SCIENTIFIC SESSIONS, WORKSHOPS AND POSTERS

LOCATION:
Contributed Talks
Workshops & Panels
Undergraduate Posters
Graduate/Post Doc Posters

**Friday, November 6**

Session Time: 10:00 am – 11:30 am

**Auditorium – Opening Session**
**Speaker:** Dr. Larry Gladney, *Yale University*

**Friday, November 6**

Session Time: 1:00 pm – 2:15 pm

**Auditorium – Virtual Luncheon**
**Speaker:** Dr. Tabbetha Dobbins, *Rowan University*

**Friday, November 6**

Session Time: 4:00 pm – 5:00 pm

**Auditorium – What Can Scientists Learn from Artists?**
**Speakers:** Stephon Alexander, *NSBP President & Brown University*

**Description:** The Simons Foundation hosts public lecture with NSBP President Stephon Alexander
**Link:** [https://www.eventbrite.com/e/what-can-scientists-learn-from-artists-registration-126274687991](https://www.eventbrite.com/e/what-can-scientists-learn-from-artists-registration-126274687991)

**Friday, November 6**

Session Time: 5:00 pm – 6:00 pm
**Auditorium – Simons-NSBP Undergraduate Scholars**  
**Speakers:** Undergraduate Scholars Present Summer Research  

**TIME:** 5:10 pm – 5:15 pm  
**TITLE:** Chern-Simons Modified Gravity: From String Theory to Rotation Curves  
**Speaker(s):** Nico Cooper, *Princeton University*

**Abstract:** In this project, conducted during the Simons-NSBP Scholars Program, we investigate recent techniques to calculate observables in dynamical Chern-Simons modified gravity. Attempting to model dark matter phenomena is of particular interest with gravitational observables such as geodesics and galactic rotation curves. In particular, galactic rotation curves are a concrete form of data that a model aims to fit, while geodesics are indicative of the large scale kinematics of the theory. Following the work of Konno, Matsuyama, Asano, and Tanda, we calculate the Kretschmann scalar and equations of motion, including the ChernPontryagin density term unique to dynamical CS modified gravity. Under the given metric, we find that equatorial trajectories follow the expected Newtonian 1/r behavior, plus an asymptotically constant term involving two constants of integration. Using 21-cm galactic emission spectra, we fit these constants to the well-observed flat galactic rotation curve of the Milky Way. Using these values for the constants of integration, we also construct equatorial geodesics, and compare them to those of the Schwarzschild metric, using the xAct Mathematica packages.

**TIME:** 5:15 pm – 5:20 pm  
**TITLE:** Universal Shorts Diagnostic Code  
**Speaker(s):** Tarisa Ross, *North Carolina Central University*

**Abstract:** Simons Observatory (SO) will be located at 5200 m in the Atacama Desert in Northern Chile and will consist of instruments that detect the temperature and polarization of the cosmic microwave background radiation. The five instruments include a large (6 m) aperture telescope and four small (42 cm) aperture telescopes. Simons Observatory detector modules, called Universal Focal Plane Modules (UFMs), are a critical component of both the small aperture telescopes and large aperture telescope. In total, 49 detector modules will be fielded, most of which hosts 1764 transition edge sensor (TES) detectors, fabricated on a 150 mm silicon wafer. The UFMs have additional silicon wafers with accompanying readout circuitry, which are electrically connected with over 10,000 aluminum wire bonds (25um in diameter). Due to fabrication and assembly processes, some main electrical lines develop shorts between each other. Shorts are detected with a current-controlled probing station during assembly validation, which measures the drop in resistance across the niobium traces. Here we will describe the development of a Universal Short Diagnostic Code (USDC), which models the complex network of microscopic wiring in the UFMs and predicts the location of shorts within the UFM. Because of the flexibility of the design, the code can be applied to other high-resistance systems that have complex circuitry. The code developed for the SO UFMs consistently predicts locations of electrical shorts with 90% accuracy.

**TIME:** 5:20 pm – 5:25 pm  
**TITLE:** Local Reconnection Simulations for the Affirmation of Synchrotron Radiation Induced Photon Distribution Changes  
**Speaker(s):** Emmanuel Anneke, *Stanford University*

**Abstract:** Supernovae are the explosion that signify the death of a star however with its death also comes life. Pulsars, one of the potential remnants of a supernova, are magnetized spinning neutron stars that narrowly emit particles from its magnetic poles. Because of their rotation, we observe their radiation in pulses, hence the name. When the intense magnetic field of a pulsar interacts with the emitted radiation and debris, the astrophysical phenomenon known as reconnection occurs. Magnetic reconnection is the mechanism by which the emitted particles gain and lose energy as they leave the pulsar’s realm of influence. With simulations, we affirm our mathematically derived theories on what causes reconnection to a finer detail. The light we see gives us a photon distribution. That photon distribution gives us a particle distribution tells us about the physical parameters that makes reconnection possible. Synchrotron radiation is light emitted by particles that experience a change in acceleration due to a magnetic field which causes the particles to lose energy and “cool”. In this talk, I will computationally verify the direct correlation between the intensity of synchrotron radiation cooling and the shape of the photon distribution of a pulsar.

**TIME:** 5:25 pm – 5:30 pm
TITLE: SZ Galazy Clusters and Dust Emission in Planck Legacy Archive Data  
Speaker(s): Alyssa Johnson, Humboldt State University

Abstract: This report discusses research completed under the Simons Observatory and National Society of Black Physicists inaugural scholar program. Partnered with mentor Professor Kevin Huffberger at Florida State University, I worked to study and model dust emission in Planck Legacy Archive data, using the positions of SZ Galaxy Clusters from recent Atacama Cosmology Telescope data products. This report also discusses involvement with the SO-NSBP program and summer research in the time of COVID-19.

TIME: 5:35 pm – 5:40 pm  
TITLE: TBA  
Speaker(s): Gilles Djomani, University of California Los Angeles

Abstract: At the 2020 Annual Conference of the National Society of Black Physicists (NSBP), Gilles will speak on his experience as a Simons-NSBP Scholar, including how his collaboration with Philip Mauskopf, Professor at Arizona State University (ASU)'s Department of Physics and School of Earth and Space Exploration; the NSBP; the Simons Observatory; and the Quantum Engineered Sensors and Technology (QuEST) group at ASU, allowed him to begin research he expected to be doing once in a graduate program. Next, he will speak on his research in the development of Microwave Superconducting Quantum Interference Device (SQUID) Multiplexers (μmux) and their applications in Simons Observatory’s Large Aperture Telescope (LAT) and Small Aperture Telescope (SAT). Lastly, he hopes to shine light on the many skills obtained within the Simons-NSBP Scholars program.

TIME: 5:45 pm – 5:50 pm  
TITLE: TBA  
Speaker(s): Jacob Brown, University of Pennsylvania

Abstract: Context: Galaxy clusters, the largest gravitationally bound structures in the universe, become both more important to cosmology with high redshift and more difficult to detect and characterize. It can be difficult or expensive to estimate the mass of a cluster, which is why astronomers have sought a cheaper and easier indirect way to do so for a while. Using data from WISE, or Wide-field Infrared Survey Explorer, the Massive and Distance Clusters of Wide-field Infrared Survey Explorer (WISE) Survey (MaDCoWS) found roughly 2,500 clusters from a redshift range of between 0.7 and 1.5.

Aims: This study aimed to verify MaDCoWS clusters by using measurements of their Sunyaev-Zeldovich (SZ) effect signatures; these detections would also be used to establish a relation between SZ-inferred mass and the richness of a cluster as defined by MaDCoWS.

Methods: The study used data from the Advanced Atacama Cosmology Telescope (AdvACT) 2018 survey to explore the mass-richness relation. My role in this was to compare the detected clusters that overlapped between surveys and use this to connect SZ-inferred mass and richness.

Results: The study found a bimodality in the mass-richness relation that can be explained by contamination in MaDCoWS’ measure of richness by unvirialized components near the line of sight of the telescope. Furthermore, MaDCoWS consistently recorded higher redshift values than ACT.

TIME: 5:50 pm – 5:55 pm  
TITLE: Evolution of stars in AGN Disks  
Speaker(s): Aidan Simpson, Rensselaer Polytechnic Institute

Abstract: Used One dimensional stellar evolution code to simulate a star a disk around an Active Galactic Nuclei, and tested how larger networks of elements effected the evolution of the star in its later stages of life. Stars in this region of space evolve very differently, they slowly accrete mass from the disk of the AGN, and that mass causes it to accrete more mass in a runaway effect. The change in mass causes a variety of effects to occur within the star.

Friday, November 6

Breakout Room: Dr. Shirley Jackson  
Session Time: 9:00 am – 10:00 am  
Physics Research Education (PER)
Session Chair(s): Juan Burciaga, Colorado College

TIME: 9:00 am – 9:30 am  
TITLE: See the Physics and Astronomy SEA Change project  
Speaker(s): Alexis Knaub, American Association of Physics Teachers

Abstract: The American Association for the Advancement of Science (AAAS) has recently started the STEMM Equity Achievement (SEA) Change project. Institutions interested in participating in the SEA Change project undergo a self-assessment to examine the institution in terms of equity, especially with regards to race, gender, disabilities, and intersections of these identities. Representatives from physics and astronomy professional societies have been working with AAAS to pilot a similar award. This presentation provides an overview of the Physics and Astronomy SEA Change project, thus far, and highlights ways to stay informed and get involved.

TIME: 9:30 am – 9:45 am  
TITLE: Improving Student Success in Introductory Physics Courses at the U.S. Air Force (USAFA)  
Speaker(s): Tuwaner Lamar, Morehouse College

Abstract: Can success in the first Physics course taken be predicted by placement into first Math course taken, at or above Calculus I? Could it be that students who are successful in their Calculus I course have a greater chance of succeeding in their first Physics course? We found a positive correlation between initial Math placement at Calculus I or higher and success in the first Physics course for both students at Morehouse College and cadets at the United States Airforce Academy (USAFA). Interventions to improve chances of student success in their first Physics course at USAFA were designed, implemented, and analyzed.

TIME: 9:45 am – 10:00 am  
TITLE: Development of a Simulation and an Educational Game to Help with the Understanding of Electric Fields  
Speaker(s): Ted Mburu, Ithaca College

Abstract: Because electric fields cannot be touched or seen, simulations are often utilized to build students' understanding of them by providing them with a visual of electric fields and the motion of test charges through them. The objective of the simulation is to improve students' qualitative understanding of how electric fields are impacted by a configuration of charges by creating a dynamic representation of the electric field lines, field vectors, equipotential lines and the voltage created by the charges on screen. After creating a charge configuration, the simulation visualizes the motion of test charges through the electric field. The core physics principles of the simulation have also been used as the foundation of the mechanics of an educational game. Our aim in the gamification of the simulation is to improve motivation and engagement in the material. Both the simulation and game were built in JavaScript so they will run on most browsers on a computer or mobile device. In the talk, we will discuss how pilot test study data and multimedia instructional tool research was used to guide the development of these tools and how you can use these tools.

Friday, November 6

Breakout Room: Dr. Jim Gates  
Session Time: 9:00 am – 10:00 am  
Earth and Planetary Systems Sciences (EPSS) – 1.A  
Session Chair(s): Lynnae Quick, NASA & Alex Evans, Brown University

TIME: 9:00 am – 9:15 am  
Speaker(s): Carissma McGee, Howard University

Abstract: The NASA Earth Venture Cyclone Global Navigation Satellite System (CYGNSS) is a constellation of eight microsatellite observatories that was launched into a low (35°) inclination, low Earth orbit on 15 December 2016. Each observatory carries a 4-channel GNSS-R bistatic radar receiver. The radars are tuned to receive the L1 signals transmitted by GPS satellites, from which near-surface ocean wind speed is estimated. The mission
architecture is designed to improve the temporal sampling of winds in tropical cyclones (TCs). The 32 receive channels of the complete CYGNSS constellation, combined with the ~30 GPS satellite transmitters, results in a revisit time for sampling of the wind of 2.8 hr (median) and 7.2 hr (mean) at all locations between 38° North and 38° South latitude. Operation at the GPS L1 frequency of 1575 MHz allows for wind measurements in the TC inner core that are often obscured from other spaceborne remote sensing instruments by intense precipitation in the eye wall and inner rain bands. An overview of the CYGNSS mission is presented, followed by early on-orbit status and results.

TIME: 9:15 am – 9:30 am
TITLE: Imaging the Upper Plate and Mantle Wedge in the Nicaraguan Subduction Zone with Sp Phases
Speaker(s): Emily Carrero-Mustelier, Columbia University

Abstract: The goal of this study is to better understand how subduction zone melting processes appear in the structure of the mantle wedge and modify the upper plate lithosphere. We focused on the Nicaraguan segment of the Central American subduction zone, where the Cocos plate subducts beneath the Caribbean plate, and partial melting in the mantle wedge above the slab creates a well-defined volcanic arc. We imaged mantle seismic velocity gradients using Sp converted waves. Broadband waveforms were employed from the Nicaraguan INETER network, the TUCAN broadband seismometer experiment, and other regional networks. Using periods of 4-100s and time-domain deconvolution, we calculated Sp receiver functions. With common-conversion point (CCP) stacking that employs weighting functions based on Sp sensitivity kernels, the receiver functions were mapped to three-dimensional positions in space. In the resulting CCP stack, Sp arrivals indicate a negative velocity gradient at the base of the Caribbean upper plate where it meets the warm mantle wedge. In the near back-arc, this velocity gradient lies at depths of approximately 75 km, but it deepens to 100 km depth further into the back-arc in northeastern Nicaragua. This result is consistent with thinning of the upper plate by subduction zone flow and melting processes closer to the arc. The CCP stack also shows positive gradients in the mantle wedge, and the strongest and most widespread of these occurs at depths near 150 km. This feature likely represents the onset of partial melting in the deeper regions of the mantle wedge.

