temperature component of the coronal plasma, in the absence of the intermittent solar observations from the Focusing Optic X-ray Solar Imager (FOXSI) sounding rocket and the Nuclear Spectroscopic Telescope Array (NuSTAR). MinXSS-2 is scheduled to launch in late 2018 for improved solar observations for at least a four-year mission.

***4:15pm - 4:30pm***

**NUMERICAL SIMULATIONS OF SUPERNOVA REMNANTS IN TURBULENT MEDIUM**

*Dong Zhang, University of Michigan*

**ABSTRACT**

Core-collapse supernova (SN) explosions may occur in the highly inhomogeneous molecular clouds (MCs) in which their progenitors were born. We perform a series of 3-dimensional hydrodynamic simulations to model the interaction between an individual supernova remnant (SNR) and a turbulent MC medium, in order to investigate possible observational evidence for the turbulent structure of MCs. We find that the properties of SNRs are mainly controlled by the mean density of the surrounding medium, while a SNR in a more turbulent medium with higher supersonic turbulent Mach number shows lower interior temperature, lower radial momentum, and dimmer X-ray emission compared to one in a less turbulent medium with the same mean density. We compare our simulations to observed SNRs, in particular, to W44, W28 and IC 443. We estimate that the mean density of the ambient medium is ~10cm^{−3} for W44 and W28. The MC in front of IC 443 has a density of ~100cm^{−3}. We also predict that the ambient MC of W44 is more turbulent than that of W28 and IC 443. The ambient medium of W44 and W28 has significantly lower average density than that of the host giant MC. This result may be related to the stellar feedback from the SNRs' progenitors.

***4:30pm - 5:00pm***

**SYNTHETIC OBSERVATIONS OF THE HIGH REDSHIFT UNIVERSE**

*Kirk Barrow, Stanford University (Kavli Institute of Particle Astrophysics and Cosmology) – Invited*

**ABSTRACT**

As astronomers peer ever-deeper into the high-redshift Universe, a bevy of astrophysical enigma on early star, black hole, and galactic structure formation await on the precipice of their discovery. However, to truly and more completely decipher the first faint images from the Cosmic Dawn, a new generation of diagnostic and predictive tools is needed to bridge the gap between the state-of-the-art in astrophysical theory and observation. To this end, we have developed the CAIUS Monte Carlo radiative transfer pipeline, which takes cosmological simulations and produces synthetic observations and diagnostics for infrared space telescopes. Using our tools, we produce James Webb Space Telescope diagnostics for a direct-collapse black hole scenario as well as for a statistically significant sample of star-forming galaxies at $z = 15$. Our studies have found previously unexplored trends in both the evolution of the radiative environment in the early Universe as well as in the ways objects might be discerned and in particular, hope that we might soon observe the formation of a massive black hole.

***5:00pm - 5:15pm BREAK***

***5:15pm – 5:30pm***

**OBSERVING JAB SIMULATIONS - PROBING NEAR-HORIZON SCALES IN AGN**

*Richard Anantua, University of California, Berkeley*

**ABSTRACT**

Plasma emission models are self-consistently input into general relativistic magnetohydrodynamic (GRMHD) simulations of jet (or outflow)/accretion disk/black hole (JAB) systems in order to infer physical processes observed by very long baseline interferometers such as the Event Horizon Telescope (EHT). Inspired by physical processes in active galactic nuclei (AGN) such as equipartition and electron heating, models relating electron temperature or energy density to GRMHD variables are input in postprocessing to produce ray-traced intensity maps, spectra and light curves. The methodology is applied here to Sgr A* at the Galactic Center and the giant elliptical galaxy M87, though the methodology is readily generalizable to the near-horizon regions of any AGN. Additional Comments: Collaborators: Roger Blandford, Alexander Tchekhovskoy, Sean Ressler and Eliot Quataert

***5:30pm - 5:45pm***

**USING DIFFUSION K-MEANS TO ESTIMATE COMPLETE STAR FORMATION HISTORIES OF GALAXIES**

*Gregory Mosby, NASA Goddard Space Flight Center – Invited*

**ABSTRACT**

Galaxies process the raw materials of the universe. Thus, the stars in galaxies and their histories can give us an insight into how the universe has changed with time, how galaxies likely formed, and how they will evolve. We commonly estimate the star formation histories of galaxies by comparing sums of single age, single metallicity, simple stellar populations to the integrated spectra or photometry of an observed galaxy. This procedure is called stellar population modeling. In our recent work, we used the machine learning algorithm diffusion k-means to form a basis set of average simple stellar populations. We showed we could derive star formation histories of galaxies with low signal-to-noise spectra to comparable accuracy to that of a traditional method but more precisely. However, this method only returned a single metallicity star formation history. Subsequent epochs of star formation are formed from the interstellar medium enriched by previous generations of star formation, so we expect an evolution in the metallicity of the stars in galaxies. To capture the complete (stellar age and metallicity) star formation history, we have begun to explore using diffusion k-means to form a set of basis spectra of multiple metallicities. Using similar methodology of our previous work, we have formed basis sets of spectra using diffusion k-means for multiple metallicities. We compare these basis set spectra and their results on select star formation histories.

*5:45pm - 6:00pm*

**HUNTING FOR DARK MATTER**

*Alvine Kamaha, State University of New York, Albany*

**ABSTRACT**

Over the past few decades, the search for the missing matter of the Universe so-called dark matter has become the main focus of particle physics research. Many experiments around the globe are utilizing diverse detection techniques to directly or indirectly search for dark matter under the form of Weakly Interacting Massive Particles (WIMPs).

## MONDAY, NOVEMBER 5

### *MEETING ROOM 31*

### SESSION TIME: 11:30am – 12:00noon

**PHOTONICS AND OPTICAL PHYSICS (POP) – 1.A**

*11:30am – 12:00noon*

**WAVEFRONT SHAPING: A NEW TOOL IN OPTICS**

*Moussa N'Gom, Assistant Professor, Department of Physics, Applied Physics and Astronomy, Rensselaer Polytechnic Institute*

**ABSTRACT**

Background radiation can often be a significant issue with large scale nuclear physics experiments. A background spectrum for the PULSTAR reactor can be vital information for ongoing projects like UCN nEDM, Neutron Activation Analysis, and Neutron Radiography of turbine blades for jet engine manufacturing (to name a few). High-purity germanium detectors are used for gamma-ray spectroscopy and are more efficient and sensitive than standard 3" x 3" Na(Tl) detectors. I used a 2001A Canberra HP Ge detector and conducted several 24 hour runs in the reactor bay. Using ROOT, I generated a smoothed histogram and fitted the data with a Gaussian and linear model. Using the known Ar-41 and K-40 peaks (energies 1293 keV and 1460 keV), I was able to produce a calibrated spectrum which allowed me to find other gammas like Na-24 and Th-232. Currently I'm working with Geant4, to subtract the Compton scattering portion of the spectrum. The resulting product will be a well-calibrated background spectrum of the reactor including the total and peak efficiency.

### SESSION TIME: 2:00pm – 3:00pm

**PHOTONICS AND OPTICAL PHYSICS (POP) – 1.B**

*2:00pm – 2:15pm*

**ELECTRICALLY PUMPED MIE SPHERE SINGLE PHOTON SOURCE**

*Oluseye Akomolede, Purdue University*

**ABSTRACT**

A major focus of Quantum Information Processing is the development of efficient tools to control spin as a quantum state. Single photon sources, utilizing crystal defects, are emerging as an ideal candidate for realizing such tunable spin-photon interfaces in an integrated optical quantum-computing platform. One of the most established directions for such solid-state impurity generation, diamond vacancy centers, have narrow lines at room temperature. However, such vacancy centers can be susceptible to local field fluctuation and low quantum yields while lacking adequate environmental isolation and spin coherence. Here we propose a high-efficiency, electronically controlled silicon-based Multilayer-Mie-sphere design having Xenon-vacancy based diamond nano-rod inside acting as a highly efficient Single Photon Source. According to our simulated results, small-radius nanorod design aligned with dipole axis of the emitter minimizes the perturbation and permits nearly complete enhancement preservation. Aligning perturbation with the null of the dipole emission minimizes effects of adding a conducting channel. Although the refractive index of the nanorod is high, the contrast at the nanorod/silicon boundary is low. Therefore, unlike the thin sheet structure, nanorod offers little confinement and emission enhancement remains largely that of the resonant sphere. An additional benefit of the Mie sphere design is its all- dielectric material composition, which, unlike metal surface topologies, permits coherent spin control of the embedded vacancies. Unlike traditional large non-

spherically symmetric cavities, here, enhancement is mitigated through the cavity modes whose field profile results in energy localization to a subwavelength central region. The xenon vacancy is a particularly promising impurity center in diamond featuring a low Huang-Rhys factor and consequently, minimal background emission and a narrow bandwidth. Under high injection conditions, the total current reaches its near-steady state value within 0.5 ns, providing path for GHz-range photon emission rates . The Xe-vacancy-Zero-Phonon-Line (ZPL) is in the infrared region and magnetic dipole in character, making it ideal for fiber-based Quantum-Communication.