TIME: 9:30 am – 9:45 am
TITLE: Modeling the Seismic Wave Velocity Structure of Mars
Speaker(s): Kara Jaramillo, Brown University

Abstract: For the first time in history, scientists are able to detect Marsquakes with high-quality data. Thanks to NASA’s 2018 InSight mission to Mars, we are now equipped to understand Mars’ crustal composition and layering, using seismic waves to measure boundaries within Mars’ crust. Our main goal is to resolve the seismic velocity structure of the shallow crust of Mars through modeling receiver functions of teleseismic converted waves, which

TIME: 9:45 am – 10:00 am
TITLE: I’ve Looked at Clouds from Both Sides, Now: Viewpoints from Surface and Spaceborne Lidar System
Speaker(s): Jasper Lewis, University of Maryland Baltimore County

Abstract: Clouds play a critical role in the Earth’s climate system because they are inextricably linked to the hydrological cycle and radiation budget. Information about cloud height, thickness, occurrence, and amount are critical inputs for a host of numerical applications involving climate research. Therefore, it is important to have highly accurate and quantitative data records of cloud properties that span several years and geographic regions. Verification of even the most basic modeling processes demands long term and continuous observations of global cloud occurrence, if there is to be any confidence in their fidelity. For a number of reasons, however, it is impossible to gauge the complexities of clouds from a single source. Fundamentally, an array of remote sensing methods is needed in order to provide a complete picture. Within the Micropulse Lidar Network (MPLNET), we have developed a new algorithm to improve the quality of our cloud products. The largest impact of the changes to the cloud detection algorithm is evident with high clouds (those with cloud base > 5 km). Furthermore, polarized measurements enable us to determine the cloud thermodynamic phase. Naturally, the next step is to investigate how these improvements compare with observations from spaceborne lidars (e.g. CALIOP) which have a better (unobstructed) view of high clouds. Recent advances in remote sensing have revealed that cirrus clouds are the most common cloud genus observed in the atmosphere. Furthermore, cirrus skew highly towards relatively low cloud optical depths, as observed from both surface and spaceborne viewpoints. The radiative impacts of these findings are quite significant, considering the cumulative effect cirrus exhibit when compared to low clouds.
are sensitive to the depth of crustal discontinuities. I employed Sp and Ps receiver functions obtained from InSight data (Lekic and Kim, pers. comm.). For many different velocity structures, I calculated the synthetic seismic waves using the propagator matrix method and predicted their receiver functions, to which I compared the observed receiver functions. Initial modeling results show that both Sp and Ps data require velocity increases at depths of ~10 km and 20-30 km. The Sp data also indicates a deeper discontinuity at a depth of ~54 km, which is consistent with prior estimates of crustal thickness. The velocity contrasts at discontinuities are less well-constrained; however, our best-fitting models indicate mid-crustal velocities of ~3.5 km/s, which is consistent with a basaltic composition. Overall, these results show evidence of a relatively thick crust of basalt below 10 km with two distinct layers within the basalt. In the future this project could help with the planning of seismic studies on other planets in our solar system while simultaneously being able to compare in situ data from Mars to that of other planets.

Friday, November 6

**Breakout Room:** Dr. Jim Gates  
**Session Time:** 11:30 am – 1:00 pm  
**Earth and Planetary Systems Sciences (EPSS) – 1.B**  
**Session Chair(s):** Lynnae Quick, NASA & Alex Evans, Brown University

**TIME:** 11:30 am – 12:00 pm  
**TITLE:** Lifetime of a transient atmosphere produced by Lunar Volcanism  
**Speaker(s):** Orenthal Tucker, NASA Goddard Space Flight Center

**Abstract:** The lifetime of an early CO atmosphere on the Moon produced by volcanic outgassing is estimated. Here we re-examine the relevant processes for removing such an atmosphere both in the presence and absence of a possible transient magnetic field. Both thermal and nonthermal escape processes are evaluated as a function of the total atmospheric mass as well as the effect of the presence of a light constituent such as H2. Our simulations indicate that solar driven non-thermal escape could remove a CO millibar atmosphere similar to the present Mars atmosphere on the order of ~0.1 Myrs since escape is much more efficient on the Moon. This result, of course, depends on the efficiency of solar UV/EUV absorption heating the upper atmosphere and powering escape. We show that hypothetical CO atmospheres with average exobase temperatures < ~275 K would have been relatively stable against thermal escape. Whereas if heating of the upper atmosphere by solar UV/EUV absorption results in average exobase temperatures > ~ 325 K, thermal escape increasingly dominates the loss rate.

**TIME:** 12:00 pm – 12:15 pm  
**TITLE:** Regolith Structural Characterization Of Lunar Swirls Within Mare Ingenii.  
**Speaker(s):** Deborah Domingue, Planetary Science Institute

**Abstract:** Lunar swirls are distinctive bright albedo markings associated with lunar crustal magnetic anomalies [1,2], though maps comparing crustal magnetic anomalies and swirl locations show that not all lunar magnetic anomalies have an associated swirl [3,4]. The two hypotheses that are best supported by the spectral evidence for the formation of swirls include magnetic shielding of the surface from solar wind bombardment, which reduces the space weathering alteration of the surface, and electrostatic dust transport and/or magnetic sorting of the fine-grained portion of the regolith. One mechanism for possibly distinguishing between these two swirl formation hypotheses is to examine and compare the physical structure of the regolith both in the swirl region and off-swirl. Thermal measurements of swirl regions have shown that the thermophysical properties within the swirls and the surrounding regions are nearly identical, suggesting similar roughness and porosity/compaction properties [5]. Photometric studies to date, however, have demonstrated variations between swirls and off-swirl regions. There have been several photometric studies of lunar swirls suggesting that the regolith within the swirls have lower millimeter-scale roughness and greater compaction [6,7,8]. These studies are based on phase ratio and empirical photometric modeling to examine and characterize the lunar surface. We present photometric analyses of an area in the Mare Ingenii swirl region (Fig. 1) using Hapke’s set of photometric equations [9]. This analysis uses stereophotoclinometry (SPC) to generate incidence, emission, and phase angle information that accurately accounts for topography. The output from the SPC analysis includes high-resolution topography in addition to the aforementioned photometric angles. Preliminary model results (Fig. 2) show a correlation with single scattering albedo, but no correlation with roughness or scattering properties. Since the swirl is defined by its albedo properties, it is expected to show correlations in single scattering albedo. The lack of correlations with scattering
phase function and roughness imply similar structural properties in the on- and off-swirl regoliths. Both visual and statistical correlations with topography are currently being examined.

TIME: 12:15 pm – 12:30 pm  
TITLE: Subsurface water-rock-gas interactions, habitability, and planetary evolution  
Speaker(s): Jesse Tarnas, Brown University

Abstract: Water-rock-gas alteration in subsurface environments affects the crustal and atmospheric evolution of planetary objects. Methane produced in the subsurface of Mars may have generated warming events to form fluvial features on its surface. Water-rock reactions at the ocean-rock interface on Europa may generate redox energy to support life there. Long-isolated deep brines in Earth’s crust may represent the largest terrestrial reservoir of industrially-useful noble gas and H2 resources. Here we investigate the large- and small-scale physical and chemical architectures controlling geochemical and biogeochemical processes in subsurface environments across the Solar System. We also characterize how these processes affect the evolution of different planetary objects, causing some to host habitable environments for Earth-like life, and some to not. The results presented here establish a framework linking water-rock-gas interactions, habitability, and planetary evolution. They also establish key questions for subsurface planetary science that can be answered by future Earth-based fieldwork and space exploration by humans and robots.

TIME: 12:30 pm – 12:45 pm  
TITLE: Finding and Characterizing Earth's Nearest Neighbors: Asteroids and Comets  
Speaker(s): Amy Mainzer, University of Arizona

Abstract: Asteroids and comets are continued sources of study both because they record conditions in the pre-solar nebula and its subsequent thermal and collisional processing, and because they have the potential to impact the Earth. Efforts to quantify the probability of near-term Earth impacts are ongoing through dedicated ground- and space-based surveys using modest-sized (meter-class) telescopes. While most of the very large near-Earth asteroids have already been discovered and pose no collisional hazard, more work remains to be done to find, catalog, and characterize the majority of objects that are still large enough to cause large-scale consequences. Searches for potentially hazardous objects have as a byproduct provided data on the physical and orbital properties of small bodies throughout our solar system, enabling detailed study of their origins and evolution. These studies also facilitate measurement of the more detailed parameters of individual objects that must be understood in order to successfully mitigate a potential impact event. The choice of strategies that might be employed to deflect an object depend greatly on how much time is available, and what can be determined about it in advance. Since the impact energy depends strongly on relative velocity and mass, it is important to rapidly obtain robust measurements of objects’ orbits and effective spherical diameters. The process of identifying potential hazards involves first finding the objects, obtaining robust orbits for them, making basic measurements of physical properties such as size, and then obtaining more detailed characterization data such as composition, density, shape, spin state, porosity, and multiplicity for a smaller subset of objects. One of the best ways to enable mitigation of a potential impact is to ensure that objects are found when they are decades away from any possible close encounters.

TIME: 12:45 pm – 1:00 pm  
TITLE: The Composition and Formation of Mud Volcanoes on Mars  
Speaker(s): Angela Dapremont, Georgia Institute of Technology

Abstract: Mud volcanism has been suggested to explain the formation of pitted cones and domes on Mars. We take advantage of multiple remote sensing datasets from recent Mars missions to address knowledge gaps related to the compositional characteristics and formation of putative Martian mud volcanoes. A global examination of putative mud volcanoes using the CRISM visible and near-infrared (VNIR) spectroscopy dataset reveals that these features exhibit variable degrees of hydration, which suggests that there are differences in water content associated with this process across Mars. Two separate features in the Martian canyon system, Valles Marineris, also exhibit VNIR signatures consistent with unaltered hydrated glass and high-calcium pyroxene of potential volcanic origin. Topographic profiles were acquired from HiRISE camera digital terrain models to investigate the emplacement of mud volcanoes using an analytical model that has been previously applied to volcanic domes on Venus, Ceres, and Jupiter's moon Europa. When compared to eruption durations of terrestrial mud flows, lava domes, and pahoehoe toes, preliminary modeling suggests that pitted cones in Acidalia Planitia, Mars may be emplaced on the order of days to months, with maximum eruption durations closer to 1-2 months being most likely.
The methods we apply to the study of mud volcanism on Mars provide insight into landform evolution on a terrestrial planet other than Earth, and are useful for comparative planetology.

**Breakout Room: Dr. Jim Gates**  
**Session Time:** 2:15 pm – 3:45 pm  
**Earth and Planetary Systems Sciences (EPSS) – 1.C**  
**Session Chair(s):** Lynnae Quick, NASA & Alex Evans, Brown University  

**TIME:** 2:15 pm – 2:45 pm  
**TITLE:** The Columbus Crater Exploration Zone: Preparing for Astrobiology-Focused Exploration in Human Missions  
**Speaker(s):** Kennda Lynch, Lunar and Planetary Institute  

**Abstract:** Humans missions to Mars are projected to start as early as 2035 and work has begun within the science community to assess potential landing sites/exploration zones. Given the diversity of aqueous minerals, the flat basin floor, and biosignature potential due to evidence for groundwater/mineral interaction, we examined the potential of Columbus crater as a candidate landing site for the first human mission to Mars. We used a digital terrain model (DTM) from the High-Resolution Imaging Science Experiment (HiRISE) and near-infrared (~ 1.0 – 3.9 µm) spectroscopy data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) to investigate terrain traversability and supplemental mineralogy in a northeastern section of the crater.

**TIME:** 2:45 pm – 3:00 pm  
**TITLE:** Investigation of Wind Variability on the Stability of Martian Protodunes  
**Speaker(s):** Jalen Garner, Howard University  

**Abstract:** An aeolian sand dune can simply be described as a pile or mound created by the transportation of free sand grains. Despite very different environmental conditions, aeolian sand dunes have been found on several planetary bodies in the solar system, including: Earth, Mars, Venus, and Titan. The presence and morphometrics of these dunes provide information on the surface wind conditions and local atmospheric conditions. What is the effect of wind directional variability (i.e., discriminating between multidirectional, bidirectional & unidirectional wind flow patterns) on the stability of martian protodunes? High-resolution images of the martian surface were examined so as to categorize 427 equatorial dune fields and locate precursors to mature dunes (i.e., protodunes). Of these dune fields, 83 were inspected at higher resolution and 16 were chosen for our study. Within these 16 fields, the direction of winds as suggested by dune and ripple orientation was noted and was further used to determine the level of wind variability – specifically: unidirectional, bidirectional, or multidirectional. In addition, 8 of the 16 studied fields contained protodunes. Of these 8 we noted the complexity of the ripple orientation on protodunes, as well as their shapes. It was found that dune fields with one dominant wind direction (i.e., unidirectional) contain more protodunes than fields with two dominant wind directions (i.e., bidirectional). This suggests that increased wind directional variation may destabilize protodunes, explaining why fewer protodunes in areas of bidirectional winds were found.

**TIME:** 3:00 pm – 3:15 pm  
**TITLE:** Planetary dunes: remarkable records of atmospheric and surface processes across the Solar System  
**Speaker(s):** Serina Diniega, Jet Propulsion Laboratory  

**Abstract:** As of 2020, dune fields have been identified and studied on Earth, Mars, Venus, and the Saturnian moon Titan. Additionally, candidate “aeolian bedforms” have been identified on Comet 67P/Churyumov-Gerasimenko, the Jovian moon Io, and Pluto. These aeolian (wind-driven) bedforms are unique and useful records of the interaction between wind and granular materials – finding such features on a planetary surface immediately suggests certain information about climate and surface conditions. Additionally, studies of extraterrestrial dune characteristics such as shape, size, and location allow for “tests” of aeolian process models that are based primarily on observations of terrestrial features and dynamics. Refinement of such process models, to include consideration of a wider range of environmental and planetary conditions, improves our understanding of the fundamental physics involved in how a shear fluid interacts with topography to loft and transport sediment, and how the layer of moving sediment causes erosion. This presentation will provide a concise overview of the similarities and differences seen in dune fields across the solar system, and what those characteristics imply about the fundamental physics involved in dune initiation, evolution, and destruction. Current open big science questions will then be outlined, along with the new measurements needed to further our understanding if these remarkable features. Some of these measurements
may be addressed via ongoing or planned missions (such as Dragonfly), but some require new mission concepts and opportunities.

TIME: 3:15 pm – 3:30 pm
TITLE: The Dragonfly Mission to Titan and the Student and Early Career Investigator Program: Broadening Participation on Planetary Mission Teams
Speaker(s): Lynnae Quick, NASA Goddard Space Flight Center

Abstract: With its Earth-like hydrological cycle, dense atmosphere, lakes, seas, and abundant organic material, Saturn’s largest moon Titan is a prime target for planetary exploration. Titan is an ideal destination for studying extraterrestrial habitability and pre-biotic chemical interactions. Dragonfly is a NASA New Frontiers mission that will send a rotorcraft to this Earth-like moon to explore its chemistry and habitability. The purpose of the Dragonfly Student and Early Career Investigator Program is to formally extend opportunities for students and postdocs from a variety of STEM disciplines to participate in the development of the Dragonfly mission’s science investigations, and eventually in science activities, at Titan. The program’s overarching goal is to encourage broader participation on planetary mission teams by making it easier for students and early career researchers who don’t already have a connection to Dragonfly or other NASA missions to gain mission experience. The initial phase of the Dragonfly Student and Early Career Investigator Program is open to graduate students at U.S. institutions. These students will be mentored by Dragonfly team members and will have the opportunity to participate in planning aspects of the science measurements that will be made at Titan with various instruments onboard Dragonfly. Applications were widely solicited to facilitate participation of groups that have been historically underrepresented in planetary science and on planetary mission teams. In this presentation we will provide a brief overview of NASA’s Dragonfly Mission, review the structure of the Dragonfly Student and Early Career Investigator Program, and introduce the inaugural graduate student cohort.

TIME: 3:30 pm – 3:45 pm
TITLE: Europa Clipper: Mission Status
Speaker(s): Serina Diniega, Jet Propulsion Laboratory

Abstract: The top-level science goal of NASA’s Europa Clipper Mission is to: Explore Europa to Investigate its Habitability. The mission will observe Europa’s ice shell and ocean, study its composition, investigate its geology, and search for and characterize any current activity. Scheduled for launch in the next several years, the mission is now in Phase C, with construction begun on the highly capable payload of in situ and remote-sensing instruments and accommodations for the payload now being completed. The science team continues to perform preliminary planning, including evaluation the capability of potential trajectories to meet science objectives and design of operations procedures enabling integrated science activities. The instruments are now in their critical design phase of development. Via a mission design that provides >50 globally distributed flybys over a period of ~3.5 years, the Clipper payload will access a diverse and widely distributed set of geologic terrains, providing data to constrain and test geophysical and geochemical models of the ice shell and ocean. The project abides by a “One Team” philosophy, all science team members to participate as part of a single integrated science team. Additionally, the science team’s Rules of the Road document spells out expected behaviors by team members, including the expectation of inclusiveness, respect, and fair and equal treatment for all team members. The team also recently welcomed 12 student and early career “Observers” to a Europa Clipper science team meeting, via a new NASA program aimed at improving diversity within the next generation of mission leadership.

Friday, November 6

Breakout Room: Dr. Elmer Imes
Session Time: 11:30 am – 1:00 pm
Nuclear Particle Physics (NPP) – 1.A
Session Chair(s): Paul Gueye, Michigan State University

TIME: 11:30 am – 12:00 pm
TITLE: COVID-19 Studies from African Countries
Speaker(s): Kétévi Assamagan, Brookhaven National Laboratory
**Abstract:** COVID-19 is a new pandemic disease that is affecting almost every country with a negative impact on social life and economic activities. The number of infected and deceased patients continues to increase globally. Mathematical models can help in developing better strategies to contain a pandemic. Considering multiple measures taken by African governments and challenging socioeconomic factors, simple models cannot fit the data. We studied the dynamical evolution of COVID-19 in selected African countries. We derived a time-dependent reproduction number for each country studied to offer further insights into the spread of COVID-19 in Africa.

**TIME:** 12:15 pm – 12:30 pm  
**TITLE:** Searching for New Physics with High-Energy Neutrinos  
**Speaker(s):** Carlos Arguelles Delgado, Harvard University

**Abstract:** Particle physicists are living in interesting times. We are faced with the paradox of a highly predictive theory --the Standard Model -- that is filled with patterns that are hard to explain. We are also faced with “known unknowns,” like dark matter. Right now, neutrinos are the only particles exhibiting beyond Standard Model behavior, seen in the flavor transitions called neutrino oscillations, which are due to neutrino mass. This is an important clue towards a larger theory. Building on this, I am interested in what other types of flavor transitions neutrinos may have due to new particles, new forces or new symmetries. The IceCube Neutrino Observatory turns out to be an ideal site for these studies. I will discuss our latest results.

**TIME:** 12:30 pm – 12:45 pm  
**TITLE:** Investigation of a GEM based Neutron Detector for the MoNA Collaboration  
**Speaker(s):** Maya Watts, Michigan State University

**Abstract:** The technological advances of gas detector technologies, especially in the areas of micromegas and gas electron multipliers (GEMs), has enabled sub-mm position accuracy and pico-second timing resolution that have impacted greatly the fields of low and high energy nuclear physics research. The MoNA Collaboration is investigating the development of a Gas Photo-Multiplier (GPM) that will be coupled to plastic scintillators for a next generation neutron detector to complement the existing MoNA-LISA neutron array. Preliminary work includes measurement of the light attenuation in a 1 cm x 10 cm x 110 cm BC408 scintillator using an alpha source, comparison of the data with a Geant4 simulation and the construction and testing of a standard GEM detector. We will provide an update on the progress of this work.

**TIME:** 12:45 pm – 1:00 pm  
**TITLE:** Visualization and Interpolation of Field Mapping Data1  
**Speaker(s):** Anita Agasaveeran, Michigan State University

**Abstract:** The MoNA Collaboration utilizes a large-gap (14 cm) high-field (4 T) Sweeper dipole magnet in invariant mass studies of neutron-unbound states. For the invariant mass reconstruction, charged particles need to be tracked through the magnetic field of the Sweeper. 2D planar maps of the vertical component of the magnetic field were measured across the gap when the magnet was commissioned using an array of seven Hall probes placed at different vertical positions. The collected data is being analyzed to generate a 3D field map. Techniques to visualize and interpolate the measured field map will be presented and discussed.

**TIME:** 1:00 pm – 1:15 pm  
**TITLE:** A Study of Rare-Isotope Beams in Hadron Therapy  
**Speaker(s):** Paige Lyons, Michigan State University

**Abstract:** Hadron (e.g., proton, neutrons, heavy ions) beams in Radiotherapy have many biological and physical advantages in comparison to traditional beams such as electrons and photons. Within the past decades, many researchers have found promising results in the use of radioisotopes. For instance, one important advantage in hadron therapy is the possibility of accurately measuring delivered doses in real-time by monitoring the nuclear decay of the isotopes. These advantages have been at the forefront of cancer research, further expanding clinical modalities for cancer patients of various classifications. We first performed a comprehensive review of existing isotopes and techniques (imaging, dose measurements) used in clinical settings (from hadron therapy to brachytherapy) to identify the specificities of the use of radiotopes. In our second study, we use the hadron therapy examples of the Geant4 simulation tool kit to compare the dose distributions between stable and rare isotope
beams. We will present and discuss the results obtained from this study. In the near future, the impact on the DNA single and double strand breaks will be investigated. The Facility for Rare Isotope Beams (FRIB) under construction at Michigan State University will provide rare-isotope beams of high intensities. Ion sources are currently being used to deliver heavy ion rare-isotope beams to accelerator systems for nuclear physics. The current work will provide the foundation for the possible development of an ion source optimized for the delivery of rare isotope beams for hadron therapy and hence the treatment of various diseases.

Breakout Room: Dr. Elmer Imes
Session Time: 2:15 pm – 3:45 pm
Nuclear Particle Physics (NPP) – 1.B
Session Chair(s): Paul Gueye, Michigan State University

TIME: 2:30 pm – 3:00 pm
TITLE: Facility for Rare Isotope Beams
Speaker(s): Thomas Glasmacher, Michigan State University

Abstract: TBA

TIME: 3:15 pm – 3:30 pm
TITLE: Studies of Isovector Giant Resonances via the $^{60}$Ni($^{3}$He,t) reaction at 140 MeV/u
Speaker(s): Felix Ndayisabye, Michigan State University

Abstract: Nuclear charge-exchange reactions at intermediate energies are powerful probes of the isovector response of nuclei. In particular, they provide an opportunity to study isovector giant resonances, such as the Gamow-Teller Resonance, and the isovector giant monopole and dipole resonances. The properties of these giant resonances provides important insights into the bulk properties of nuclear matter, and have important implications for neutrino and astrophysics. In this work, the focus is on the study of the properties of isovector giant resonances excited via the $^{60}$Ni($^{3}$He,t) reaction at 140 MeV/u. The experiment was performed at the Research Center for Nuclear Physics, in Osaka, Japan.

TIME: 3:30 pm – 3:45 pm
TITLE: Exploring the Physics of Neutron-Unbound Nuclei Produced from Ne-28 and Ne-29 Fragment Beams
Speaker(s): Alaura Cunningham, Virginia State University

Abstract: Experimental studies of neutron-unbound systems provide important input to aid the development of theoretical models that describe exotic nuclei. In 2016, the MoNA Collaboration performed an experiment at the National Superconducting Cyclotron Laboratory to measure the half-life of O-26. The Coupled Cyclotron Facility provided a 140 MeV/u Ca-48 primary beam that impinged on a beryllium target to produce F-27, Ne-28, Ne-29, and Na-30 secondary beams. The analysis of the recorded data focused on events in which the two-neutron decay of O-26 produced from the F-27 secondary beam was measured. As such, a large fraction of the dataset is unused. The current project will extract the decay energy spectra for neutron-unbound systems produced from the Ne-28 and Ne-29 beams and compare them to previous measurements while also searching for new neutron-unbound states. In particular, measurements of one- and multi-neutron coincidences with F-25, F-24, or O-22 fragments produced from the Ne-28 beam and F-27, F-26, O-24, or O-22 produced from the Ne-29 beam will be compared to previous studies.

TIME: 3:45 pm – 4:00 pm
TITLE: The Study of Be13
Speaker(s): Yannick Gueye, Michigan State University

Abstract: Experiment e19013 ran on September 25-29, 2020 at the NSCL to study neutron-unbound states of $^{13}$Be. The experimental setup consisted of a 76 MeV/u $^{14}$Be incident on a beryllium target placed in front of a newly constructed telescope to identify the charged fragments produced during the reaction process. The telescope consists of two tetra lateral position sensitive silicon detectors, five silicon PIN diode detectors, one cesium iodide
calorimeter and a veto scintillator paddle. The setup was simulated using the G4Beamline software. The fragments exiting the telescope that deposited energy inside the veto detector were identified and studied using the ROOT analysis framework.

TIME: 4:00 pm – 4:15 pm
TITLE: Simulations of various GEM foil hole geometries using Garfield++
Speaker(s): Phuonganh Pham, Michigan State University

Abstract: The Gaseous Electron Multiplier (GEM) detector is used in nuclear physics to detect ionizing radiation. A GEM detector consists of a gas filled volume containing a thin polymer layer that is coated with metal on both sides that can handle rates up to a few MHz. The thin layer is perforated to achieve a high density (50 - 100 mm$^{-2}$) of small holes with diameters of roughly 50 microns. A large potential difference (typically 400 V) is applied between the two metal surfaces in order to create a large electric field inside the holes, thus producing an electronic avalanche from the electrons created from the ionization of gas molecules by the incoming radiation. Ultimately, the electron shower drifts to a collection electrode where they produce a measurable charge that is proportional to the energy deposited by the radiation in the gas volume. Multiple GEM layers can be stacked on top of each other to enhance the electron gain while operating the individual layers at a lower potential difference to reduce discharges. Simulations using Garfield++ were run for five different geometries with various sizes (top/middle/bottom µm): double conical (70/50/70 µm), conical (30/50/70 µm), inverted conical (70/50/30 µm), cylindrical (70/70/70 µm), and cylindrical-50 (50/50/50 µm). Preliminary simulations show that a larger hole size will allow more electrons to pass through the GEM layer, however, a reduction in gain due to a smaller hole size can be compensated by a higher density of electric field lines which produces a larger avalanche.

Friday, November 6

Breakout Room: Katherine Johnson
Session Time: 11:30 am – 1:00 pm
Photonics and Optical Physics (POP) – 1.A
Session Chair(s): Thomas Searles, Howard University

TIME: 11:30 am – 12:00 pm
TITLE: TBA
Speaker(s): Abdoulaye Ndao

Abstract: TBA

TIME: 12:15 pm – 12:30 pm
TITLE: Study of optical emission from GeSn waveguides under optical pumping: Theory and experiment
Speaker(s): Zairui Li, University of Dayton

Abstract: Silicon is the backbone of the electronics industry, but silicon photonics is still an emerging field with many new directions. As the Si industry grows, it provides numerous opportunities for new research directions and applications not just for electronics, but also for photonics. Today, Si-photonics plays an important role in communications, lighting and displays, signal processing and many other potential applications. Development of a monolithic Si-based laser is highly desirable, and could lead to new devices and architectures for optical interconnects, optical sensing, optical detection, and many others. The recent development of epitaxial grows Ge$_{1-x}$Sn$_x$ alloys on Si has opened a completely new venue from the traditional III-V integration approach. In this work, we study the results of optical emission from waveguides fabricated from Ge$_{1-x}$Sn$_x$ -on-Si, which shows promise as a gain medium for development of an on-chip laser. Waveguides were fabricated from highly n-type doped GeSn layers with Sn content at 5.4-6.2 % Sn grown on Ge-buffered Si substrates. The waveguides were optically-pumped using a 976 nm continuous wave laser, the waveguide emission was collected and the output spectrum was captured. Theoretical models for the spontaneous emission, gain, and amplified spontaneous emission were developed and the results were compared to the data. The results indicate that population inversion was achieved, and that gain through stimulated emission was observed. The model also yields possible directions for achieving room temperature lasing in GeSn waveguides.
TIME: 12:30 pm – 12:45 pm
TITLE: Reconfigurable circular dichroism in chalcogenide nanostructures
Speaker(s): Joshua Burrow, University of Dayton

Abstract: Circular dichroism spectroscopy (CDS) is widely used in chemistry, material science and biophysics to characterize the conformations in proteins and other dissymmetric molecules. CDS provides unique information by measuring the wavelength dependent differential absorbance between left and right hand circularly polarized light. In this work, we use CDS to characterize the temperature dependent phase change exhibited by chalcogenide phase change material Ge$_2$Sb$_2$Te$_5$. Nanocolumnar thin films are deposited onto highly oblique angled substrates during electron beam evaporation yielding a densely packed thin film of helical nanorods of 25nm diameter. We observe a difference in differential transmissive CD response upon the non-volatile phase transition between amorphous and crystalline states that is in good agreement with full-wave FDTD simulations.

TIME: 12:45 pm – 1:00 pm
TITLE: Guided-mode resonances in flexible 2D terahertz photonic crystals
Speaker(s): Chan Kyaw, Howard University

Abstract: Dielectric PhC slabs exhibit in-plane modes that are excited by incident radiation to produce sharp guided-mode resonances with minimal absorption loss for applications in sensors, optics, and lasers. In this talk, we demonstrate the existence of guided resonances in a THz PhC slab fabricated on subwavelength thicknesses of flexible dielectric polyimide films. The transmission of the resonances was measured for different structural parameters of the photonic crystal unit cell. In addition, we utilized the flexibility of the polyimide films to modulate the guided modes for a bend angle of $\theta \geq 5^\circ$, confirmed in experiment by the suppression of these modes. The mechanical flexibility of the sample allows for an additional degree of freedom in design of flexible electronics, soft wearable photonics, and implantable medical devices.

Breakout Room: Katherine Johnson
Session Time: 2:15 pm – 3:45 pm
Photonics and Optical Physics (POP) – 1.B
Session Chair(s): Thomas Searles, Howard University

TIME: 2:15 pm – 2:45 pm
TITLE: Tunable Strong Coupling in THz Metsaurfaces
Speaker(s): Thomas Searles, Howard University

Abstract: In this work, we investigate a THz planar metamaterial and observe the excitation of a polaritonic state as well as a VRS with a coupling strength of $\sim 21\%$. Strong splitting results in the formation of a forbidden frequency gap that can be evaluated as a transparency window caused by the hybridization of two eigenmodes. The physics of the transparency window is analogous to the lattice induced transparency effect in which there are limited demonstrations in the literature of strong coupling due to cavity-cavity interactions. Further, we show that by increasing the capacitive gap width of the MM unit cell, we increase the overall capacitance of the MM and demonstrate an anti-crossing behavior; a key signature to strong-light matter coupling. Lastly, we present graphene micro-ribbons and a nanohole array in a carbon nanotube film as two tunable platforms for actively tuned strong coupling in hybrid metasurface devices.