***2:15pm – 2:30pm***

**THE GROWTH OF ORGANIC LANTHANIDE CRYSTALS FOR NANO-OPTICS STUDIES**

*Alexis Bullock, Norfolk State University*

**ABSTRACT**

The purpose of the experiment is to grow organic lanthanide crystals to use for Nano-Optics Studies and perform excitation spectra on the crystals. Organic Crystals were produced from the following lanthanides Eu,Gd,Nd,Tm,Er,La,Yb, with the addition of 2,2 bipyrimidal. The lanthanides were able to grow under two different methods seed crystal method and slow evaporation at room temperature method for crystal growth. Then the crystals that were produce using the various methods were placed onto a slide to be observed under the optical microscope. Pictures of the quality crystals were taken and measured in length and width in micrometers. The lanthanide crystals Europium, Neodium, and Erbium were used for Emission spectra at UV excitation. These crystals can be used to fabricate thin films and are excellent samples for nan-optics studies. The crystals quality demonstrated high efficiency of luminescence and are suitable for film fabrication. Overall these crystals can be used to fabricate thin films and are promising for Nano-optics studies.

***2:30pm – 2:45pm***

**EUV TOF DATA ANALYSIS DETERMINING INTER-ELEMENT RATIOS**

*Eric Patterson, Morehouse College (AMO)*

**ABSTRACT**

This project was focused on Colorado State's Extreme Ultraviolet (EUV) mass spectrometer system created and developed by Dr. Carmen Menoni and Dr. Jorge Rocca. This mass spec system uses laser ablation to analyze samples for the identification of and mapping of the spatial distribution of elemental and molecular components in solid sample. Using the EUV laser ablation has these benefits for identifying and mapping the samples: direct solid photo absorption, EUV- created plasma stays cold, and less molecular fragmentation occurs. When a sample is analyzed a collimated EUV laser beam gets focused by the zone plate onto a solid sample. From the ablation crater a plasma plume containing a partially ionized vapor mixture emerges. Ions from the plume accelerated towards the TOF mass discriminator. The main goal was to integrate the peaks of the mass spectrum plot data using three different integration techniques: Gaussian Curve Peak Fitting, Lorentzian Curve Peak Fitting, and Total Peak integration. Finding the relative area of individual peaks is effective in trying to enumerate the properties of the compositions of the sample. The type of data was Uranium focused with elements and compounds consisting of Uranium (235 Da), Uranium (238 Da), Uranium Oxide (251 Da), Uranium Oxide (254 Da), Uranium Dioxide (267 Da), and Uranium Dioxide (270 Da). When the areas of each crucial peak was discovered the ratios calculated were compared with the known ratio value (235U/238U) of 0.2513 + or - 0.003.

***2:45pm – 3:00pm***

**REALIZING A BETTER MAGNETO-OPTICAL TRAP BY BUILDING A LASER LOCKING CIRCUIT**

*Dimitri Klauss, Georgia Institute of Technology (AM0)*

**ABSTRACT**

Research on the physics of strongly correlated electron systems has gained increased momentum and interests have begun to focus on tools that can further explore these fascinating systems. Quantum-degenerate bosons are known to have potential uses as the building blocks for developing such tools and the cooling and trapping of these atoms with lasers has emerged as a good way to study strongly correlated electron systems. Thus, here we plan to cool down atoms using the effects of Doppler cooling. The goal of this project is to create a circuit that can successfully lock the laser that will be used to Doppler cool cesium atoms, allowing us to produce a better Magneto-Optical Trap (MOT) and become more efficient in creating cold atoms. The boson nature of cesium allows this project to be a good resource for future attempts at realizing a Bose-Einstein Condensate (BEC).

## SESSION TIME: 4:00pm – 6:00pm

**ATOMIC, MOLECULAR AND OTPICAL PHYSICS – 1**

### *4:00pm – 4:45pm*

**TIME-RESOLVED SPECTROSCOPY: MEASUREMENT OF THE RADIATIVE LIFETIME OF THE SODIUM DIMER 6Σ (3S+5S) ELECTRONIC STATE**

*Burcin Bayram, Associate Professor of Physics, Department of Physics, Miami Ohio University*

**ABSTRACT**

Recent advances in experimental atomic, molecular and optical physics continue to make major contributions to the innovations in science and technology and impacts global society. For example, developments of ultrafast pulse lasers and pulse shaping techniques yielded production of ultracold molecules with the dream of quantum controlling and manipulating the internal degrees of freedom of molecules. This research helps understanding the radiative properties of the molecular sodium in the highly excited electronic state by using a combined time-resolved spectroscopy and photon counting techniques applied to sodium molecules with thermal energies about 390 wavenumbers. I will present our recent results on the lifetime measurement of the rotational-vibrational level of the 6Σ (3s+5s) electronic state and compare with the theoretical predictions. This research is supported by the National Science Foundation.

### *4:45pm – 5:00pm*

**MAGNETIC LEVITATION OF SUPERFLUID HELIUM: TOWARDS QUANTUM OPTOMECHANICS WITH LIQUID DROPS**

*Charles Brown, Yale University*

**ABSTRACT**

The field of optomechanics studies the interactions of light with the vibrational motion of an object contained within an optical resonator, providing an avenue to study the quantum behavior of macroscopic objects. Because the observation of quantum behavior suffers from heat exchange with the environment, we have developed a system to minimize heat exchange– a mm-scale, magnetically-levitated superfluid liquid Helium (SLHe) drop in vacuum. SLHe is a promising material in which to access new regimes of quantum optomechanics, due to its extremely low optical and mechanical dissipation, its high thermal conductivity, its ability cool itself via evaporation, and its unconventional degrees of freedom (such as surface waves and quantized vortices). Magnetic levitation is expected to remove an important source of environmental heat exchange by allowing the optomechanical system's mechanical energy and optical energy to be stored entirely within the SHLe drop. We will describe the stable levitation and thermal characteristics of isolated SLHe drops in vacuum.

### *5:00pm – 5:45pm*

**OPTICAL CONTROL OF PHOTOEMISSION AT THE ATTOSECOND TIMESCALE**

*Guillaume Laurent, Associate Professor of Physics, Department of Physics, Auburn University*

**ABSTRACT**

Coherent control of electron dynamics in matter is a growing research field in ultrafast science, which has been mainly driven over the last two decades by major advances in laser technology. Recently, the advent of extreme-ultraviolet (XUV) light pulses in the attosecond time scale (1as = 10-18s) has opened up new avenues for experimentalists to manipulate the electronic dynamics with unprecedented temporal precision [1, 2]. In this work, we demonstrate that an asymmetric electron emission from atomic targets can be generated and controlled by combining an attosecond pulse train and a weak femtosecond IR field (1011 W/cm2) [3]. Continuum electron wave-packets are formed by absorption of one or two photon. These interfere, leading to an asymmetric electron emission along the polarization of the optical field. We show that the direction of the emission can be controlled by varying the time delay between the two pulses [4].

***5:45pm – 6:00pm***

**THE IMPACT OF VAPOR SUPERSATURATION ON THE MORPHOLOGY, MIXING STATE AND OPTICAL PROPERTIES OF ATMOSPHERIC SOOT**

*Ogochukwu Enekwizu, New Jersey Institute of Technology*

**ABSTRACT**

Soot nanoparticles, produced from the incomplete combustion of fossil fuels, absorb solar radiation and contribute to climate change by direct radiative forcing. The magnitude of forcing is strongly influenced by the changes in morphology and mixing state of the soot aggregates as they interact with other aerosols during atmospheric transport. Presently, the pathways leading to these structural transformations and their associated impacts are not well understood. In this study, soot aerosols were exposed to supersaturated vapors of organic and inorganic liquids with a broad range of physical and chemical properties to generate thinly coated soot aggregates. We observed two distinct restructuring behaviors which were governed by the level of vapor supersaturation in our coating chamber. With the aid of a simple analytical model, we show that high vapor supersaturation results in uniform condensation over the aggregates. Conversely, low vapor supersaturation causes preferential condensation in the junctions between contacting primary spheres to form pendular rings which induce structural collapse. We surmise that the degree of vapor supersaturation is the driving factor for the different mixing states and morphological changes observed in lab and field studies. We also discuss the impacts of changes in morphology and mixing state on the optical properties of soot for both condensation behaviors. By incorporating vapor supersaturation in atmospheric models, improvements can be made in simulations of the radiative forcing of soot.

## MONDAY, NOVEMBER 5

***MEETING ROOM 32***

**SESSION TIME: 11:30am – 12:00noon**

**MEDICAL PHYSICS AND CHEMICAL AND BIOLOGICAL PHYSICS (MED/CBP) – 1.A**

***11:30am – 11:45am***

**WHAT IS MEDICAL PHYSICS?**

*Christopher Njeh*

***11:45am – 12:00noon***

**EDUCATIONAL PATHWAYS TO THE MEDICAL PHYSICS PROFESSION**

*Wilfred Ngwa,*

**SESSION TIME: 2:00pm – 3:00pm**

**MEDICAL PHYSICS AND CHEMICAL AND BIOLOGICAL PHYSICS (MED/CBP) – 1.B**

***2:00pm – 2:30pm***

**INCREASING ACCESS FOR MINORITIES TO PHYSICS EDUCATION AND RESEARCH EXCELLENCE AMPERE 2.0**

*Wilfred Ngwa,*

***2:00pm – 2:30pm***

**THE NEW ERA OF RADIATION THERAPY FROM 2D TO 4D AND BEYOND**

*Christopher Njeh*

## SESSION TIME: 4:00pm – 6:00pm
## PHYSICS EDUCATION RESEARCH (PER)

***4:00pm – 4:30pm***

### INVITING THE RESULTS OF PHYSICS EDUCATION RESEARCH INTO OUR CLASSROOMS

*Kathleen Harper, Ohio State University*

**ABSTRACT**

The past two decades have seen a significant growth in the amount of discipline-based educational research taking place in STEM fields, with physics leading the way. While some studies have investigated, evaluated, and/or recommended large-scale overhauls of existing courses, the average instructor is not going to have the time or resources to engage in such incorporation of research results. Fortunately, the results of many PER studies can be applied to the classroom in much more modest ways, involving far less effort on the part of the instructor. This talk will share several examples of small-scale, research-based course modifications (developing new styles of problem-solving tasks, designing appropriate cooperative learning activities, and requiring students to revisit graded exams).

***4:30pm – 5:00pm***

### CAN PERFORMANCE SUPPORT BLACK PHYSICS IDENTITY? AN INVESTIGATION OF THE CONNECTIONS BETWEEN IDENTITY, RACE, PHYSICS, AND PERFORMANCE ART

*Simone Hyater-Adams*
*University of Colorado*

**ABSTRACT**

There is a current push to understand and address the underrepresentation of Black folks in physics, and STEM more broadly. This talk discusses research that explores ways to address this through studies of identity and practice. This work is premised on an understanding that the systems of oppression operate within the culture of physics, and postulates that bridging the gaps between science and art can help us begin to address this challenge. In this talk, I will describe three ongoing studies that explore these ideas. The first is an overview of the Critical Physics Identity (CPI) framework, a methodological tool to understand the structural and systemic factors that impact the ways that folks identify with the physics discipline. The second applies the CPI framework for an analysis of Black physicists' narratives in order to highlight themes in the institutional and structural resources that mold their physics identities. The third explores ways that the performance arts might be used as a tool to address the issues found in the analysis of these narratives. This talk concludes with a working model for informal physics programs designed to support student identity, that incorporates the content and practices from the performing arts and from physics.

***5:00pm – 5:30pm***

### MUTUAL MENTORING WITH EALLIANCES

*Jennifer Blue, Miami University*
*CoAuthors: Anne Cox (Eckerd College), Cindy Blaha (Carleton College), Barbara Whitten (Colorado College), Idalia Ramos (University of Puerto Rico – Humacao), and Beth Cunningham (AAPT)*

**ABSTRACT**

Being a woman in physics or astronomy can be a very isolating experience. Peer mentoring has been shown to help combat this isolation. eAlliance, an NSF ADVANCE PLAN-D program hosted by AAPT, is seeking to establish mutual mentoring networks of women faculty within the physics and astronomy community. The eAlliance program will reduce the isolation of participating faculty members and provide support to help members achieve their personal goals and enhance their career development. Participants register at the eAlliance website (ealliance.aapt.org) and complete a personal profile which is used to match them to other registered women faculty with similar mentoring goals. So far, over 100 women have registered in the eAlliance database. Currently the project has five sponsored eAlliances (with 4-5 members each) and three more in the process of forming. The mentoring cohorts are holding regular electronic meetings and using project funds to support annual face-to-face meetings at national meetings of their own choosing. The first eAlliance Summit Meeting was held in July 2018 and brought all the cohorts together to share their peer mentoring experiences and gather advice for future cohorts just starting out. All women faculty in physics and astronomy are invited to join the eAlliance program.

## MONDAY, NOVEMBER 5

### *MEETING ROOM 33*
### SESSION TIME: 11:30am – 12:00noon
**NUCLEAR AND PARTICLE PHYSICS (NPP) – 1.A**

***11:30am – 12:00noon***
**EXCELLING AS AN UNDERGRADUATE STUDENT: SUCCESS AND FAILURE**
*Jordan Owens-Fryar (FRIB)*

**ABSTRACT**
Being an undergraduate physics major at a majority school in the US comes with many challenges that could be overwhelming and decisive for pursuing graduate degrees in this field. While every institution is different, many experiences are very similar. They too often point to very similar stories and mistakes from which a large fraction is self made by undergraduate students and could be avoided. This presentation aims at setting the stage for an interactive session to position physics undergraduate students to become successful early on in their education.

### SESSION TIME: 2:00pm – 3:00pm
**NUCLEAR AND PARTICLE PHYSICS (NPP) – 1.B**

***2:00pm –2:30pm***
**FROM FRIB PHYSICS TO NEUTRON STAR MERGER**
*Scott Bogner, FRIB*

**ABSTRACT**
The announcement in October 2017 of the ground-breaking detection of the binary neutron-star merger event, GW170817 LIGO-Virgo collaboration ushers in the era of Multi-Messenger Astrophysics. In addition to the tremendous contributions from astronomy where telescopes from four corners of the work provide observation of the kilonova and the emission spectroscopy of the neutron star merger event, nuclear physics will also provide one of the messenger in the understanding of the neutron star. Isotopes created in terrestrial laboratories such as the Facility for the Rare Isotope Beams (FRIB) will help us to understand the synthesis of the elements heavier than Iron as well as the nature of the neutron rich material. In this talk, I will discuss nuclear experiments at FRIB/NSCL that will shed lights to the properties of the neutron stars.

***2:30pm – 3:00pm***
**THE ELECTRON-ION COLLIDER: A NEW SCIENCE FRONTIER**
*Rolf Ent, Thomas Jefferson National Accelerator Facility*

**ABSTRACT**
The understanding of the structure of matter at the level of atoms and molecules is a cornerstone of the technical achievements of the modern civilization; everything from modern medicine to communication infrastructure depend on this knowledge. The current understanding of the internal structure of nucleons – protons and neutrons - and nuclei, however, are at a comparatively primitive level. While we know the interior landscape of nucleons includes a strong-force driven sea of quarks, antiquarks and gluons, with a net surplus of a few ever-present valence quarks, we have very little idea how the macro-properties and structure of nucleons and nuclear matter emerge from their strong dynamics. This lack of understanding has been due both to the difficulty of the theory of Quantum Chromodynamics (QCD) that govern quarks and gluons, and experimental limitations. Advances in the theoretical understanding of QCD in the past decades, however, have led to a framework that enables to precisely image the gluons and quarks, and to understand the role they and their interactions play in nucleons and nuclei. For this, a new accelerator facility is required, the Electron-Ion Collider. This would be the world's first polarized electron-proton collider, and the world's first e-A collider. The science foreseen at and the status of such a future US-based polarized Electron-Ion Collider will be presented.

### SESSION TIME: 4:00pm – 6:00pm
**NUCLEAR AND PARTICLE PHYSICS (NPP) – 1.C**

***4:00pm – 4:30pm***

**REVISITING THE DARK PHOTON INTERPRETATION OF THE MUON G-2 ANOMALY**

*Gopolang Mohlabeng, Brookhaven National Laboratory*

**ABSTRACT**

We investigate the parameter space in which the dark photon may still explain the muon g-2 anomaly. We consider a model of an inelastic dark sector which couples directly to the dark photon. This scenario may lead to semi-visible decays of the dark photon leading to a parameter space in which the dark photon interpretation of the muon g-2 anomaly may still be viable as opposed to both exclusively visible and invisible decays, which have been excluded by experiments. Furthermore, we show that one of the dark sector states may contribute to the required dark matter relic abundance. It is possible that the semi-visible events we discuss, may have been vetoed by experiments searching for the invisible dark photon decays, such as BABAR.

***4:30pm – 4:50pm***

**PHENIX RESULTS USING TWO PARTICLE CORRELATIONS AS A PROBE OF THE QUARK GLUON PLASMA**

*Anthony Hodges, Georgia State University*

**ABSTRACT**

Heavy ion collisions at the Relativistic Heavy Ion Collider (RHIC) offer a unique environment in which to study Quantum Chromodynamics (QCD). Colliding gold nuclei at near the speed of light creates a hot, dense fireball known as the Quark Gluon Plasma (QGP). This plasma, theorized to have existed microseconds after the big bang, is trillions of degrees hotter than the core of the sun and hot enough to effectively melt nuclei, creating an unbound state of quarks and gluons which is not observed in nature. In addition to the Quark Gluon Plasma, highly energetic, collimated sprays of particles -- known as jets -- are also created during the collision. These jets are modified by the QGP as they traverse it and can be used to probe the unique properties of the fireball. Studying two particle correlations, in particular, allows us to study the energy loss effects (known as "Jet Quenching") caused by jet interactions with the medium. In the presented analysis, high momentum particles are used to trigger on a jet event and are correlated in azimuth to "associate" charged hadron particles. The resulting angular distribution allows us to quantify the impact of the QGP on quantities such as the per trigger yield and Gaussian width of jets that have been modified by the plasma.

***4:50pm – 5:10pm***

**APPLYING ARTIFICIAL INTELLIGENCE TO PARTICLE ACCELERATORS**

*Dorian Bohler, SLAC National Laboratory*

**ABSTRACT**

Particle accelerators are designed and operated in a wide range of beam phase space distributions which require many man hours to set up and optimize. Because of the uncertainty due to limited diagnostics and time varying performance there are significant limitations in the utility of using methods such as look-up tables, simulators, and models to quickly switch between widely varying operational ranges. In this talk I will discuss recent progress in applying machine learning, neural networks, and adaptive feedback algorithms to enable automatic accelerator tuning and optimization.