TIME: 2:45 pm – 3:15 pm
TITLE: IBM HBCU Quantum Center
Speaker(s): Kayla Lee, IBM
Abstract: TBA

TIME: 3:15 pm – 3:45 pm
TITLE: Collimating Channel Array Optics for Confocal (micro) X-ray Fluorescence Microscopy at CHESS
Speaker(s): David Agyeman Badu, SLAC – Stanford University

Abstract: A novel X-ray optic called Collimating Channel Arrays (CCA)\(^1,2\) for high-resolution Confocal (micro) X-ray fluorescence microscopy (CXRF) has been developed at the Cornell High Energy Synchrotron Source (CHESS). CXRF is a three dimensional XRF imaging technique, which relies on a well-defined probe volume in 3D to spatially map out the elemental distributions in heterogeneous and un-thinned samples. The 3D probe volume is defined by a pair of optics at the X-ray excitation and detection channels respectively. The conventional implementation of CXRF utilizes a polycapillary lens as the collection optic at the detection channel and that choice limits the depth resolution of the probe volume to \(~10 \mu m\) at 10 keV. By using polycapillary optics, the depth resolution also varies strongly as a function of energy, which ranges from 10 \(\mu m\) to over 30 \(\mu m\). In our approach to CXRF, we use CCAs developed at CHESS as the collection optic. CCA optics are lithographically fabricated from germanium substrates\(^3\), and are an array of radially-spanning set of collimating channels, which collect x-rays from a single source position at the focus. With our setup, the geometry of the channels defines a spatial resolution, which is invariant over a wide energy range, and significantly smaller than the depth resolution of polycapillary optics. We have been able to achieve a depth resolution of 2 \(\mu m\) for an energy range spanning from 1.7 keV to 20 keV, and our technology has been incorporated into the general user program at the Advanced Photon Source station ID 2.

Friday, November 6

Breakout Room: Dr. Shirley Jackson
Session Time: 11:30 am – 1:00 pm
Medical Physics (MED) & Chemical and Biological Physics (CBP) – 1.A
Session Chair(s): Christopher Njeh, Franciscan Health Indianapolis & Mooresville & Wilfred Ngwa, Brigham and Women’s Hospital, Dana-Farber Cancer Institute, Harvard Medical School

TIME: 11:30 am – 11:45 am
TITLE: Increasing Access to Medical Physics Education and Research Excellence (AMPERE)
Speaker(s): Wilfred Ngwa, Brigham and Women’s Hospital, Dana-Farber Cancer Institute, Harvard Medical School

Abstract: Medical Physics is a branch of Applied Physics, that uses physics principles, methods and techniques in practice and research for the prevention, diagnosis and treatment of human diseases with a specific goal of improving human health and well-being. Medical Physics Careers are also very rewarding. There is major need to increase diversity in Medical Physics and black physicists are greatly needed to enhance the talent pool. This requires engaging students early in education pipeline. Having greater diversity can only increase the creativity and impact in this field. Studies have shown that racial and ethnic diversity has both direct and indirect positive effects on the educational outcomes, career advancement and motivation of students. Underrepresented populations have had low numbers over the years not only in medical physics but also in the sciences in general. With the rapidly changing face of the USA we need to address how we attract and train the next generation of scientists in Medical Physics to stay competitive. It is necessary to examine the role that diversity and inclusion play in the long term goals of institutions, workplaces and classrooms. To increase innovation, we must engage people from all walks of life with different perspectives and life experiences to solve the problems that we will face. Diversity should be viewed as a strategy to achieve our goals instead of acts of good citizenship. Many of today's businesses and corporations have discovered that embracing diversity prepares future leaders in today's global market. This presentation will provide insight into the need for greater diversity in Medical Physics and why black STEM (Science, technology, Engineering and Math) students should join this field. It will also provide an overview of major opportunities in clinical practice, education, research and global health in medical physics.

TIME: 11:45 am – 12:00 pm
TITLE: Can the Adoption of Hypofractionation Guidelines Expand Global Radiotherapy Access? An Analysis for Breast and Prostate Radiotherapy and combination with Immunotherapy
Speaker(s): William Swanson, Dana-Farber Cancer Institute, University of Massachusetts Lowell
Abstract: Previous studies demonstrate non-inferior clinical outcomes using hypofractionation (HF) EBRT for breast and prostate cancer cases. The purpose of this work is to estimate the percentage cost-savings per radiotherapy course and increased radiotherapy (RT) access in low and middle income countries (LMIC) after adopting hypofractionation for breast and prostate radiotherapy. For perspective, results are compared with high-income countries like the USA.

TIME: 12:00 pm – 12:15 pm
TITLE: From Physics to Medical Physics: my Journey and Motivation
Speaker(s): Zaphanlene Y. Kaffey, Fisk-Vanderbilt

Abstract: I could wax poetic about how I wanted to be a physicist since I was a young girl. I could also write about how I looked up at the stars, not knowing I would conduct research on quasars in the future. However, to avoid being cliche, I will write about how I actually came across physics. During my sophomore year of my undergraduate studies, I was required to take an introductory physics course towards my pre-med degree. I fell in love with this course and often stayed after class or came to office hours to ask my professor numerous questions. I spent countless hours watching YouTube and khan academy videos on physics. No teacher needed to “sell” me on why we learned physics—it was evident in everything that we do. Physics is all around us.

TIME: 12:15 pm – 12:30 pm
TITLE: Simultaneously Targeting Cancer and Pain with Cannabinoids during radiotherapy
Speaker(s): Sayeda Yasmin-Karim

Abstract: The management of pain is a primary challenge for the cancer patient and for the treating oncologists including radiation oncologists. Many studies have highlighted the potential of cannabinoids (CBD) for cancer pain management. The purpose of this project is to develop a new approach for targeting cancer and pain with superior therapeutic efficacy and safety using medical cannabis during radiotherapy (RT).

TIME: 12:30 pm – 12:45 pm
TITLE: Rapid search and repair strategies of DNA damage repair proteins on chromatin
Speaker(s): Genesis Imbert, University of Puerto Rico – Rio Piedras Campus

Abstract: Chromatinis are tightly packed DNA-protein complexes that contain the genome of eukaryotic cells. Regardless of its tight packaging, chromatin still incurs damage, which causes a variety of DNA lesions and creates genomic instability. Such lesions result in the activation of DNA repair mechanisms. Despite the detailed understanding of DNA repair machinery, it remains unclear how proteins rapidly locate the approximately two-nanometer wide nuclear-damaged sites on a three-meter long DNA strand. The prevailing mechanism is that proteins combine 3D diffusion through space with 1D sliding along the DNA to their specific lesion site. However, existing models may be missing key features of the search process in eukaryotes. Here, we discuss molecular dynamics simulations aimed at determining the relative contributions of observed properties of DNA damage response proteins.

TIME: 12:45 pm – 1:00 pm
TITLE: Bulk light-scattering measurements of viral capsid self-assembly around RNA
Speaker(s): Lanell Williams, Harvard University

Abstract: Self-assembly is a vital part of the RNA virus life cycle. The assembly of viral coat proteins around viral RNA occurs both in vivo and in vitro, suggesting that viral capsid assembly may be driven by minimization of free energy. To better understand this process, we modify the interactions between coat proteins and between the coat proteins and RNA of MS2 bacteriophage in vitro by varying the ionic strength and pH, and we study the assembly using dynamic and static light scattering. From dynamic light scattering we determine the assembly yield and the size distribution of assembled products. From static light scattering, we measure the kinetics of assembly in bulk. By comparing the results from these two different techniques to each other and to results from gel electrophoresis, we infer features of the assembly pathway. This work is supported by funding from the National Science Foundation Graduate Research Fellowship Program (NSF-GRFP).
Abstract: With each visit to the hospital, everyone has experienced medical physics in action at one time or the other without knowing. The standard definition of medical physics is “the application of concepts, theories and methods of physics to the diagnosis, management and treatment of human disease. Aspects of medical Physics are prominent in the hospital including simple chest x-rays to the more complicated linear accelerator. Medical Physics can be categorized into three main subfields namely: diagnostic physics, radiation therapy and radiation safety. Diagnostic medical physics branch is mainly involved with development and establishment of quality assurance for the safe and effective use of imaging techniques to the management of human diseases. These imaging techniques include planar x-rays, computed x-rays (CT), ultrasound, magnetic resonance imaging (MRI), nuclear medicine imaging, single photon emission computed tomography (SPECT) and positron emission tomography (PET). Radiation therapy physics involves the use of high energy radiation for the treatment of different forms of cancer. Radiation therapy most often uses high energy x-rays, electron, gamma radiation and protons to destroy or damage cancer cells. Radiation therapy can be delivered from outside of the body (external beam radiation therapy) or within the body (brachytherapy). More than 50% of all cancers are treated with radiation. The use of radiation in the management of cancer has significantly improve survival rate, up to 90% for early stage cancer and quality of life of cancer patients. Lastly health physics also referred as radiation safety or radiation protection is the applied physics of radiation protection for health care purposes. It is the science concerned with recognition, evaluation and control of health hazard associated with ionization radiation. By implementing appropriate safety measures ionizing radiation can be used safely for patients and staff. In conclusion, the broad application of physics in medicine has resulted in improved diagnosis and management of human diseases.

Abstract: This talk continues the presentation at APS March Meeting 2019 and APS April Meeting 2019. In this part of the project the first submodel is presented; The information processing from teeth to the nerves. Information processing is modeled via p-waves passing through the tooth layers enamel and dentin. Odontoblasts located in the liquid in the tubules of the tooth dentin layer perform finally the transformation into electrical information (an electrical signal) that passes along nerves. The presentation was scheduled for the APS March Meeting 2020 Conference (the APS March Meeting 2020 Conference got canceled because of Covid-19), the presentation was given at the APS April Meeting 2020 Conference.

Abstract: In the event of metastatic disease, emergence of a lesion can occur at varying intervals from diagnosis and in some cases following successful treatment of the primary tumor. Genetic factors that drive metastatic progression have been identified, such as those involved in cell adhesion, signaling, extravasation and metabolism. However, organ specific biophysical cues may be a potent contributor to the establishment of these secondary lesions. We developed a novel optical tweezer based active microrheology to measure tissue mechanical properties in vivo using a bespoke home built optical tweezers. We also developed preclinical models using the zebrafish to recapitulate human disease. We then asked if biophysical properties of the stromal architecture...
regulated organ colonization in vivo? We determined that physical properties of the blood vessels regulates organ selectivity in vivo. This was only possible due to our combined intravital imaging, vessel topographical analysis and mechanical mapping in a living animal. This work was the first demonstration that physical properties can regulate organ selectivity by metastasizing tumor cells in vivo.

TIME: 3:00 pm – 3:15 pm
TITLE: The New Era of Radiation Therapy: From Conventional to 4D and Beyond
Speaker(s): Christopher Njeh, Franciscan Health Indianapolis & Mooresville

Abstract: Cancer is a major public health problem worldwide as it accounts for a quarter of all deaths. Radiation therapy has played a critical role in the treatment of malignant tumors for more than a century now. Radiation is administered either alone or in association with surgery and chemotherapy. Recent advances have improved the effectiveness of radiation therapy. These advances include 3D conformal radiation therapy, intensity-modulated radiation therapy (IMRT), volumetric modulated arc therapy (VMAT), stereotactic radiosurgery (SRS), stereotactic body radiation therapy (SBRT), brachytherapy and radioimmunotherapy. More recently these developments were augmented by proton and particle beam radiotherapy such as carbon ions. The toxicity of organ at risk has been a limiting actor in dose escalation regime. However, with the introduction of image guided radiation therapy (IGRT), radiation can be delivered more accurately to the target, while limiting the dose to surrounding sensitive organs. This is because IGRT helps address errors due to organ motion during treatment (intra-fraction) and between treatment (inter-fraction) resulting in reduction in treatment margins. Advances imaging is also playing a critical role not only in treatment planning, but also in target delineation, monitoring of intra-fraction motion, monitoring treatment response and adaptive radiation therapy (ART). This paper reviews the recent technical development in radiation therapy, including target volume delineation, treatment planning, treatment delivery methods and positional verification methods.

TIME: 3:15 pm – 3:45 pm
TITLE: Keynote address from the President of the American Association of Physicists in Medicine (AAPM)
Speaker(s): Saifuq Huq, American Association of Physicians in Medicine

Abstract: The American Association of Physicians in Medicine (AAPM) is a society of Medical Physicians in North America with a global membership of over 9000. Its mission is to advance medicine through excellence in science, education and professional practice of medical physics. Medical Physicists are professionals involved in scientific and clinical innovations to improve human health. They work hand-in-hand with clinicians in the clinic to provide diagnostic and high quality therapeutic care to cancer patients globally. AAPM has historically been involved in various kinds of educational training of diagnostic, nuclear medicine and radiotherapy professionals all over the world. In this Lecture, the President of the AAPM Professor Saiful Huq will talk about the AAPM, and the pathway he followed to become a practicing Medical Physicist. He will also share about AAPM efforts and opportunities to enhance diversity and reduce disparities in the USA and across the globe.

Friday, November 6

Breakout Room: Dr. Willie Hobbs Moore
Session Time: 11:30 am – 1:00 pm
Astronomy and Astrophysics (ASTRO) – 1.A
Session Chair(s): Dara Norman, NSF’s NOIRLab and Gregory Mosby, NASA

TIME: 11:30 am – 12:00 pm
TITLE: Astrophysical Intelligence: Applications of AI to modern challenges across astronomy
Speaker(s): Brian Nord, Fermilab

Abstract: Artificial Intelligence (AI) refers to a set of techniques that rely primarily on the data itself for constructing highly accurate models of observed phenomena. AI has had a long history of development, and there has been a recent resurgence in its research and deployment. This is marked by extraordinary results in many contexts across society --- from the promise of self-driving vehicles and accelerated biomedical engineering to the peril of automation in the criminal justice system, retail stores, and the military. Moreover, in the last few years, AI has had substantial impacts in the physical sciences, like molecular chemistry, particle physics, and more recently, astronomy. However,
the story is far from over: these techniques face significant challenges to reach their full potential, especially in scientific contexts.

During this conversation, we'll discuss the application of modern AI techniques to astrophysics and cosmology. This will include problems in AI algorithms themselves, like bias and uncertainty quantification.

**TIME:** 12:00 pm – 12:15 pm  
**TITLE:** Measuring the Eccentricity of GW170817 and GW190425 using LIGO/Virgo Gravitational Wave Observations  
**Speaker(s):** Amber Lenon, *Syracuse University*

**Abstract:** The LIGO/Virgo collaborations announced the detection of the first binary neutron star (BNS) merger, GW170817, that ushered in a new era of multi-messenger astronomy and recently announced the detection of a second neutron star merger, GW190425. These systems are most likely field binaries which are expected to have radiated any eccentricity away and circularized by the time their gravitational waves reach the LIGO-Virgo sensitive band. However, binaries formed through interactions in dense stellar environments, like globular clusters or galactic nuclei, may still retain a significant amount of their eccentricity. Eccentric binaries are binaries in elliptical orbits and at merger may have different electromagnetic emission than circular BNS and allow us to probe various formation channels. Although these binaries were detected by searches with waveform models of binaries in circular orbits, they could still have some small eccentricity. We use gravitational-wave observations and Bayesian parameter estimation to measure and constrain the maximum allowed eccentricity of GW170817 and GW190425. Even though these binaries were detected by waveform models in circular orbits, we find that they have a small eccentricity at merger that is negligible. Although these binaries have no significant eccentricity, the proposed third-generation detectors will have the ability to detect these mergers at higher eccentricities and probe the dynamical formation channel.

**TIME:** 12:30 pm – 12:45 pm  
**TITLE:** Implementing Eccentricity into enterprise: Searching for Eccentric Sources in NANOGrav  
**Speaker(s):** Belinda Cheeseboro, *West Virginia University*

**Abstract:** Gravitational waves (GWs) are small ripples that stretch and compress the fabric of spacetime and travel at the speed of light. They provide more information about binary compact object (i.e. neutron stars or black holes) systems and possibly supernovae. There are several types of detectors that probe various gravitational wave frequency ranges, but the focus of this presentation is on the pulsar timing array regime (10−9 to 10−6 Hz). Pulsar timing arrays monitor an array of millisecond pulsars looking for deviations in the time it takes their signals to reach Earth using radio telescopes. Supermassive black hole binaries (SMBHB) with total masses of 10^8−10^10 M☉ are one of several gravitational wave sources that could be detected by pulsar timing arrays like the North American Nanohertz Observatory for Gravitational waves (NANOGrav). In the past, the calculation of gravitational waveforms from eccentric SMBHB was computationally expensive as compared to the circular case, thus only circularized binaries have been considered in past all-sky GW searches. Recent algorithmic development has optimized the eccentric waveform search process allowing us to develop an all-sky search pipeline for eccentric gravitational waves. Detecting eccentric GWs from eccentric SMBHBs can help us study the inspiral phase of these binaries which gives dynamical information to further understand the evolution of galaxies and their central supermassive black holes. We will present on the current progress of this project.

**TIME:** 12:45 pm – 1:00 pm  
**TITLE:** The NASA Astrophysics Research and Analysis Diversity, Equity, and Inclusion Task Force  
**Speaker(s):** Evan Scannapieco, NASA

**Abstract:** I will discuss the newly-formed NASA Astrophysics Research and Analysis (R&A) Diversity, Equity, and Inclusion (DEI) Task Force, whose purpose is to break down barriers for underrepresented groups to participate in and benefit from NASA’s Astrophysics R&A programs. I will describe the group’s core desired outcomes, present areas that we are considering, and invite NSBP members to contribute their expertise to the process.
Panel: Careers, Funding and Opportunities in Astronomy and Astrophysics
Description: Session will include opening remarks by panelists and an extensive question and answer period.

TITLE: Non-academic Careers in STEM
Speaker(s): Jessica Harris, University of Virginia

BIO: Jessica Harris is a physicist, informal educator, science communicator, business owner and diversity and inclusions change agent. She has decade of progressive leadership experience in education and public outreach (EPO) and equity, diversity, and inclusion. She is currently the Program Director for the Clark Scholars Program at the University of Virginia (UVA) in the School of Engineering and Applied Science (SEAS). Prior to UVA she worked at the National Radio Astronomy Observatory (NRAO). She was the STEAM Education Program Development Officer and the site led for the National Astronomy Consortium (NAC). Prior to NRAO she was the education outreach specialist and director of the Space Astronomy Summer Program (SASP) at Space Telescope Science Institute (STScI) in Baltimore, MD. She is a proud alumna of Grambling State University and the Fisk-Vanderbilt Bridge Program.

TITLE: Scientist at one of the largest Ground-based observatories
Speaker(s): Marie Lemoine-Busserolle, Gemini/NOIRLab

BIO: Marie Lemoine-Busserolle is originally from Martinique (French Caribbean) and got her PhD in Astrophysics at the University of Toulouse (France) end of 2003. She moved shortly after to a two-years postdoctoral position at the Institute of Astronomy at Cambridge (UK). She also held a position as an UK Gemini support scientist in the UK National Gemini Office at the university of Oxford for three years and an half before joining the Gemini Observatory in 2009. The Gemini Observatory is a Program of NSF’s NOIRLab, which is managed by the Association of Universities for Research in Astronomy (AURA) under a cooperative agreement with the National Science Foundation. The Gemini Observatory consists of twin 8.1-meter diameter optical/infrared telescopes located on two of the best observing sites on the planet. From their locations on mountains in Hawaii and Chile, Gemini Observatory’s telescopes can collectively access the entire sky. Astronomers from United States, Canada, Chile, Brazil, Argentina, Korea and from the University of Hawaii have regular access to the Gemini Observatory for their research. Marie is involved in various observatory support duties and her research interest focuses on galaxy formation and evolution through the study of physical properties of spatially resolved distant galaxies populations using mostly adaptive optics and integral-field spectroscopy in the optical and infrared on 8-m class telescopes.

TITLE: Programs for Early-Career Scientists through NSF’s Division of Astronomical Sciences
Speaker(s): Harshal Gupta, National Science Foundation

BIO: In this talk, I will discuss funding opportunities for early-career scientists (graduate students, postdocs, and assistant professors) available through the Division of Astronomical Sciences (AST) at the National Science Foundation (NSF), and how these opportunities fit within the broader context of grant programs and observatories funded by NSF and managed by AST. I will also briefly discuss my own experiences with a career in science and service.

Harshal Gupta is a Program Officer at NSF/AST, where he has served since 2015. His primary responsibilities include administration of the NSF Astronomy and Astrophysics Postdoctoral Fellowships program, management of the laboratory astrophysics portfolio within the Astronomy and Astrophysics Research Grants program, and oversight of NSF’s Green Bank Observatory. In addition to his service at NSF, Gupta maintains an active research program centered around the laboratory and astronomical study of reactive molecules and the evolution of the interstellar medium.

TITLE: Astrophysics Careers at NASA’s Goddard Space Flight Center
Speaker(s): Rita Sambruna, NASA/GSFC

BIO: The NASA’s Goddard Space Flight Center, whose largest campus is located in Greenbelt, MD, is the biggest space science organization in the world. Nested in this campus, in close proximity and collaboration with other disciplines, the Astrophysics Science Division conducts a broad program of research in astronomy, astrophysics,
and fundamental physics. Individual investigations address issues such as the nature of dark matter and dark energy, which planets outside our solar system may harbor life, and the nature of space, time, and matter at the edges of black holes. Observing photons, particles, and gravitational waves enables researchers to probe astrophysical objects and processes. Researchers develop theoretical models, design experiments and hardware to test theories, interpret and evaluate the data, archive and disseminate the data, provide expert user support to the scientific community, and publish conclusions drawn from research. The Division also conducts education and public outreach programs about its projects and missions. This talk will review the various career opportunities in the Division for both undergraduate, graduate, and post-doctoral students in Physics and Astronomy, as well as permanent employment options.

Dr. Rita Sambruna is the Deputy Director of the Astrophysics Division at NASA’s Goddard Space Flight Center. Previously she was at NASA Headquarters, where she held positions in science management and strategy. Her research focuses on high-energy observations and interpretation of supermassive black holes, and multiwavelength studies of relativistic jets in galaxies. She can be reached at rita.m.sambruna@nasa.gov.

Friday, November 6

Breakout Room: Dr. Edward Bouchet  
Session Time: 11:30 am – 1:00 pm  
Condensed Matter and Material Physics (CMMP) – 1.A  
Session Chair(s): William Ratcliff, National Institute of Standards and Technology

TIME: 11:30 am – 12:00 pm  
TITLE: State of Condensed Matter Experiment  
Speaker(s): Joseph Berry, National Renewable Energy Laboratory

Abstract: TBA

TIME: 12:00 pm – 12:30 pm  
TITLE: State of Theoretical Condensed Matter  
Speaker(s): Trevor Rhone, Rensselaer Polytechnic Institute

Abstract: TBA

TIME: 12:30 pm – 1:00 pm  
TITLE: A first-principles investigation of V2O5 as a sensor  
Speaker(s): Christopher Sherald, University of Kansas

Abstract: Using density functional theory, as implemented in the VASP code, and python scripts based on the Atomic Simulation Environment module, we will investigate under what conditions V2O5, a layered material, can be used as a sensor material for simple molecules such as NH3, CO, H2O etc. Some experiments have revealed that it is possible to use V2O5 as a sensor at an operating temperature of 200°C, and that nanowires and ultrathin films of V2O5 are reported to have further enhanced physiochemical and electronic properties. Thus, in this experiment, we will be probing these mechanisms of V2O5 at an atomic level to better understand how this material functions.

TIME: 12:45 pm – 1:00 pm  
TITLE: Nickel Cobalt Manganese (NMC) Cathode With Carbon Nanofiber Additive  
Speaker(s): Yahya Alqahtani, Howard University

Abstract: Lithium-ion batteries (LIBs) for electric vehicles (EVs) require lower weight, lower cost, higher capacity and longer lifetime. Nickel Cobalt Manganese (NMC) is widely used in EVs and energy storage applications. Nowadays, most EVs are produced with over 30KWh capacities for a longer driving range which results in a significant increase in the overall weight of vehicles. The high weight of the battery leads to unproductive power consumption and adversely impacts on the vehicle’s performance. Additionally, operating the battery at high voltage provides a higher discharge capacity but creates an aggressive decrease in the lifetime of the batteries. In
this research, approaches are proposed to overcome these two obstacles; (1) adding carbon nanofibers to NMC cathode material and (2) increasing the ratio of the binder, Polyvinylidene fluoride (PVDF). Preliminary electrochemical measurements indicate a weight reduction of the cathode and an improvement in the lifetime of the modified battery in comparison with a battery with pristine cathode material.

**Breakout Room: Dr. Edward Bouchet**  
**Session Time: 2:15 pm – 3:45 pm**  
**Condensed Matter and Material Physics (CMMP) – 1.B**  
**Session Chair(s):** William Ratcliff, National Institute of Standards and Technology

**TIME: 2:15 pm – 2:30 pm**  
**TITLE:** Investigation of the FeSe/SrTiO3 interface using Electron Energy Loss Spectroscopy  
**Speaker(s):** Samantha O'Sullivan, Harvard University

**Abstract:** Monolayer iron selenide (FeSe) grown on a SrTiO3 (STO) substrate is a high-temperature superconductor with a transition temperature Tc above 100 K. Multilayer FeSe on STO, however, has a significantly lower Tc of 8 K. What accounts for this difference? Characterizing the monolayer FeSe/STO interface is important to gain further understanding on the mechanism for the unexpected high-temperature superconductivity in this system. In this study we investigated the monolayer FeSe/STO interface structure using the atomic resolution imaging and characterization techniques of transmission electron microscopy (TEM) and electron energy loss spectroscopy (EELS). These techniques produced atomic resolution images of the interface which revealed that the STO substrate is terminated with a double TiO2 layer interfacing the FeSe monolayer, as well as possible selenium diffusion into the top STO layers. These results corroborate previous studies predicting the existence of a double TiO2 layer, and for the first time provide EELS evidence of selenium diffusion. By clearly depicting the interface structure, these results may provide insight into the mechanisms of this system’s high-temperature superconductivity. Understanding these mechanisms can bring physicists a step closer to eventually engineering room-temperature superconductors.

**TIME: 2:30 pm – 2:45 pm**  
**TITLE:** Isolating and Studying the properties of 2D Transition Metal Dichalcogenides (TMD) within a Superlattice Architecture.  
**Speaker(s):** Pheona Williams, Howard University

**Abstract:** Misfit compounds are structures comprised of two differing sublattices. Their layered structures possess the ability to probe the pristine 2-D to very thin layer related characteristics of the transition metal dichalcogenides(TMD) within their structures. These characteristics include the enhancement or suppression of superconductivity, the observation of quantum spin Hall effect, nonsaturating magnetoresistance, and charge density wave (CDW) formation. This project proposes an interesting way of isolating and studying the properties of 2D Transition Metal Dichalcogenides (TMD) within a pristine bulk superlattice architecture.

**TIME: 2:45 pm – 3:00 pm**  
**TITLE:** Novel 2D-based van der Waals Materials for neuromorphic applications  
**Speaker(s):** Chinedu Ekuma, Lehigh University

**Abstract:** van der Waals (vdW) materials designed with atomic layers of 2D-based materials exhibit one of the broadest sets of novel properties that are highly desirable for enabling heterogeneous device concepts such as neuromorphic and quantum computing. Because of their flexible electronic structure, both carrier dynamics and charge injection are easily tunable with chemical or electrical doping. Using first-principles modeling and experiment, we achieve efficient electrochemical intercalation of electronically active organometallic molecules of the family of metalloocene into vdW gaps of the homostructure of HfS2-based prototype vdW materials. We achieve high tunability of the electronic and vibrational properties of the hybrid material. Our findings demonstrate a unique approach to create an organic/inorganic interface that tunes and tailor the properties of host materials for distinctive device applications.

**TIME: 3:00 pm – 3:15 pm**
Title: Magneto-Raman Spectroscopy to Identify Spin Structure in Low-Dimensional Quantum Materials

Speaker(s): Angela Hight-Walker, National Institute of Standards and Technology (NIST)

Abstract: Raman spectroscopy, imaging, and mapping are powerful non-contact, non-destructive optical probes of fundamental physics in graphene and other related two-dimensional (2D) materials, including layered, quantum materials that are candidates for use in the next quantum revolution. An amazing amount of information can be quantified from the Raman spectra, including layer thickness, disorder, edge and grain boundaries, doping, strain, thermal conductivity, magnetic ordering, and unique excitations such as charge density waves. Most interestingly for quantum materials is that Raman efficiently probes the evolution of the electronic structure and the electron-phonon, spin-phonon, and magnon-phonon interactions as a function of temperature, laser energy, and polarization. Our unique magneto-Raman spectroscopic capabilities will be detailed, enabling diffraction-limited, spatially-resolved Raman measurements while simultaneously varying the temperature (1.6 K to 400 K), laser wavelength (tunability from visible to near infrared), and magnetic field (up to 9 T) to study the photo-physics of nanomaterials. Additionally, coupling to a triple grating spectrometer provides access to low-frequency (down to 6 cm−1, or 0.75 meV) phonon and magnon modes, which are sensitive to coupling. By utilizing electrical feedthroughs, studying the strain-dependent effects on magnetic materials utilizing MEMs devices is also a novel opportunity. Current results on intriguing quantum materials will be presented to highlight our capabilities and research directions. Research outcomes will be presented on α-RuCl₃, a Kitaev magnet and possible quantum spin liquid, on antiferromagnetic metal phosphorus trichalcogenide family, highlighting FePS₃ and MnPSe₃ and on the exciting ferromagnetic 2D material CrI₃.