***5:10pm – 5:30pm***

**AN OVERVIEW OF NUCLEAR SAFEGUARDS IN NUCLEAR FUEL REPROCESSING FACILITIES**

*Batie Grey, University of California Berkeley*

**ABSTRACT**

The International Atomic Energy Agency (IAEA) is an independent intergovernmental organization tasked with, among other responsibilities, verifying that member countries uphold their pledge to only use nuclear science and technology for peaceful purposes[1]. This task is accomplished through the establishment of safeguards, or technical measures used to verify each member state's commitment to the peaceful use of nuclear technology. Different stages of the nuclear fuel cycle require different safeguards based on the nuclear material present and its

form. For example, in most nuclear reprocessing facilities, nuclear material is handed in bulk form, meaning the material is in a form that is not individually identifiable for accounting purposes (i.e. liquid, gas or powder)[2]. It is in these facilities where distinct techniques are vital to the prevention of both inadvertent or deliberate material hold-up. This presentation will explore existing safeguards technology and present challenges associated with material accountancy, in addition to future work to be done to ensure the peaceful use of nuclear technology.

*5:30pm – 5:50pm*

**SPECTROSCOPIC ANALYSIS USING FUSION EVAPORATION REACTIONS**

*Kalisa Vilafana, Florida State University*

**ABSTRACT**

High-spin states in 179,180W (Z=74) were produced via fusion evaporation reactions carried out at the Florida State University's John D. Fox Laboratory. To produce the nuclei of interest, a 14C beam was impinged on a 1mg/cm^{2} 170Er target, at beam energies of 75MeV and 68MeV respectively. The emitted gamma-rays were detected using three escaped-suppressed clover detectors and seven single element escape-suppressed high-purity germanium detectors. As a result of this analysis, new decay transitions and new energy levels have been observed in both nuclei building on previously known structures. The analysis of this data using gamma-gamma and gamma-gamma-gamma coincidences was done using the Radware analysis package. Additionally, due in part to results obtained from this analysis, new systematic data in the A~180 region is also discussed, with an emphasis on the role that pair-blocking effects play during the rotation of the nucleus. This systematic investigation builds upon the classic findings of Garrett et al., who investigated systematically the critical band crossing frequencies of the first pair of i_{13/2} neutrons (AB) in rare-earth nuclei. The present work carries out a similar comprehensive investigation for the second pair of aligning i_{13/2} neutrons (BC) at higher rotational frequencies.

*5:50pm – 6:00pm*

**A STATISTICAL METHOD FOR DETERMINING STELLAR REACTION CROSS SECTIONS**

*Keilah Davis, North Carolina State University*

**ABSTRACT**

The 22Ne(p,ɣ)23Na reaction may have a significant effect on the surface abundance of sodium in asymptotic giant branch (AGB) stars. The rate of this reaction can be calculated using the angular momentum results from the 22Ne(3He,d)23Na cross section. We measured the 22Ne(3He,d)23Na cross section and used Bayesian statistics and Monte Carlo methods to determine uncertainties for angular momentum fitting parameters. We also used chi-squared tests and the overlap coefficient to quantify the impact of those uncertainties. We will present our findings and discuss their impact on the 22Ne(p,ɣ)23Na reaction rate.

## TUESDAY, NOVEMBER 6

### *MEETING ROOM – HAYES ABC*

### SESSION TIME: 4:00pm – 6:00pm

**WORKSHOP: CAREERS: LOCKHEED, CORNING, COLLEGES**

## TUESDAY, NOVEMBER 6

### SESSION TIME: 8:00am – 8:30am

**ONE-MINUTE POSTER REVIEW**

*Each morning from 8-8:30am there will be a 'Poster POP' session divided by topic area, where you can give a 1-minute elevator pitch for your poster. This is your opportunity to sell your audience on why they should review your work during the formal poster review sessions.*

| MEETING RM 21 | MEETING RM 22 | MEETING RM 30 | MEETING RM 31 | MEETING RM 32 | MEETING RM 33 |
|---|---|---|---|---|---|
| 1-MIN POSTER (CM) | 1-MIN POSTER (NPP) | 1-MIN POSTER (ASTRO) | 1-MIN POSTER (POP/AMO) | 1-MIN POSTER (MED/CBP) | 1-MIN POSTER (PER/EPSS) |

## *MEETING ROOM 21*

## SESSION TIME: 2:00pm – 3:00pm

**STUDENT TALK – MED/CBP**

***2:00pm – 2:15pm***

### DETERMINATION OF FETAL DOSES FROM A CONE BEAM CT FOR RADIATION THERAPY PATIENTS

*Blake Benyard, University of Wisconsin-Madison*

**ABSTRACT**

Measuring dose outside the primary radiation field is a critical component of radiotherapy and imaging dosimetry. The goal of this project is to quantify in-field dose and peripheral dose (PD) from a kilovoltage cone-beam computed tomography (kv-CBCT) and compare the two measurements. This comparison is used for the purpose of optimizing the radiation dose outside the field of radiation that could reach vital organs and other structures, such as a fetus. The peripheral doses are comparable to the Intensity Modulated Radiation Therapy (IMRT) and Image Guided Radiation Therapy (IGRT) delivery techniques for a linear accelerator. Measurements of the CBCT in-field and PD were performed using TLD 100H detectors in depth (2cm) in virtual water slabs with the high-quality head protocol. In-field doses were found to be up to 9 cGy for ten successive scans. Peripheral doses were found to have an average of 0.032 cGy, 32.5 to 57.7 cm out-of-field for ten successive scans . The amount of PD that reaches the fetus, which is typically 45 cm from the treatment field is indicative of the CBCT protocol that is performed. Utilizing a protocol, such as the high-quality head that has reduced mAs and number of frames will have a significant effect on the in-field and PD from a CBCT.

***2:15pm – 2:30pm***

### LIGHTS, CAMERA, HEMODYNAMICS: A NOVEL TECHNIQUE TO MONITOR BLOOD USING SPECTROSCOPY

*Wesley Matingou, Morehouse College*

**ABSTRACT**

Noninvasive measurements of hemodynamics (i.e., blood flow, BF) and oxygen metabolism (MRO2) can serve as biomarkers of tissue health and cellular function. Although other modalities such as PET or MRI can quantify these parameters, numerous limitations, including high-cost, immobility, and the need for exogenous contrast agents, make these techniques inappropriate for continuous monitoring. Recently, speckle contrast optical spectroscopy (SCOS) has been developed to non-invasively measure blood flow using a low-cost (~$2k) camera (Valdes 2014). As part of larger project, we are extending the capabilities of SCOS by using a new technology we call 3D-SCOS to measure not only deep-tissue BF but also the wavelength-dependent scattering (μs'(λ)) and absorption (μa(λ)) coefficients of the tissue. The additional information of μa at multiple wavelengths enables extraction of MRO2. However, fitting for these parameters (i.e, BF, μa, μs') with this complex multi-spectral, multi-distance, and multi-exposure dataset must be done with machine learning techniques. Accuracy of these fit is improved by constraining μa and μs' to realistic ranges. Herein, we develop a novel technique to estimate μeff(λ) =μa (λ)*μs(λ)', that will be used to constrain 3D-SCOS fitting. Multi-distance spatially resolved intensity images accurately estimate μeff to within ±2% error. Accurately estimating μeff is an important preliminary step for 3D-SCOS, because it creates a finite range of values from which we can derive μa and μs' which we hypothesis will significantly increase the speed of 3D-SCOS data analysis. We experimentally validate the estimation of μeff for use in 3D-SCOS measurements of blood flow and oxygen metabolism. Additional Comments: Sponsors: GT Petit Research Scholarship and NIH award R21 EB023689-01A1

***2:30pm – 2:45pm***

### HIV, THE IMPACT ON AFRICAN AMERICANS

*Barbara Thompson, Grambling State University*

**ABSTRACT**

HIV presents as a prevalent health issue in the United States. As of 2016, The Center for Disease Control (CDC) reports that approximately 1.1 million people live with the viral infection. However, subsets of the data illuminate that HIV tremendously affects certain groups at disproportional rates. Weak state legislature and the inability to

receive medication are some of many contributing factors that cause these disproportional rates. In this research project, I am exploring those rates and factors. More specifically, I am utilizing mathematical tools such as statistical data and graphs to investigate the spread of HIV amongst African Americans in Tennessee. By the end of my investigation, I will hopefully present effective solutions to decrease the spread of the deadly virus amongst African Americans.

*2:45pm – 3:00pm*

**A NATURAL LANGUAGE PROCESSING TOOL TO AUTOMATICALLY CATEGORIZE RADIATION EXPOSURE DATA FROM COMPUTED TOMOGRAPHY EXAMINATIONS**

*Tracy Edwards, Hampton University*

**ABSTRACT**

Hospitals are required to monitor and track the radiation dose used for computed tomography (CT) examinations. Individual CT scanners send such information to a dose monitoring database after every patient is scanned. These raw data are potentially very valuable in understanding how imaging examinations are being performed in the hospital and to ensure optimal patient safety. However, the data are often difficult to analyze due to the inconsistent ways that various CT manufacturers organize and report the radiation dose information and due to the natural complexity of imaging data in a real-world radiology department. With over 100k examinations performed every year at some hospitals, there is a need for automated solutions to help clean up such data. Therefore, the objective of this study was to create a machine learning algorithm that can automatically categorize raw radiation dose data from a radiology department at a major academic hospital. The raw radiation dose data from 65,356 CT examinations was collected from the radiology department at Duke University Hospital. The data was organized in tabular format with each row corresponding to a radiation event and each column corresponding to either a text-based (Study Description, Institution name, Model Station Name) or numerical-based (CT dose index, Dose Length Product ) descriptor of the radiation event. The goal was to train a model that could predict the category of each radiation event (scout, contrast timing, or diagnostic) based on these predictor columns. A decision-tree model was trained using the text processing tools in the Natural Langue Took Kit (NLTK) and the machine learning tools in the Scikit-learn Python package. Text-based columns of interest that contributed to predicating the scan purpose were vectorized (converted to numerical values) based on a Word2Vec word embedding algorithm. Once vectorized, they were included with CT Dose Index and Dose Length Product as predictors of the scan purpose. Training data was manually labeled under the guidance of an expert clinical medical physicist and included 6,000 cases. Once the model learns which scan purpose label is associated with the each vectored column, it is then able to make a prediction for data it has not seen before. The model was able to achieve a 99% predication accuracy, demonstrating that such an approach is potentially valuable in helping to categorize and eventually analyze radiation dose data for the ultimate benefit of patients. Future work will focus on applying similar methods to better clean-up and categorize other aspects of the radiation dose data.

## SESSION TIME: 4:00pm – 6:00pm

**WORKSHOP: NATIONAL LABS**
**PNNL, FERMI, LANL, NIST**

## *MEETING ROOM 22*

## SESSION TIME: 11:30am – 12:00noon

*11:30am – 12:00noon*

**TRENDS IN CMMP EXPERIMENT**

*Nadya Mason, University of Illinois at Urbana-Champaign*

What does a condensed matter experimentalist do? What topics and techniques are relevant to this area? This talk will give a basic overview of topics, techniques, and trends in current condensed matter experiment research.

## SESSION TIME: 2:00pm – 3:00pm

**STUDENT TALK – ASTRO**

***2:00pm - 2:15pm***

**A NOVEL APPROACH TO DETERMINING THE ACCELERATION MECHANISM OF CORONAL JETS: COMBINING NON-LINEAR FORCE FREE MODELING AND CORONAL PLASMA DIAGNOSTICS**

*Samaiyah Farid, Vanderbilt University/Harvard-Smithsonian Center for Astrophysics*

**ABSTRACT**

Coronal jets are thought to be the result of magnetic reconnection when bipolar magnetic fields emerge into the open ambient field, or when bipolar regions merge. Jet parameters vary widely, making the ability to understand the acceleration mechanism difficult. This is further complicated by the wide range of jet topologies, local environments, and magnetic field configurations. In this work we approach this problem twofold. First we calculate the plasma parameters of several active region jets, including the plane of sky velocity, Doppler velocity (when available), the differential emission measure (DEM), and characterize the underlying magnetic flux. We also use the Coronal Modeling System, a Non-Linear Force Free Field (NLFFF) model, to examine the topology of selected jets before and during their eruption. In cases where a filament is observed in EUV, we employ the flux rope insertion method. We find that in several jets, the NLFFF or even potential field model matches the EUV observations of the jet spire well, allowing us to identify the height of the null point (region) and the axial and poloidal fluxes of the best fit flux rope. Finally, we estimate the thermal flux during the jet eruption and determine if we should expect explosive or gentle reconnection. All of these observations combined give unique insight into the acceleration mechanism(s) of coronal jets.

***2:15pm - 2:30pm***

**USING POPULATION SIMULATIONS TO PLACE CONSTRAINTS ON BLACK HOLE - PULSAR BINARY SYSTEMS**

*Eileen Gonzales, CUNY Graduate Center, AMNH, Hunter College*

**ABSTRACT**

We are using the open-source package PsrPopPy to simulate populations of black hole - pulsar binary systems. The initial physical parameters for these pulsars make use of standard models for spin-down widely used in modeling the isolated pulsar population. We also make use of the StarTRACK package to obtain realistic binary parameters from stellar population synetheses. We then model previous pulsar surveys to determine which pulsars from our simulation may be detected. The populations of detectable pulsars is being used to allow us to place constraints on the black hole - pulsar binary systems and make predictions for future detections by ground-based gravitational wave detectors.

***2:30-2:45***

**THE IMPACT OF BINARITY ON LARGE STELLAR ROTATION SAMPLES**

*Gregory Simonian, The Ohio State University*

**ABSTRACT**

Rotation is a fundamental property of stars. As low-mass stars age, their rotation slows due to efficient angular momentum loss from solar-like winds. The Kepler satellite has yielded a large data set of stellar rotation rates, which serve as a crucial benchmark for studies of stellar rotation and ages in field stars. However, tidally-synchronized binaries spin down much more slowly than single stars because angular momentum is extracted from the orbit, not just the star. Using Gaia DR2 distances, we examined the population of rapid rotators ($P < 7$ day) on the unevolved lower main sequence for luminosity excesses indicating binarity. We found that the large majority of the rapid rotators are photometric binaries, and we argue that essentially all short-period systems are old binaries rather than being young single stars. As a result, interpreting rapid rotation as a sign of youth should be done with caution. We also describe future work that can be done with a large population of synchronized binaries.

*2:45pm - 3:00pm*

**ASYMMETRIES OF HEAVY ELEMENTS IN CASSIOPEIA A**

*Tyler Holland-Ashford (The Ohio State University)*

**ABSTRACT**

In the past decades, evidence has mounted that supernovae (SNe), the violent explosions of massive stars at the end of their lifetimes, can have significant deviations from spherical symmetry. Supernova remnants (SNRs) offer the means to study SNe for long periods post explosion and can provide more insights into the mechanism that govern these energetic events. Recently, observations and simulations have provided evidence that the anisotropic distribution of expanding ejecta in these remnants is closely tied to the hundreds of km/s kick given to the compact object created during the explosion. In this work, we examine the X-ray morphologies of different elements (from Oxygen to Titanium) found in the youngest core-collapse SNR in the milky way, Cassiopeia A. We find that each element has a distinct morphology, which we relate to the burning process that created it and the proximity of its synthesis site from the center of explosion.

*4:00pm – 6:00pm*

**WORKSHOPS: THE APS BRIDGE PROGRAM: CHANGING THE FACE OF GRADUATE EDUCATION**

*Erika Brown (American Physical Society) and Jon Pelz (Ohio State University)*

**ABSTRACT:**

The American Physical Society Bridge Program (APS-BP) is an NSF-funded initiative to increase the number of physics PhDs awarded to underrepresented minority (URM) students. The project works to reach this goal through creation of sustainable "bridge" programs and a national network of masters and doctoral granting institutions to mentor students as they transition from their undergraduate to graduate education. Since its inception in 2012, APS-BP has placed over 180 URM students into supportive physics graduate programs, and maintains a high rate of retention. Session attendees will learn about key objectives and activities of the APS-BP, as well as how students can apply to multiple graduate programs through the free common application. This session will also host a Q+A with bridge participants who will share their personal experiences within the program.

## TUESDAY, NOVEMBER 6

*MEETING ROOM 30*

**SESSION TIME: 11:30am – 12:00noon**

**ASTRONOMY - 2**

*11:30am – 12:00noon*

**COMPARATIVE EXOPLANETOLOGY: WHAT CAN THE BODIES IN OUR SOLAR SYSTEM TEACH US ABOUT THE GEOLOGY AND HABITABILITY OF EARTH-LIKE EXTRASOLAR PLANETS?**

*Lynnae Quick, Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution*

**ABSTRACT**

The James Webb Space Telescope (JWST) and other proposed space observatories (e.g., LUVOIR, HabEx, & OST) will usher in a new era of exoplanet characterization that may lead to the identification of habitable, Earth-like worlds. Like the planets and moons in our solar system, the surfaces and interiors of terrestrial exoplanets may be shaped by volcanism and tectonics. The magnitude and rates of occurrence of these dynamic processes may either facilitate or preclude the existence of habitable environments on these worlds. The presence of volcanic and tectonic activity on solid exoplanets will be intimately linked to planet size and heat output in the form of radiogenic and/or tidal heating. In order to place bounds on the potential for such activity, we estimate the heat output of exoplanets observed by the Kepler space telescope, considering planets whose masses and radii range from 0.067 to 8 Earth masses, and 0.5 to 1.8 Earth radii, respectively. We then compare the heat output of these exoplanets to that of the planets and moons in our solar system, many of which exhibit volcanic and tectonic activity. We also calculate the

depths to potential molten layers inside of the exoplanets considered. These same calculations also reveal the depths to internal oceans, which may serve as habitable niches, on colder worlds whose densities, orbital parameters, and effective temperatures are consistent with the presence of significant amounts of water and ice (e.g., TRAPPIST-1h). As is the case for the icy moons in the outer solar system, cryovolcanic eruptions, in the form of geyser-like plumes, could indicate the presence of internal liquid reservoirs or subsurface oceans on cold, water-rich exoplanets. Given the limits of current instrumentation, spectroscopic detection of water and other molecules that are vented into space during cryovolcanic eruptions may be the only way to infer the presence of internal oceans, and therefore indirectly assess the habitability of, cold exoplanets. With this in mind, we also discuss prospects for utilizing next-generation space telescopes to detect cryovolcanic eruptions on cold, water-rich worlds.