Time: 3:15 pm – 3:30 pm

Title: Molecular Spin Quantum Materials and Entanglement Platforms for Quantum Technologies

Speaker(s): Ashley Blackwell, Howard University

Abstract: Quantum technologies are based on the quantum bit, or qubit, which is the basic unit of quantum information, similar to binary bits that make up current classical computers. The design of viable qubits and their assembly into functioning technologies is one of the greatest scientific challenges of our time. There are several requirements for a qubit to be viable for quantum computers; a long coherence time, initialized in a specific initial state, well-defined and scalable, individually measurable, able to devise universal quantum gates. In order to meet these requirements simultaneously, we plan to design and synthesize new molecular spin quantum materials of either a transition metal or a lanthanide ion and assemble such candidates on on either a 2D platform such as graphene, or a superconducting platform such as lead, enabling their entanglement using RF or microwave radiation. We are interested in this structure because it can work as a quantum machine with the ensemble providing quantum memory. A thorough characterization of the electronic properties of the molecular spin quantum materials will be performed using superconducting quantum interference devices (SQUID) and scanning near field optical microscopy (EPR) studies. Further characterization of these complexes will also include scanning tunneling microscopy (STM) and scanning near field optical microscopy (SNOM) which will also be used in characterizing the entangled platform described. The proposed research will help to streamline discovery and entanglement of molecular spin qubits, which are a promising material platform for quantum technologies.

Time: 3:30 pm – 3:45 pm

Title: Atomic-scale design of quantum materials

Speaker(s): Divine Kumah, North Carolina State University

Abstract: Transition metal oxides (TMOs) exhibit a wide range of physical properties including high-temperature superconductivity, ferroelectricity, ferromagnetism and metal-insulator transitions. While these physical properties are understood in the bulk forms of these materials, open questions remain with regards to the effects reduced dimensionality and quantum confinement and the effect of electronic, orbital, spin and structural interactions at heterointerfaces. In this talk, a combination of atomic-scale materials synthesis, synchrotron X-ray high-resolution diffraction and spectroscopy, temperature-dependent transport and magnetometry, high resolution electron microscopy and first-principles density functional theory are used to elucidate the interplay between structural and electronic degrees of freedom at TMO interfaces. First, we show that magnetic and orbital degrees of freedom are coupled to structural interactions at the interfaces between atomically-thin TMO films. We demonstrate the stabilization of robust ferromagnetism in sub-nanometer thick LaSrMnO₃ films. We show that polar structural distortions at LSMO interfaces lead to magnetically ‘dead’ ultra-thin layers. By suppressing these polar distortions using iso-valent and iso-structural LaSrCrO₃ spacer layers, we show that ferromagnetic ordering is restored in LaSrCrO₃ / LaSrMnO₃ / LaSrCrO₃ heterostructures. Additionally, we show that the degeneracy of the transition
metal d orbitals can be controlled by epitaxial strain leading to competition between ferromagnetic and antiferromagnetic instabilities.[1][2] Secondly, we demonstrate the realization of a high mobility two-dimensional conducting interface between a polar anti-ferromagnet, LaCrO3 (LCO) and non-polar SrTiO3 (STO).[3] Here, the parent materials are insulators, however, structural and electronic interactions at the LCO/STO interface lead to the formation of an electron gas confined to the interface. These results demonstrate the strong correlation between the atomic-scale structural properties of 2D materials and their electronic and magnetic ground states with important implications for discovering and understanding quantum materials.

Saturday, November 7

**Session Time: 11:00 am – 12:30 pm**

**Auditorium – General Session**
**Speaker:** Mr. Jared Crooks, Schmidt Futures

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Saturday, November 7

**Session Time: 2:30 pm – 3:30 pm**

**Auditorium – Virtual Luncheon**
**Speaker:** Dr. Lisa Dyson, Air Protein & Kiverdi Companies

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Saturday, November 7

**Breakout Room: Dr. Edward Bouchet**  
**Session Time: 1:00 pm – 2:30 pm**

**Condensed Matter and Material Physics (CMMP) – 2.A**
**Session Chair(s): William Ratcliff, National Institute of Standards and Technology**

**TIME:** 1:00 pm – 1:30 pm
**TITLE:** Understanding the Mechanism of Proximity Induced Magnetism in Thin-film Heterostructure
**Speaker(s):** Oto-obong Inyang, Durham University UK

**Abstract:** Advances in magnetism have led to the possibility of large memory storage capacity and recently, pure spin current has been proposed for the next generation energy-efficient and faster memory devices. However, these possibilities depend on the spin transport across interfaces in these devices, which is sensitive to the details of the interface structure. At the interface, the magnetic properties can also be significantly modified by magnetic degradation due to inter-diffusion and alloying at the interface [1], or proximity polarization of the heavy metal [2]. Hence the need to understand the underlying effects at the buried interface such as proximity induced magnetism (PIM). Here, we supported the SQUID magnetization information using two complementary reflectivity techniques of polarized neutron reflectivity (PNR) and X-ray resonance magnetic reflectivity (XRMR) to shed light on the phenomenology of PIM in Pt at proximity with TM in a Pt/TM/Pt trilayer system [3]. The PNR provides the depth-dependent magnetization of the entire sample while XRMR turned to Pt L3 absorption edge provides the spin-polarized magnetic moment of Pt. In addition, I will present our recent finding on the alignment of PIM in an antiferromagnetically coupled alloy of transition metal and rare-earth metal (RE) ferrimagnet of RE dominated and TM dominated ferrimagnetic system. This was inspired by an initial investigation on the magnetization reversal behaviour of low Gd doped RE-TM alloy of GdCo, GdFe and GdCoFe thin-films [4]. Using X-ray magnetic circular dichroism (XMCD) and XRMR, we demonstrated that PIM follows the TM magnetization direction despite the dominant sublattice or net magnetization [5]. These pieces of information are essential in the design of Spintronic devices and spin-dependent transport experimental analysis.

**TIME:** 1:30 pm – 1:45 pm
TITLE: Suppression of magnetic ordering in Fe-deficient Fe3-xGeTe2 from application of pressure  
Speaker(s): Dante O’Hara, U.S. Navy Research Laboratory

Abstract: Two-dimensional (2D) van der Waals magnets with multitude functionalities are becoming increasingly important for emerging technologies in spintronics and valleytronics. Applications of external pressure is one method to cleanly explore the underlying physical mechanisms of the intrinsic magnetism. In this work, the magnetic, electronic, and structural properties of van der Waals-layered, Fe-deficient Fe3-(3-x)Ge2Te2 are investigated. Magnetotransport measurements show a monotonic decrease of the Curie temperature (T_c) and the magnetic moment with increasing pressure up to 13.9 GPa. The electrical resistance of Fe3-(3-x)Ge2Te2 shows a change for metallic to a seemingly nonmetallic behavior with increasing pressure. High-pressure angle dispersive powder x-ray diffraction shows a monotonic compression of the unit cell and a reduction of the volume by ~25% with no evidence of structural phase changes up to 29.4(4) GPa. We suggest that the decrease in the T_c due to the pressure from increased intralayer coupling and delocalization that leads to a change in the exchange interaction.

TIME: 1:45 pm – 2:15 pm  
TITLE: Condensed Matter Discussion  
Speaker(s): William Ratcliff, National Institute of Standards and Technology  

Abstract: This will be an open discussion on opportunities and challenges in condensed matter. Audience participation will be key.

TIME: 2:15 pm – 2:30 pm  
TITLE: High energy density science: simulating materials under extreme temperature and pressure  
Speaker(s): David Strubbe, University of California Merced

Abstract: At the intersection of condensed-matter physics, nuclear physics, and plasma physics lies a new research area called high energy density science (HEDS), which deals with matter under extreme conditions. HEDS is crucial for understanding the sun and other stars, large planets like Jupiter, nuclear explosions, and the possibility of controlled nuclear fusion as an energy source. The Consortium of High Energy Density Science (CFHEDS) brings together faculty and students from Florida A&M University; the University of California, Merced; and Morehouse College to collaborate with Lawrence Livermore National Laboratory on bringing new insight into HEDS. To explore what happens to material when subjected to extreme temperatures and pressures in laser experiments at the National Ignition Facility, we are developing new theoretical methods that can be used in this regime where our usual approximations break down. Specific directions include calculations of the optical and X-ray spectra of highly compressed crystals, improved quantum mechanical approximations for the interactions between atoms in extreme conditions, time-dependent methods to simulate ultrafast compression, and better models for handling electrons at high temperatures. The consortium includes opportunities for undergraduate and graduate students to do research with national lab mentors and facilities, and participate in specialized courses and training in high-energy density science.

Breakout Room: Dr. Edward Bouchet  
Session Time: 3:30 pm – 5:00 pm  
Condensed Matter and Material Physics (CMMP) – 2.B  
Session Chair(s): William Ratcliff, National Institute of Standards and Technology  

TIME: 3:30 pm – 3:45 pm  
TITLE: DNA Sequencing Using Monolayer Silicene: A Computational Study  
Speaker(s): Mukesh Tumbapo, University of Central Oklahoma

Abstract: Graphene’s success for nanopore DNA sequencing has shown that it is possible to explore other potential single- and few-atom thick layers of 2D elemental materials beyond graphene, and also that these materials can exhibit fascinating and technologically useful properties for DNA base detection that are superior to those of graphene. The buckled honeycomb lattice of silicene monolayer makes it an ideal material for rapid DNA sensing applications. Using density functional theory, we modeled and studied the interaction of silicene nanopore...
and nanoribbon with DNA bases. The ability of silicene to distinguish the individual DNA bases is then compared with graphene using three evaluation metrics, namely, binding energy, band gap, and density of states. In this talk, we will present the results of our research findings.

**TIME:** 3:45 pm – 4:00 pm  
**TITLE:** Individual Identification of DNA Bases Using Phosphorene Nanomaterials  
**Speaker(s):** Matthew Henry, *University of Central Oklahoma*

**Abstract:** The need for enhanced DNA sequencing techniques at the resolution of individual nucleobases is ever-increasing and research into new methods seeks to provide rapid, high-resolution, and cost-effective sequencing of longer strands. The single-layer nature of 2D materials make them ideal materials for use in rapid DNA sequencing at single-base resolution. Despite the large number of 2D materials, most research efforts have mostly focused on a small number of candidates such as graphene, MoS2, and hexagonal boron nitride. In this talk, we present the results of DFT studies of the interaction of phosphorene nanomaterials with DNA bases. We observe that phosphorene nanomaterials show a characteristic change in the density of states for each base. Furthermore, the band gap of phosphorene nanoribbon is significantly changed compared to other nanomaterials (e.g., MoS2, graphene, h-BN, and silicon nanowire) due to physisorption of bases on nanoribbon surface. Our findings show that phosphorene is a promising material for DNA base detection using advanced detection principles such as transverse tunneling current measurement.

**TIME:** 4:00 pm – 4:15 pm  
**TITLE:** DNA Base Detection Using Elemental 2D Materials Beyond Graphene  
**Speaker(s):** Benjamin Tayo, *University of Central Oklahoma*

**Abstract:** Graphene’s success for nanopore DNA sequencing has shown that it is possible to explore other potential single- and few-atom thick layers of elemental 2D materials beyond graphene (e.g. phosphorene and silicene), and also that these materials can exhibit fascinating and technologically useful properties for DNA base detection that are superior to those of graphene. Using density functional theory, we studied the interaction of DNA bases with nanomaterials from phosphorene and silicene. We observe that binding energies of DNA bases using nanopores and nanoribbon from phosphorene are smaller compared to graphene and silicene devices. This shows that minimal sticking of DNA bases to phosphorene’s surface is expected for phosphorene devices. Furthermore, both nanopore and nanoribbon devices from phosphorene show a characteristic change in the density of states for each base. The band gap of phosphorene is significantly changed compared to other nanomaterials (e.g., MoS2, graphene, silicene, and h-BN) due to physisorption of bases on nanoribbon surface. Our findings show that phosphorene is a promising material for DNA base detection using advanced detection principles such as transverse tunneling current measurement.

**TIME:** 4:15 pm – 4:30 pm  
**TITLE:** Ambient Conditions Determine the Wettability Property of Graphene  
**Speaker(s):** Christina McBean, *Howard University*

**Abstract:** Graphene, which is the first two-dimensional material to be discovered, boasts a unique combination of structural and electronic properties. Over the years, experiments that studied water-graphene interactions showed that graphene was a hydrophobic material - agreeing with expectations. But then, more recent works reported that graphene’s true intrinsic hydrophilicity was masked by surface-adsorbed hydrophobic contaminants. We now see that the ambient environment of the experiment may have a strong influence on graphene’s wettability. In this theoretical work, we use density functional theory to study the effects of some “real life” conditions that affect the adsorption of water on graphene. Our calculations reveal that the intrinsic water-graphene interactions have several inter-dependent components, viz., the van der Waals interaction, polarization, and charge transfer, which results in electrostatic interactions. We further show that the presence of different ambient gases, defects and substrates influence all of these individual components, resulting in contradictory observations made in experiments.

**TIME:** 4:30 pm – 4:45 pm  
**TITLE:** Carbon Nanotube Fabrication for the National Ignition Facility at Lawrence Livermore National Lab  
**Speaker(s):** Eric Carter, *Morehouse College/University of Michigan*
**Abstract:** During my time at Lawrence Livermore National Laboratory during the summer of 2019 I did work on Carbon Nanotube Fabrication and how they could used for Capsule Support in NIF Targets. The task that NIF (the National Ignition Facility) was trying to accomplish is self-sustained heating of fusion fuel to be used as renewable energy using lasers and a small capsule and target. Heating of the target inside capsule causes the target to burst and the reaction energy to be greater than the laser energy spent in the material. The main problem found by physicists at NIF were perturbations in the explosion caused by what used to hold the target in place in the middle of the capsule, tents. Therefore, research by NIF physicists had found that carbon nanotubes could be spun and woven to be able to hold the target in a tetracage. My job was to be able to spin these carbon nanotubes, measure and characterize them based on mass, length, and strength and see if they would be more useful at holding the target in the NIF chamber without causing perturbations. My second duty was to be able to come up with ways to improve the process to be able to spin more carbon nanotubes. The task went well and I was not only able to improve the process at which carbon nanotubes are spun by improve the way the carbon nanotubes are manufactured and tested for stability as well.

**TIME:** 4:45 pm – 5:00 pm  
**TITLE:** Doping-limitations of cubic boron nitride: effect of unintentional defects on shallow doping  
**Speaker(s):** Tamanna Joshi, [Howard University](https://www.howard.edu)  

**Abstract:** Cubic boron nitride (cBN) is an ultra-wide bandgap, super-hard material with potential for extreme temperature and extreme-pressure applications. Although, a p-n junction using this material was demonstrated almost three decades ago, the full potential of cBN in device applications has not been realized. Two main hurdles have been: (i) difficulties in producing high-quality cBN films and (ii) controllable n- and p- doping its matrix. In this theoretical work, we study the reasons for doping limitations, an acute issue in realizing cBN-based electronics. In particular, we find that different intrinsic and extrinsic defects act as compensating defects and/or introduce trap states. Amongst different possible foreign impurities, we explored defects containing carbon (C) and oxygen (O), as large numbers of these impurities are detected in as-grown cBN. We find that the unintentional defects and their complexes not only affect the incorporation of the shallow dopants [silicon (Si) and beryllium (Be)], but can also introduce deep trap states, which will adversely affect cBN-based devices. Our analysis of doping-limitations due to unintentional defects/impurities is an important step towards finding solutions for controllably n- or pdoping cBN.