## SESSION TIME: 2:00pm – 3:00pm

## COSMOLOGY, GRAVITATION AND RELATIVITY (CGR)

***2:00pm – 2:20pm***

### COORDINATE FAMILIES FOR THE KERR BLACK HOLE GEOMETRY BASED ON FREELY FALLING OBSERVERS

*Tehani Finch, James Madison University*

#### ABSTRACT

This work presents coordinate systems adapted to freely falling observers in the background of a rotating (Kerr) black hole, and contrasts them to the analogous coordinate systems that naturally arise in the background of a non-rotating and uncharged (Schwarzschild) black hole. Various families of trajectories and certain aspects of their behavior, both inside and outside the event horizons of the Kerr geometry, are discussed.

***2:20pm – 2:40pm***

### POLARIZATION WHORLS FROM HIGH-SPIN BLACK HOLES

*Delilah Gates, Harvard University*

#### ABSTRACT

The Event Horizon Telescope (EHT) is expected to soon produce polarimetric images of the supermassive black holes at the centers of our galaxy and the neighboring galaxy M87. The black hole of M87 is believed to be very rapidly spinning, within 2% of extremality. General relativity predicts that a high-spin black hole has an emergent conformal symmetry near its event horizon. We will show this symmetry to analytically predict the polarized near-horizon emissions of high-spin back holes and find a distinctive pattern of whorls aligned with the spin.

***2:40pm – 3:00pm***

### THE HOLOGRAPHIC UNIVERSE

*Ibrahima Bah, Johns Hopkins University*

#### ABSTRACT

One of the most important developments in theoretical physics is holography. It is a duality that relates gravitational theories described by general theory to non-gravitational theories in quantum field theories. This relation provides a definition of quantum gravity in terms of quantum field in a way that doesn¹t require quantization of general relativity. Holography provides a new avenue for exploring fundamental aspect of gravity. The duality can also be used to study the strong dynamics of quantum field theories. In this talk I describe this framework and discuss how it is used to study quantum field and quantum gravity.

***4:00pm – 6:00pm***

### WORKSHOPS: NSF PANEL

## TUESDAY, NOVEMBER 6

### *MEETING ROOM 31*
### SESSION TIME: 11:30am – 12:00noon

***11:30am – 12:00noon***

**COSMOLOGY IN THE ERA OF MULTI-MESSENGER ASTRONOMY WITH GRAVITATIONAL WAVES**

*Marcelle Soares-Santos, Brandeis University*

**ABSTRACT**

Motivated by the exciting prospect of a new wealth of information arising from the first observations of gravitational and electromagnetic radiation from the same astrophysical phenomena, the Dark Energy Survey (DES) has established a search and discovery program for the optical transients associated with LIGO/Virgo events. This talk presents the discovery of the optical transient associated with the neutron star merger GW170817 and discusses its implications for the emerging field of multi-messenger cosmology with gravitational waves and optical data.

### SESSION TIME: 2:00pm – 3:00pm
**STUDENT TALK – CMMP**

***2:00pm – 2:24pm***

**HIGH PRESSURE PHYSICS: FUNDAMENTAL EQUATION-OF-STATE TO TIME-RESOLVED DYNAMIC OF PHASE TRANSITIONS**

*William Evans, Physics Division, Lawrence Livermore National Laboratory*

**ABSTRACT**

High-pressure research investigates a variety of properties including pressure-volume relationships and pressure-induced phase transitions. These properties are important to a broad range of topics, including planetary science, condensed matter physics, advanced technology and national security. At LLNL, using diamond anvil cells, pressures exceeding that of the earth's core (3.8 Mbar) can be achieved. Our recent work emphasizes time-resolved studies of the dynamics of phase transitions in metals (Bi, Ga) using impulsive drives and advanced 3rd and 4th generations x-ray synchrotron sources. We have identified the influence of compression rate on nucleation and growth rates in these systems and the associated appearance/absence of thermodynamic equilibrium phases. In this presentation activities of the LLNL static high-pressure effort will be discussed, with an emphasis on the approaches, impacts, and future directions.

***2:24pm – 2:36pm***

**THERMO-ELECTRIC TRANSPORT PROPERTIES IN BULK GE2SB2TE5**

*Jeresha Bush, Benedict College*

**ABSTRACT**

Change materials (PCM) such as $Ge_2Sb_2Te_5$ can be reversibly and rapidly switched between amorphous and crystalline. PCMs are widely used in flash memory applications. Thermoelectric materials can directly convert to low-grade waste heat to electrical power no pollution, low maintenance and long life. But the low temperature experimental data is limited. We report on thermal conductivity ($\kappa$) and Seebeck coefficient (S) from room temperature down to -3K in bulk $Ge_2Sb_2Te_5$. Seebeck coefficient is line propulsion to the D.C. conductivity. The correlation coefficient for this is 0.99. This is an indicator of conduction by a single type of carrier and, the signature of more than one type of scattering process. In addition, the electric conductivity s and S is observed to follow a generalized Noritheim-Gorter like scaling behavior. To indicate that two independent types of scattering processes are in control of the transport rate.

*2:36pm – 2:48pm*

**KINOFORMS FOR HIGH ENERGY PHOTONS**

*Kenneth Evans-Lutterodt, Brookhaven National Laboratory*

**ABSTRACT**

Studying materials with high energy ( > 50 keV ) X-ray photons brings some advantages for materials characterization. For example, the pair distribution function method (PDF) gets better real space resolution with higher energy photons. The ability to focus X-ray beams of high energy photons brings further experimental benefits for materials characterization, including greater flux on small samples, improved signal to background, and also enabling spatial scanning of samples. In this talk, we present our recent results using silicon kinoform lenses to focus X-ray photons with energies as low as 52keV and as high as 107 keV, measured on beamlines 1-ID and 11-ID-C at the Advanced Photon Source. In a number of experiments, we have created micron and sub-micron beams, in some cases as small as 225 nm. Latest improvements in lens fabrication will also be presented. We will also show a numerical comparison between refractive lenses made from Beryllium, Silicon and Aluminum and kinofom lenses made from Silicon and discuss the relative merits for these high photon energies.

*4:00pm – 6:00pm*

**WORKSHOPS: WOMEN AND GENEDER MINORITIES**

After an introduction by chair Dr. Chanda Prescod-Weinstein (University of New Hampshire), this session will feature a talk by co-chair Grey Batie (UC Berkeley) on Black trans/non-binary experiences, followed by a panel including Black women/gender minority students and faculty in physics.

## TUESDAY, NOVEMBER 6

***MEETING ROOM 32***

**SESSION TIME: 11:30am – 12:00noon**

**ADVANCED LIGHT SOURCES - 1**

*11:30am – 12:00noon*

**THE INTERNATIONAL EXCITEMENT SURROUNDING ADVANCED LIGHT SOURCES**

*Sekazi K. Mtingwa, Principal Partner, TriSEED Consultants*

**ABSTRACT**

We provide a general overview of advanced light sources and how they are enabling exciting breakthroughs in many fields of research, including physics, materials science, chemistry, biology and even cultural heritage studies. First, we briefly summarize the basic principles of electromagnetism involved in generating synchrotron radiation. We then highlight the physics behind advanced light sources. Next, we discuss their applications to a variety of science and engineering fields. Finally, we describe a new initiative called LAAAMP (Lightsources for Africa, the Americas, Asia, and Middle East Project) that seeks to enhance advanced light source and crystallographic sciences in developing regions of the world.

**SESSION TIME: 2:00pm – 3:00pm**

**STUDENT TALK – POP/AM0**

*2:00pm – 2:15pm*

**INGAAS/GAASSB TYPE II SUPERLATTICES FOR SWIR APPLICATIONS**

*Justin Easley, University of Michigan*

**ABSTRACT**

Type II superlattices (T2SL) have garnered significant interest in recent years as an important infrared material system, particularly for Short-wave infrared (SWIR) applications. The T2SL of interest in this study is In(0.53)Ga(0.47)As/GaAs(0.51)Sb(0.49) (5nm/5nm) lattice matched to InP substrates. Eight band k.p simulations were utilized to extract information on the electronic band structure, which were in turn used to calculate the optical

absorption spectrum. The effective band gap is calculated to be 0.494 eV, corresponding to a cutoff wavelength 2.51 µm, and significant optical absorption near 2 µm. Quantum efficiency was calculated using Sentaurus TCAD and a standard InGaAs/T2SL/InGaAs p-i-n structure on an InP substrate with a varying absorber layer thickness, where QE at 2 µm is calculated to be approximately 55%. The two primary sources of dark current are Shockley-Read-Hall (SRH) and radiative recombination. A range of SRH trap densities were simulated, where SRH is found to be the limiting mechanism for Nt > 5x10^(14) cm^(-3), while smaller Nt result in a radiative recombination limited operation. Based on these lifetime values, the resulting dark current density was estimated and compared to extended-range In(0.83)Ga(0.17)As and the Rule 07 metric for HgCdTe. With trap densities ~10^(13) cm^(-3), a T2SL is expected to outperform HgCdTe and extended range InGaAs in dark current by an order of magnitude as a competitive SWIR technology.