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**Saturday, November 7**

**Breakout Room:** Dr. Willie Hobbs Moore  
**Session Time:** 1:00 pm – 2:30 pm  
**Astronomy and Astrophysics (ASTRO) – 2.A**  
**Session Chair(s):** Greg Mosby, [NASA Goddard Space Flight Center](https://www.nasa.gov)  

**TIME:** 1:00 pm – 1:15 pm  
**TITLE:** Poster Pops - ASTRO poster presenters will have 1 minute and one slide to summarize their posters.

**TITLE:** Searching for Distant Ultracool Dwarfs in Deep HST/WFC3 Surveys  
**Speaker(s):** Christian Aganze, [University of California San Diego](https://www.ucsd.edu)  

**Abstract:** Ultracool dwarfs (UCDs, mass M < 0.1 Msun, effective temperature Teff < 3000 K) are the lowest-mass stars and brown dwarfs. They trace the structure, star-formation history and chemical evolution of the Milky Way, due in part to the cooling evolution of non-fusing brown dwarfs. The wide-field optical and infrared spectroscopic and photometric surveys that have uncovered the majority of ultracool dwarfs now known are generally limited to the local volume (distances < 100 pc) due to these objects’ faint luminosities. To expand this sample, we have searched for distant ultracool dwarfs in 0.5 square degrees of low-resolution near-infrared spectral survey data in the WFC3 Infrared Spectroscopic Parallel Survey (WISPS) and the 3D-HST parallel survey using spectral indices and machine learning methods. We report the discovery of 182 M7-T9 dwarfs in these samples, with spectro-photometric distances up to 2 kpc for L dwarfs and 400 pc for T dwarfs. We model the number density distribution with population simulations incorporating various assumptions of the initial mass function, star formation history, binary fraction, Galactic scaleheight, and different ultracool dwarf evolutionary models. Our number counts are...
consistent with a scaleheight that varies with spectral type, ranging from 350 pc for late M dwarfs, 150–200 pc for L dwarfs and >300 pc for T dwarfs, generally consistent with population simulations.

**TITLE:** Vertical Structure of Turbulence around DM Tau  
**Speaker(s):** Amina Diop, *Williams College*

**Abstract:** Turbulence is one of the key processes influencing planet formation, hence we are investigating the mechanism driving it by studying its vertical structure. We have been working with the disk around DM Tau, since it is so far the only system where significant non-zero turbulence has been robustly detected in its upper layers using molecular line emission. To estimate turbulence near the midplane in the outer disk, we used N2H+(3-2) and DCO+(4-3) emission alongside a ray-tracing radiative transfer code with a parametric model of the disk structure and Bayesian statistics to find a best fit model. Our preliminary results show N2H+ emission inside the previously determined CO snowline. Moreover, the DCO+(4-3) emission is depleted between ~104 and ~156 au; which could be explained by CO freezeout, non-thermal desorption and radial migration of dust grains.

**TITLE:** Algorithm Optimization for Fast Transient Identification in the Deeper Wider Faster Data  
**Speaker(s):** Michael Dow, *University of the Virgin Islands*

**Abstract:** Fast transients are astronomical objects whose brightness drastically increases and decreases over timescales from a few minutes to just fractions of a second. These events are particularly difficult to study because of their fleeting nature. The Deeper Wider Faster Survey (DWF) is designed to discover these elusive objects and allow us to collect a large sample to study. Our goal is to develop a Python-based algorithm to be run on a supercomputer that will be able to run in real time with the DWF observations, build light curves that display these brightness spikes versus time, and quickly identify those objects that resemble fast transients of interest. We developed a Python-based code that allows us to model different light curves with mathematical equations and extract useful parameters for subsequent classification. The next steps include the assembly of a large sample of light curves, accurately modeling these lightcurves' behavior, and cataloging the fitting parameters that best describe these objects. This work will allow more powerful, dedicated facilities to focus on these objects once they are identified, in an effort to further our understanding of the physics behind these sources.

**TITLE:** The Variability of Herbig Ae/Be Stars as Observed by TESS  
**Speaker(s):** Marvin Morgan, *SETI Institute*

**Abstract:** Young intermediate mass stars are of particular interest for observational astronomers and theorists as they offer an excellent laboratory for studying stellar and planetary formation. Among them are the Herbig Ae/Be stars, ranging from about 2-15 solar masses; these are the most-massive stars with a visible pre-main-sequence phase. They have circumstellar disks with gas occulting on to their surfaces, which causes distinct variability patterns. We present an investigation of these stars using optical variability data from the Transiting Exoplanet Survey Satellite (TESS). Using a set of 271 known Herbigs with high quality photometry, we examine the light-curve variability properties for each star. We observe flux dipping and bursting patterns in the light curves that can mostly be attributed to physical processes of occulting gas, rotating dust, stars spots, and potentially planetesimals. To extend our analysis in the future, we will search through an additional 60 million TESS light curves to identify previously unknown young, intermediate-mass stars. To do this, we will identify key features in the variability of the initial set, subsequently applying statistical techniques to strategically pick out similar stars in the larger dataset. Identifying and characterizing the variability of these young stars will help us to further understand their stellar and circum-stellar properties in relation to the better studied objects at solar and lower mass.

**TIME:** 1:15 pm – 1:45 pm  
**TITLE:** What can corona jets tell us about magnetic reconnection?  
**Speaker(s):** Samaiyah Farid, *Yale University*

**Abstract:** Magnetic reconnection is a fundamental process in which magnetic energy is converted to thermal, kinetic, and mechanical energy. Magnetic reconnection is thought to drive large-scale cosmological events as well as eruptions in the solar corona, in particular coronal jets. Coronal jets are small-scale eruptions that are thought to be driven by magnetic reconnection however, a comprehensive model of their initiation and acceleration
mechanisms has not been described. In this work, we investigate the topological evolution of coronal jet containing a sigmoid-like flux rope using a Non-linear Force-Free Field (NLFFF) model. We examine the topological evolution predicted by the NLFFF model with respect to observations from Solar Dynamic Observatory’s Atmospheric Imaging Array (AIA). We also calculate the squeezing factor, an approximation for sharp discontinuities in the magnetic field, similar to the commonly used squashing factor, and the coiling rate an approximation for the amount of twist in neighboring field lines. We identify two topological features where magnetic reconnection is likely taking place; an internal, quadrupolar region near the filament and an external region between the closed dome of the coronal jet and the ambient field. We find that in this case, the external region initiates the eruption allowing the inner region to unwind and the filament to escape. Finally, we examine the thermal evolution of the jet and trace the regions of enhanced emission-measure weighted temperature to the location of the expected reconnection regions. We find that magnetic field lines associated with the internal reconnection region are tied to increased emission in EUV observations indicating evidence of heating. Thus, we identify this eruption as a so-called 'untwisting jet', in which unwinding magnetic field lines impart energy along the magnetic field, forming the observed features of the coronal jet. By combining calculated thermal properties with magnetic modeling, we are able to constrain the energy released by magnetic reconnection.

TIME: 2:00 pm – 2:15 pm
TITLE: Insights Discovered From Comparative Retrievals of Substellar Objects
Speaker(s): Eileen Gonzales, Cornell University

Abstract: Subdwarfs, objects that have metallicities significantly lower than that of the Sun, provide insight into understanding how metallicity affects observable features of low-mass stars and brown dwarfs. Currently, substellar subdwarfs are thought to have cloudless atmospheres due to reduced condensate opacities from their low-metallicities. In this talk, I aim to explore the nature of clouds in subdwarfs using the spectral inversion modeling technique of atmospheric retrievals. With this technique, we derive a Pressure-Temperature (PT) profile to describe the atmospheric structure of a given target. Using the retrieval code Brewster, I compare a sample of field sources of similar temperature or spectral type to SDSS J1416A -- an L dwarf primary in a widely-separated subdwarf binary system-- to determine how the PT profile of these objects compares and what may drive the differences we see in their spectra. I will present the initial findings of this work which shows the need for longer wavelength data to fully constrain the cloud properties of substellar objects.

TIME: 2:15 pm – 2:30 pm
TITLE: Constraining Detection Limits for Potential Biosignatures in super-Earth Atmospheres with JWST
Speaker(s): Caprice Phillips, Ohio State University

Abstract: No Solar System analog planet to super-Earth exists, a class of exoplanets with masses 2-10x Earth’s mass which can retain more of their atmospheres. Super-Earth atmospheres can have different compositions from Nitrogen and Oxygen dominated atmosphere of Earth. The James Webb Space Telescope (JWST) will offer unprecedented insight into the atmospheric composition of potentially habitable super-Earths through transmission and emission spectroscopy We present work on the investigation of NH3 (Ammonia, a potential biosignature) detectability on super-Earths with a H2 dominated atmosphere using the Mid-Infrared Instrument (MIRI) and the Near InfraRed Spectrograph (NIRSpec) on the upcoming JWST mission. We use a radiative transfer code, petitRADTRANS, to generate synthetic spectra of optimal targets for observations given their proximity to Earth (<50 pc), radii (1.7-3.36 Earth Radii), and equilibrium temperature (< 450 K). We find that given the constraints of the MIRI LRS Instrument (flux ratio contrast of host star and planet ~ 10^-4), the optimal target would be LP 791-18 c. For NIRSpec, we find that a lower mean molecular weight atmosphere provides more prominent spectral features. We use PandExo to simulate mock observations with JWST and find detection significance range for Ammonia features with transmission spectroscopy, >3σ significance, for LP 791-18 c, GJ 1214 b, TOI-270 c, and TOI-270 d.

Workshop

Saturday, November 7

Breakout Room: Dr. Jim Gates
Session Time: 1:00 pm – 2:30 pm
SPS for Students
Session Chair(s): Brad Conrad, American Institute of Physics

Description: Physicist Random Walk: Careers, Graduate School, & Mental Maintenance

Abstract: Physicists and astronomers hone an extremely valuable set of skills that position them to succeed in an exceptionally wide variety of graduate programs, careers, and positions. We can be really good problem solvers. Through an interactive example of fermi questions (back-of-the-envelope calculations), we’ll touch on some of the ways physicists and astronomers impact the world in profound ways. Through a variety of careers (that may appear to be random walks) we’ll end up discussing how we can help to solve the world’s problems through physics and astronomy and assess your own skills while we are at it. This is, in part, to shed light on the obstacles, for both students and faculty, but also to encourage you to consider all options. We’ll end the talk with some tips on finding the right job and career pathway. Please bring some scrap paper and a writing implement.

Saturday, November 7

Breakout Room: Shirley Jackson
Session Time: 1:00 pm – 2:30 pm
Advanced Light Source
Session Chair(s): Sekazi Mtingwa, TriSEED Consultants, LLC & Kenneth Evans-Lutterodt, Brookhaven National Laboratory

TIME: 1:00 pm – 1:22 pm
TITLE: Time-resolved x-ray diffraction and imaging measurements: Current status & future prospects
Speaker(s): William J. Evans, Lawrence Livermore National Laboratory

Abstract: The time structure of synchrotron x-ray sources and 4th generation x-ray sources (X-Ray Free Electron Lasers) is ushering in new approaches and scientific interrogation techniques. As detector technology catches up to the time structure of the x-ray sources, it is enabling new classes of experiments elucidating the time-dependence and evolution of systems under transient loading conditions. I will discuss the current status and limitations of these measurements and present my perspective on capabilities that are rapidly maturing. The new science enabled by these developments will provide new insights into pressure-induced phenomena and develop an experimental basis to accompany and drive the development of phase transition kinetics theories and models.

TIME: 1:22 pm – 1:45 pm
TITLE: Collimating Channel Array Optics for Confocal (micro) X-ray Fluorescence Microscopy at CHESS
Speaker(s): David Agyeman-Badu, SLAC – Stanford University

Abstract: A novel x-ray optic called Collimating Channel Arrays (CCA) for high-resolution Confocal (micro) X-ray fluorescence microscopy (CXRF) has been developed at the Cornell High Energy Synchrotron Source (CHESS). CXRF is a three dimensional XRF imaging technique, which relies on a well-defined probe volume in 3D to spatially map out the elemental distributions in heterogeneous and un-thinned samples. The 3D probe volume is defined by a pair of optics at the X-ray excitation and detection channels respectively. The conventional implementation of CXRF utilizes a polycapillary lens as the collection optic at the detection channel and that choice limits the depth resolution of the probe volume to ~10 µm at 10 keV. By using polycapillary optics, the depth resolution also varies strongly as a function of energy, which ranges from 10 µm to over 30 µm. In our approach to CXRF, we use CCAs developed at CHESS as the collection optic. CCA optics are lithographically fabricated from germanium substrates, and are an array of radially-spanning set of collimating channels, which collect x-rays from a single source position at the focus. With our setup, the geometry of the channels defines a spatial resolution, which is invariant over a wide energy range, and significantly smaller than the depth resolution of polycapillary optics. We have been able to achieve a depth resolution of 2 µm for an energy range spanning from 1.7 keV to 20 keV, and our technology has been incorporated into the general user program at the Advanced Photon Source station ID 2.

TIME: 1:45 pm – 2:07 pm
TITLE: Nuclear Resonance Time-domain Interferometry
Speaker(s): Dennis Brown, Northern Illinois University
Abstract: There is a renewed interest in performing Rayleigh Mössbauer Scattering due to the advent of powerful x-ray sources such as the Advance Photon Source (USA), Spring 8 (Japan), and the ESRF (Europe). These sources provide a highly collimated intense source of pulsed x-rays that are ideal for Mössbauer Spectroscopy. In particular, an interferometer operating in the time domain can be constructed to examine electronic fluctuations in non-Mössbauer materials. In principle, the intermediate scattering amplitude as a function of q and ω can be extracted from liquid materials. Nuclear Resonance Time-domain Interferometry (NRTI) experiments complement the x-ray photon correlation spectroscopy (XPCS) experiments done at Argonne National Labs, but NRTI can examine fast electronic fluctuations having lifetimes too short for XPCS to measure. These quasielastic scattering experiments can be used to extract relaxation times in the range of a 1 nanosecond to several hundred nanoseconds. Thus one can gain insight into the vibrational diffusive motion of atomic systems, and measure very soft phonon lattice modes and spin dynamics.

TIME: 2:07 pm – 2:30 pm
TITLE: TBA
Speaker(s): Gabriel Gwanmesia, Delaware State University

Abstract: TBA

Saturday, November 7

Breakout Room: Katherine Johnson
Session Time: 3:30 pm – 4:00 pm
Cosmology, Gravitation, and Relativity (CGR) – 2.B
Session Chair(s): Hume Feldman, University of Kansas

TIME: 3:30 pm – 4:10 pm
TITLE: Bubbling Spacetime
Speaker(s): Ibou Bah,

Abstract: An important problem in physics is what are the make ups of black holes? Addressing this question undoubtedly requires a quantum theory of gravity. For black holes in supersymmetric theories of gravity, the states that make up the black can be reliable described in string theory. Interestingly, there exist a class of coherent quantum gravity states that admit classical descriptions in classical theories of gravity. Motivated by such results from string theory, one can look for classical and non-supersymmetric solutions of gravity that can describe states of black holes. I will discuss recent constructions along this line and their potential implications for black hole physics.