***2:15pm – 2:30pm***

## NANOPATTERNING PHASE CHANGE MATERIAL GE2SB2TE5 FOR IMPROVED ELECTRICAL AND OPTICAL TUNABLE DEVICES

*Josh Burrow, Electro-Optics and Photonics*

### ABSTRACT

Phase change materials (PCMs) are compounds or alloys with unique optical, thermal, and electrical properties determined by the molecular arrangement of the material. The change in these properties is due to a reversible phase transition between amorphous and crystalline phase states using external excitations such as optical, electrical or thermal stimuli. Recently, the PCM, germanium antimony tellurium (GST) has gain much attention for its usefulness in optical phase control memory devices (Blu-ray disks). As opposed to other PCMs, GST is non-volatile and possesses three unique phase states. Current GST based devices are limited by power consumption and switching speeds. We present structural, thermal, electrical, and optical properties of GST thin films using various optical-based characterization techniques. We then show our progress in nanopatterning GST using both interference lithography and glancing angle deposition techniques to create nanophotonic based devices for the development towards switchable gradient index (GRIN) lenses, tunable metasurface based devices for beam steering applications, and high-speed spatial light modulators.

***2:30pm – 3:00pm***

## ADVANCES IN SCANNING PROBE SPECTROSCOPIES: MAPPING MEDIA – ELECTRIC FIELD INTERACTIONS IN NANOSCALE MATERIALS SYSTEMS

*William L. Wilson PhD., Executive Director, Center for Nanoscale Systems, Faculty of Arts and Sciences, Harvard University*

### ABSTRACT

Scanning probe spectral techniques are poised to play an important role in the development and study of next generation nanomaterials and nano-devices. In particular, Scanning Probe Microwave Reflectivity and Multimodal Atomic Force Microscopies – where the excitation and detection of two flexural eigenmodes of a cantilever with the output signal of the first mode used to image the topography of the surface and the output signal of the second mode used to measure a range of tip-sample interactions - has allowed exquisite nanoscale (sub 10nm), monitoring of the mechanical, magnetic, electrical, and optical properties of systems; in essence detecting these materials responses as pN forces at the cantilever. These new probes offer important new insights into complex nanoscale materials and devices. In this talk we will briefly review Microwave Impedance Microscopy (MIM) and PhotoInduced Force Microscopy (PiFM), two of these new paradigms, and show how they can be used to image nanoscale electronic processes and electronic fields in nanoscale systems. These techniques offer a new window onto the physics of these complex material systems and PiFM in particular, offers an interesting challenge to how we think about the measurement of spectral processes.

## SESSION TIME: 4:00pm – 6:00pm

### ADVANCED LIGHT SOURCES - 2

***4:00pm – 4:30pm***

### AN OVERVIEW OF THE NSLS-II

*Kenneth Evans-Lutterodt, Brookhaven National Laboratory*


**ABSTRACT**

Synchrotron X-ray sources are having an increasing impact in many aspects of science and engineering. NSLS-II is one of the most recently completed examples of a high brightness synchrotron source. We will give an overview of some of the key features and capabilities of this source, and similar sources that are currently planned or under construction. Some of the new scientific opportunities that these sources enable will be discussed. Finally, we will discuss the steps that one needs to follow to get access to the capabilities at NSLSII for your own research.


***4:30pm – 5:00pm***

### ROLE FOR HARD X-RAY LIGHT SOURCES IN MATERIALS SCIENCES

*Ernest Fontes (CHESS)*


**ABSTRACT**

The Cornell High Energy Synchrotron Source, CHESS, is in the final stages of an upgrade project to raise the machine energy to 6 GeV and build new longer beamlines and larger experimental stations. These all add up to brand new research capabilities providing very high X-ray intensities, wide X-ray energy ranges, all coupled to state-of-the-art fast detectors to enable time- and spatially-resolved studies. This talk will describe briefly the technical changes but focus mostly on the science applications that we hope will excite the audience to picture their own research needs.


***5:00pm – 5:20pm***

### APPLYING ARTIFICIAL INTELLIGENCE TO PARTICLE ACCELERATORS

*Dorian Bohelr, SLAC National Laboratory*


**ABSTRACT**

Particle accelerators are designed and operated in a wide range of beam phase space distributions, which require many man-hours to set up and optimize. Because of the uncertainty due to limited diagnostics and time varying performance there are significant limitations in the utility of using methods such as look-up tables, simulators, and models to quickly switch between widely varying operational ranges. In this talk I will discuss recent progress in applying machine learning, neural networks, and adaptive feedback algorithms to enable automatic accelerator tuning and optimization.


***5:20pm – 5:40pm***

### KINOFORMS FOR HIGH ENERGY PHOTONS

*Kenneth Evans-Lutterodt, Brookhaven National Laboratory*


**ABSTRACT**

Studying materials with high energy ( > 50 keV ) X-ray photons brings some advantages for materials characterization. For example, the pair distribution function method (PDF) gets better real space resolution with higher energy photons. The ability to focus X-ray beams of high energy photons brings further experimental benefits for materials characterization, including greater flux on small samples, improved signal to background, and also enabling spatial scanning of samples. In this talk, we present our recent results using silicon kinoform lenses to focus X-ray photons with energies as low as 52 keV and as high as 107 keV, measured on beamlines 1-ID and 11-ID-C at the Advanced Photon Source. In a number of experiments, we have created micron and submicron beams, in some cases as small as 225 nm. Latest improvements in lens fabrication will also be presented. We will also show a numerical comparison between refractive lenses made from Beryllium, Silicon and Aluminum and kinofom lenses made from Silicon and discuss the relative merits for these high photon energies.

*5:40pm – 6:00pm*

**PART 1: INCREASE-ING ACCESS TO ADVANCED LIGHT SOURCES**

*Eric Sheppard, Hampton University*

**ABSTRACT**

Data shows that the Interdisciplinary Consortium for Research and Educational Access in Science and Engineering (InCREASE) has had a significant impact on Minority Serving Institutions (MSIs) users at the Department of Energy (DOE) labs, particularly at Brookhaven National Lab (BNL). InCREASE is a network of faculty from MSIs formed to increase MSI faculty access to advanced research tools, particularly advanced light sources at national labs, and to create a cadre of students exposed to significant research at such facilities. We will describe InCREASE and its achievements.

**PART 2: OPPORTUNITIES FOR STUDENT AND FACULTY RESEARCHERS AT BROOKHAVEN AND OTHER DOE LABORATORIES**

**ABSTRACT**

DOE offers a variety of research experiences for students, postdocs and faculty at its national laboratories. For example, the Office of Education at Brookhaven National Laboratory is home to workforce development and education initiatives that support the scientific and diversity and inclusion missions of that lab. We will discuss these opportunities and how to get involved.

## TUESDAY, NOVEMBER 6

### *MEETING ROOM 33*
### SESSION TIME: 11:30am – 12:00noon

*11:30am – 12:00noon*

**WORKSHOPS: SPS – NETWORKING AND YOUR CAREER TOOLBOX**

### SESSION TIME: 2:00pm – 3:00pm

**STUDENT TALK – NPP**

*2:00pm – 2:10pm*

**TWO-ALPHA CORRELATION FUNCTION**

*Pierre Nzabahimana, Michigan State University*

**ABSTRACT**

In heavy-ion collisions, Two-particle Correlation Function have been important tool to determine the size of two-particle emitting sources. The nuclear interaction between two emitted particles gives rise to resonance peaks in the Correlation Function (CF). In the □−□ CF, the resonance peak, which corresponds to the unstable ground state (G.S) of 8Be at relative momentum q =18 MeV/c, is due to S-wave interactions while the one corresponding to the 1st excited state of 8Be at q =108 MeV/c is due to D-wave interaction. We have solved the radial Schrödinger Equation (SE) to find the radial wave functions and the phase shifts (□□) for different partial waves (i.e., S-wave and D-wave for low energy reactions), which can be used to construct the full scattering wave function. This full wave function and the model source are subsequently used to compute the CF that, when compared to the experimental CF, allows to determine the emitting source distribution function. We will present preliminary results from this work.

*2:10pm –2:20pm*

**BACKGROUND SPECTRUM ANALYSIS OF THE PULSTAR REACTOR USING A HP GE DETECTOR**

*Elon Price, North Carolina State University*

**ABSTRACT**

Background radiation can often be a significant issue with large scale nuclear physics experiments. A background spectrum for the PULSTAR reactor can be vital information for ongoing projects like UCN nEDM, Neutron Activation Analysis, and Neutron Radiography of turbine blades for jet engine manufacturing (to name a few). High-purity germanium detectors are used for gamma-ray spectroscopy and are more efficient and sensitive than standard 3" x 3" Na(Tl) detectors. I used a 2001A Canberra HP Ge detector and conducted several 24 hour runs in the reactor bay. Using ROOT, I generated a smoothed histogram and fitted the data with a Gaussian and linear model. Using the known Ar-41 and K-40 peaks (energies 1293 keV and 1460 keV), I was able to produce a calibrated spectrum which allowed me to find other gammas like Na-24 and Th-232. Currently I'm working with Geant4, to subtract the Compton scattering portion of the spectrum. The resulting product will be a well-calibrated background spectrum of the reactor including the total and peak efficiency.

*2:20pm –2:30pm*

**A DUAL PHASE TPC/THICK-GEM BASED TARGET TO STUDY UNBOUND NUCLEI**

*Angel Christopher, Hampton University*

**ABSTRACT**

The Facility for Rare Isotope Beams (FRIB) is currently being constructed on the campus of Michigan State University. When completed, FRIB will become an unprecedented low energy nuclear physics facility in the world to study neutron rich nuclei with heavy ion beams. The MoNA Collaboration, which consists of 11 institutions, has been involved at the National Superconducting Cyclotron Laboratory for almost two decades. Hampton University joined the collaboration in 2013 and led the development of a Si-Be segmented target that was used to measure the lifetime of 26O and neutron unbound states in the island of inversion using the invariant mass technique. This target provided for the first time detail information about the incident beam position and energy, before and exiting the Be targets to within 10%. A proposal to construct a dual-phase based time-projection chamber is being investigated by the MoNA Collaboration since it would increase the position and energy resolutions, and allow missing mass reconstruction by detecting the recoil fragments. Results from a realistic Geant4 Monte Carlo that include expected performances of this proposed target will be presented.

*2:30pm –2:40pm*

**SOFTWARE TOOL FOR PERFORMING CALIBRATION OF THE AT-TPC ELECTRONICS CHANNELS**

*Felix Ndayisabye, Michigan State University*

**ABSTRACT**

The Active Target Time Projection Chamber (AT-TPC), developed at the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University, is a gas-based system that serves a dual role of a target and detector medium for nuclear physics experiments. Active target devices have gained much attention in recent years due to their high resolution and efficiency to study reactions with very exotic nuclei. With the use of low(1-10 MeV/u) to medium energies (10-100 MeV/u) to extract the physical properties of nuclei far from stability, the AT-TPC is contributing significantly to experimental nuclear science, thanks to its high luminosity working capability without loss of resolution and low-energy detection thresholds that enable experiments with beam intensities as low as 10 2 pps. Because of its unique features, a dedicated Python based data analysis tool was developed to extract information from this target. This software tool allows to calibrate the electronic baselines, amplitudes and times of the signals recorded by each of the AT-TPC pads relative to each other. We will present an overview of the NSCL AT-TPC and results from calibration data.

*2:40pm –2:50pm*

**USING GEANT4 TO STUDY THE EFFECTS OF RADIATION DAMAGE ON SCINTILLATORS**

*Avi Kahn, University of Maryland*

## ABSTRACT

This project - performed within the CMS collaboration - involves the use of Geant4 to simulate absorption experiments conducted on scintillators at UMD. With this project we hope to create an accurate computer model of these measurements so that we can supplement our experimental data. In addition, the model can be used to study the effects of radiation damage at dose rates different from those explored experimentally, particularly the very low dose rate present near the CMS hadron calorimeter at the Large Hadron Collider (LHC).

## SESSION TIME: 4:00pm – 6:0pm

**WORKSHOPS: LEARNING QUANTUM MECHANICS**

*4:00pm – 5:00pm*

**RESEARCH-BASED TOOLS AND TIPS FOR LEARNING AND TEACHING QUANTUM MECHANICS**

*Chandralekha Singh, University of Pittsburgh*

## SESSION DESCRIPTION

We have been engaged in research to improve student learning of upper-level quantum mechanics. In this workshop, we will discuss how the common difficulties that students have in learning quantum mechanics was used to develop research-based learning tools to reduce student difficulties. These learning tools include Quantum interactive learning tutorials (QuILTs), concept-tests for peer instruction, and reflective problems which are conceptual in nature. The QuILTs are based upon research in physics education and employ active-learning strategies and Open Source Physics visualization tools. They attempt to bridge the gap between the abstract quantitative formalism of quantum mechanics and the qualitative understanding necessary to explain and predict diverse physical phenomena. This workshop is targeted to both instructors and students who would like to supplement their existing course material with research-based field-tested tools that provide scaffolding support to learn quantum mechanics and a high degree of interactivity. Participants will work in small groups on research-based interactive tools that incorporate paper-pencil tasks and computer simulations. We will discuss the general pedagogical issues in the design of the learning tools and how they can be adapted to individualized curricula. Some learning tools deal with contemporary topics such as quantum key distribution that can be taught using simple two level systems.

This work is supported by the National Science Foundation.

*5:00pm – 6:00pm*

**USING SOCIAL PSYCHOLOGICAL INTERVENTIONS TO IMPROVE LEARNING OF ALL STUDENTS**

*Chandralekha Singh, University of Pittsburgh*

## SESSION DESCRIPTION

Instructors often focus on content and pedagogical approaches to improve student engagement and learning in physics courses. However, students' motivational characteristics can also play an important role in their engagement and success in physics. For example, students' sense of belonging in a physics class, their self-efficacy, and views about whether intelligence in physics is "fixed" or "malleable" can affect engagement and learning. These types of concerns can especially impact the learning outcomes of women and other underrepresented students in the physics classes and stereotype threats can exacerbate these issues while learning physics. In this workshop, we will discuss prior research studies that show how different types of social psychological interventions (e.g., social belonging and growth mindset) have improved the motivation and learning of all students, especially women and underrepresented minorities in STEM fields. These interventions include providing data to students about how intelligence is malleable and one can become an expert in a discipline by working hard in a deliberate manner, sharing with students examples of testimonies of past students with diverse backgrounds who struggled initially but then succeeded by working hard and using deliberate practice, asking students to write a letter to a future student about how they can succeed in physics and view struggling as a stepping stone to succeeding and giving students an opportunity to share their concerns with peers. We will discuss how these interventions can be adapted and implemented in physics classes. We will also describe and have participants reflect upon a social belonging and growth mindset intervention that we have incorporated in introductory physics courses and findings from the intervention. The types of interventions discussed in this workshop are short, requiring less than one hour of regular class or recitation time even though they have the potential to impact student outcomes significantly—especially for women and other underrepresented students in physics classes. This workshop is suitable for college instructors and teaching assistants (both graduate and undergraduate). This work is supported by the National Science Foundation.

## WEDNESDAY, NOVEMBER 6

### *MEETING ROOM 21*
### SESSION TIME: 10:00am – 11:30am
**POSTER JUDGES CONVENE**

### *MEETING ROOM 22*
### SESSION TIME: 10:00am – 11:30am
**WORKSHOP: SPS – –DEPARTMENT HEALTH, COHORTS, AND COMMUNITY DEVELOPMENT**

### *MEETING ROOM 32*
### SESSION TIME: 10:00am – 11:30am
**COSMOLOGY, GRAVITATION AND RELATIVITY (CGR) – 3**

***10:00am – 10:20am***

**SEARCHING FOR HIGHLY ECCENTRIC SYSTEMS WITH BAYESWAVE**

*Belinda D. Cheeseboro, West Virginia University*

**ABSTRACT**

Recent simulations of binary systems have predicted that some binaries have non-negligible eccentricity when entering the LIGO band. Highly eccentric systems produce a series of disconnected bursts that current data analysis methods in LIGO cannot detect. Therefore we present a method for detecting these sources using BayesWave, an existing algorithm for unmodeled burst searches. Our method introduces a prior that will help BayesWave connect the quiet, disconnected bursts in the earlier stages of the signal. It does this by using an orbital model that predicts the locations for the next or previous burst. We will discuss current tests using this prior, and plans for implementation into BayesWave.

***10:20am – 10:40am***

**SEARCHING FOR DECAYING AND ANNIHILATING DARK MATTER WITH LINE INTENSITY MAPPING**

*Cyril Creque-Sarbinowski*

**ABSTRACT**

The purpose of line-intensity mapping (IM), an emerging tool for extragalactic astronomy and cosmology, is to measure the integrated emission along the line of sight from spectral lines emitted from galaxies and the intergalactic medium. The observed frequency of the line then provides a distance determination allowing the three-dimensional distribution of the emitters to be mapped. Here we discuss the possibility to use these measurements to seek radiative decays or annihilations from dark-matter particles. The photons from monoenergetic decays will be correlated with the mass distribution, which can be determined from galaxy surveys, weak-lensing surveys, or the IM mapping experiments themselves. We discuss how to seek this cross-correlation and then estimate the sensitivity of various IM experiments in the dark-matter mass-lifetime parameter space. We find prospects for improvements of

ten orders of magnitude in sensitivity to decaying/annihilating dark matter in the frequency bands targeted for IM experiments.

***MEETING ROOM 31***

**SESSION TIME: 10:00am – 11:30am**

**ASTRONOMY – 3**

## SESSION DESCRIPTION

The interactive session will be an opportunity for undergraduate and graduated students to ask questions about strategies relevant for building a career as a professional Astronomer/Astrophysicist. Tips for applying to graduate schools and postdoctoral positions, and suggested techniques for making the most of your time at each stage along your career path will be some of the topics covered.

***MEETING ROOM 34***

**SESSION TIME: 10:00am – 11:30am**

**HBCU, MSI FUTURE FACILITIES NEED ROUNDTABLE**

***10:00am – 11:30am***

**FUTURE STEM FACILITY AND EQUIPMENT NEEDS**

## SESSION DESCRIPTION

This session will take the form of a roundtable discussion. Access to research facilities and instrumentation is essential if young minds are to advance STEM knowledge and solve critical problems facing the nation and the world. In addition, access is necessary if we are to successfully diversify the future STEM workforce. This session will focus on the facilities and equipment needs of traditionally underrepresented minority institutions, and identification of potential projects and pathways moving forward. Following this session, working groups will be formed to further explore major ideas that evolve out of the discussion. In order to adequately prepare for this session, it will be important to have an estimate of the number of people planning to attend. Please indicate your intent and/or interest in attending this session no later than 10 PM Tuesday evening, November 6 at https://www.surveymonkey.com/r/HBCU_MSI_Needs . Thank you in advance for your cooperation. This session is sponsored by AUI.