TIME: 4:10 pm – 4:25 pm
TITLE: The Effects of Decaying Dark Matter on The Hubble Constant
Speaker(s): John Yevoli, Manhattan College

Abstract: We analyze models of decaying dark matter, searching for shifts in $H_0$ and $\sigma_8$ to resolve the tensions between linear and astrophysical measurements. While previous searches have focused on dark matter with lifetimes on the order of the current Hubble time, we instead consider dark matter that decays between the time of last scattering and the era of large scale structure. We find that while decaying dark matter pushes parameter likelihoods in the right direction to resolve the Hubble Tension, the bounds ($\Omega = 0$ to $10^{-2}$ for lifetimes a tenth of the Hubble Time) on decaying dark matter are too strong to resolve the tension completely, a conclusion unchanged even when spatial curvature is allowed to vary. In addition, these bounds can be used to constrain theoretical models such as coupled axions from string compactifications.

TIME: 4:25 pm – 4:40 pm
TITLE: A two fields hybrid Monodromy Inflation
Speaker(s): Morgane Konig, University of California Davis
Abstract: Inflation is the leading candidate for explaining why the universe is so old, flat and smooth. Most models realize inflation using a local quantum field theory with a single scalar field in a flat potential. Those simple single field inflation models require both a very flat potential and super Planckian field variations and usually predict observable primordial gravitational waves which are increasing in tension with current observations. In this talk I will present a model of two fields hybrid inflation. I will show that this theory agrees with the current Cosmic Microwave Background (CMB) measurement from the Planck data and does not suffer from quantum corrections. Finally I will argue that this theory can be realized as a theory of coupled axions dual to 4-forms field strength.

TIME: 4:40 pm – 5:00 pm
TITLE: Beyond Einstein’s Gravity: Formulation of Gravitational Strain Tensor Fields
Speaker(s): Ronald Gamble, National Strategic Research Institute

Abstract: In recent years, theoretical and observational investigations of gravitational interactions has led us to discover new facets of the fundamental force. The state of the theory that currently governs known gravitational wave physics, The General Theory of Relativity, has astronomers and astrophysicists alike wondering what else about gravity is there to explore. With these discoveries the general theory of relativity is under greater scrutiny now than it was 100 years ago. Development of a more advanced theory is needed for extensive predictions of gravitational interactions in local and cosmological settings. In this work, we present a novel and intuitive extension to General Relativity that describes spacetime as a viscoelastic continuum; retaining the properties of the natural +ΛCDM vacuum and building upon the established metric theory of gravity for compact dense objects. With the axioms presented, we provide a foundation for a tensor field theory of Gravitational Strain; accompanied by strong and weak background metric representations. Deformations due to the variation in the volume, surface shape, and rotation of mass-energy distributions are presented in terms of their corresponding tensor fields. The construction of a formal nonlinear field equation describing massive longitudinal gravitational waves is also presented. This viscoelastic definition of gravity serves as a natural advancement of the current gravitational field theory to include dynamical properties.

Saturday, November 7

Breakout Room: Dr. Shirley Jackson
Session Time: 3:30 pm – 5:00 pm
Atomic Molecular and Optical Physics (AMO) – 2
Session Chair(s): Dr. Clayton Simien, University of Alabama-Birmingham

TIME: 3:30 pm – 3:50 pm
TITLE: Exploring the quantum vacuum with super-intense laser pulses
Speaker(s): Wendell Hill, University of Maryland College Park

Abstract: A vacuum is often thought to be empty, devoid of all material. According to quantum mechanics, this does not comport with reality. The vacuum is full of matter and antimatter, the stuff powering the engine of starships in Star Trek, fluctuating into and out of existence. These fluctuations occur on incredibly short time scales, governed by Heisenberg’s Uncertainty Principle. The least massive particles that we are aware of are electrons and positrons. When super-intense laser pulses propagate in vacuum, theory predicts they will interact with these ephemeral particles much like ordinary laser light interacts with electrons bound to ions in material leading to nonlinear behavior. The net result is, the vacuum is expected to exhibit phenomena seen every day in the lab -- light traveling at different speeds depending on how it traverses the material and new colors generated during transit are just two examples. To observe such features, however, the most intense lasers in the world must be employed. The payoff could be spectacular, providing new insight into mysteries that continue to confound physics today. These ideas will be discussed in this talk.

TIME: 3:50 pm – 4:10 pm
TITLE: Tailoring attosecond pulses for coherent control of electron dynamics
Speaker(s): Guillaume Laurent, Auburn University
Abstract: The recent advent of attosecond pulses of light offers new opportunities for controlling quantum dynamics in matter down to the natural timescale of electron motion. So far, attosecond control of electron dynamics has been mostly achieved with pump/probe schemes where an attosecond pump pulse triggers a given electronic process and a phase-locked femtosecond probe field is used to steer its dynamics. The dynamical system under scrutiny is thus controlled by varying the time delay between the two pulses. In this work, we show that electron dynamics can also be controlled by shaping the temporal profile of the attosecond pulse. We present details on our experimental procedure to control the photoelectron emission from atoms along the polarization direction of the ionizing field.

TIME: 4:10 pm – 4:30 pm  
TITLE: Can we stop the quantum apocalypse?  
Speaker(s): Eric Hudson, University of California Los Angeles

Abstract: Governments around the world are jockeying to secure their place in the coming quantum industrial revolution. Large, multinational corporations are investing hundreds of millions of dollars to develop quantum computers. One may wonder what role physicists can play now that the technology has moved from proof-of-principle to large scale integration. I'll argue that the role of physicists is now more important than ever if we are to prevent a "quantum bust" from following the current "quantum boom".

TIME: 4:30 pm – 4:50 pm  
TITLE: Interacting Bosons in the Flat Band of an Optical Kagome Lattice  
Speaker(s): Charles Brown, University of California Berkeley

Abstract: Frustrated particle motion in a kagome lattice causes the single-particle band structure to exhibit a dispersion-less, flat energy band. Generally, frustration can cause a vast degeneracy of low-energy states, and instabilities in the presence of atomic interactions may lead to the manifestation of exotic states of matter. The kagome lattice, a pattern of vertex-sharing triangular plaquettes, offers the highest degree of frustration among two-dimensional lattice geometries. We create an optical kagome lattice by superimposing two optical triangular lattices made from laser light with commensurate wavelengths. We probe the band structure of the kagome lattice by preparing a Bose-Einstein condensate in excited Bloch states of the lattice, and then measuring the atoms' group velocity via the atomic momentum distribution. We find that atomic interactions renormalize the kagome lattice band structure, and significantly increase the dispersion of the third band, which, according to non-interacting band theory, should be nearly flat (dispersion-less). Measurements at various lattice depths and gas densities agree quantitatively with predictions from Gross-Pitaevskii equation solved on the lattice, which indicates that the observed band structure distortion, onset by atomic interactions, is caused by the deviation of the overall lattice potential away from the kagome geometry.

TIME: 4:50 pm – 5:00 pm  
TITLE: First Principle Study of Quantum Defects in Silicon Carbide  
Speaker(s): Don-Terry Veal, Morgan State University

Abstract: Newton’s laws accurately predict the movement of particles at levels visible to the human eye, but these laws are not accurate predictors of movement at an atomic level. Through Density Functional Theory (DFT), we can more accurately predict how particles at subatomic levels will interact with one another. This process is an examination of the Schrodinger equation and Hohenberg-Kohn theorems, combined with elementary quantum computing methods. DFT calculations are efficiently processed through Quantum Espresso’s material modeling software. After the initial parameters are implemented, the simulation’s role is to formulate a crystalline structure with an appropriate calculation of the spatially dependent electron density. The goal is to calculate the energy band diagrams of silicon carbide for various quantum defects. This information will supplement the experimental studies in the characterization of these defects. Preliminary results of DFT simulations on silicon carbide will be presented.

Saturday, November 7

Breakout Room: Dr. Elmer Imes
Session Time: 3:30 pm – 5:00 pm
Nuclear Particle Physics (NPP) – 2
Session Chair(s): Dr. Paul Gueye, Michigan State University

TIME: 3:30 pm – 4:00 pm
TITLE: Multidisciplinary research in nuclear astrophysics
Speaker(s): Remco Zegers, Michigan State University

Abstract: To better understand the evolution of the universe and the creation and demise of astrophysical objects such as stars, a wide variety of research data and tools are required. In particular, to better understand the role of nuclear physics in astrophysical phenomena, researchers must be multidisciplinary. In order to understand how stars evolve and eventually serve as sites for nucleosynthesis, the results from astronomical observations, stellar simulations, data from nuclear experiments and theoretical nuclear physics calculations must be combined in order to make progress. In this presentation, the focus is on the work that is being done by the Charge-Exchange Group at Michigan State University to better understand how massive stars become supernovae and detonate. At the end of the presentation, there will be a brief discussion about applying to graduate school.

TIME: 4:00 pm – 4:15 pm
TITLE: A Study Assessing Discrimination of Single Scatters from Multiple Scatters for WIMP Dark Matter Detection with the LUX-ZEPLIN Experiment
Speaker(s): Aminatou Dabo Kemp, SLAC-Stanford University

Abstract: Cosmological evidence shows that known forms of matter, which make up the stars in the Milky Way, account for only 15% of the expected mass of our universe. The remaining 85% is yet to be discovered and is known as dark matter. The LUX-ZEPLIN (LZ) dark matter detector employs a direct detection technique to observe theorized dark matter candidates known as Weakly Interacting Massive Particles (WIMPs). LZ’s objective is to observe the light and charge signals from WIMPs scattering off of xenon nuclei. LZ is designed to be the world’s most sensitive WIMP detector for WIMP masses around 40 GeV/c^2. A WIMP will only scatter off of a single xenon nucleus, but background particles can scatter multiple times inside of the detector. For a multiple scatter interaction, an overlap of signals may happen if the scatters occur in close proximity to one another. A boosted decision tree (BDT) model is used to determine whether a signal is a true single scatter collision or a multiple scatter collision. This BDT model expects to improve LZ’s background rejection. Further potential improvements will be investigated by implementing a convolutional neural network.

TIME: 4:15 pm – 4:45 pm
TITLE: Estimating the Energy Mover's Distance with Exclusive Jet Clustering
Speaker(s): Shira Jackson, Massachusetts Institute of Technology

Abstract: There exists an opportunity to innovate the way particle physicists analyze collider events in the subfield of Jet Physics. The novel Energy Mover’s Distance (EMD) metric provides a notion of distances between two jets or events, which allows particle physicists to define a space of jets. To date, the computation of the EMD Distance has been based on using all the particles in two jets, which is computationally demanding. We present the measurement of the EMD between two high-energy jets using data simulated by the Pythia Monte Carlo Generator. First, we re-cluster the jets into N constituents using an exclusive jet clustering algorithm called k_t clustering, then we compute the pairwise EMD between all quark and gluon subjets that have been clustered using the exclusive algorithm. The pairwise EMD computation allows us to extract the correlation dimension for the space of jets, which provides information about the fractal structure of the dataset. We find that N = 8 subjets provides a good approximation of the jets clustered using all their original information, with a nearly seven-fold speed gain on the computation and nearly no loss of efficacy. The fractal structure is preserved with N > 8 subjets. With this innovative way of analyzing collider events, we can provide recommendations to improve the computational efficiency in Large Hadron Collider analysis methods using natural data.
TIME: 3:30 pm – 3:45 pm  
**TITLE**: A Survey of the Neighborhood of Galaxies and Associated Circumgalactic Medium  
**Speaker(s)**: Arielle Phillips, *University of Notre Dame*

**Abstract**: The formation, evolution, and chemical composition of galaxies are influenced by their interactions with the circumgalactic medium (CGM) and therefore the local cosmic environment. This CGM is in turn embedded in the intergalactic medium (IGM) which is composed of an extensive network of clusters, filaments, and sheets of galaxies with vast empty expanses (voids) between them. We use a modified computer vision algorithm to identify these structures in largescale simulations. This allows us to study the cosmic neighborhoods where galaxies and their associated CGM evolve and therefore how these neighborhoods influence that evolution. I will include a road map for aspiring computational astrophysicists.

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TIME: 3:45 pm – 4:00 pm  
**TITLE**: Weighing a Dusty, Ultra-Massive Galaxy Cluster Core at z=4  
**Speaker(s)**: Arianna Long, *University of California, Irvine*

**Abstract**: Recent simulations and observations on galaxy cluster evolution predict that the majority of stellar mass buildup happens within cluster members within the first 3 billion years of the Universe. Protoclusters rich with dusty, star-forming galaxies (DSFGs) at z > 3 are the favored candidate progenitors for the massive galaxy clusters we see locally today. In this talk, I will discuss how we paired stellar emission with cold dust and gas continuum emission to analyze a spectroscopically confirmed z = 4.002 protocluster core rich with DSFGs, the Distant Red Core (DRC). I will review how the individual properties of these galaxies are indistinguishable from their co-eval isolated field counterparts, and how this protocluster core alone will likely evolve to become an ultra-massive object (even greater than the Coma Cluster), regardless of how you choose to ‘weigh’ it.

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TIME: 4:15 pm – 4:30 pm  
**TITLE**: Optimizing the Next GBT Pulsar Survey  
**Speaker(s)**: Gabriella Agazie, *University of Wisconsin-Milwaukee*

**Abstract**: Large-area pulsar surveys are important tools for increasing the population of known pulsars, which are used to study various extreme physical phenomena. As the current large-scale survey on the Robert C. Bryd Green Bank Telescope (GBT), the Green Bank North Celestial Cap (GBNCC) survey approaches completion, it is important to begin planning next-generation pulsar surveys that are competitive with current and upcoming pulsar surveys conducted on other instruments. We present the results of simulated pulsar population and survey studies conducted for potential GBT pulsar surveys using the 820 MHz, L-Band, S-Band, Ultra-wide band, and the Focal L-Band Array for the GBT (FLAG) receivers. We determined that a survey over 1700 square degree region along the Galactic plane would be the most effective. Such a survey conducted at frequencies of 1.1 to 1.9 GHz using the GBT L-Band receiver would detect approximately 500 new pulsars, about 50 of which would be MSPs. We also compare these results to a possible survey with the FLAG receiver over the same region with a 1260 s dwell time, which is projected to discover 550 pulsars. Radio frequency interference would likely reduce the true yields to some degree. While a FLAG survey results in a slightly higher yield, we favor the L-Band receiver survey because it would be more sensitive to binary pulsars in short orbital periods. However, expanding the instantaneous bandwidth or field of view of FLAG could make it the better option.

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TIME: 4:30 pm – 4:45 pm  
**TITLE**: The Mysteries of Supermassive Black Hole Formation  
**Speaker(s)**: Maximillian Maxwell, *University of California Irvine*

**Abstract**: Supermassive Black Holes (SMBH) are extremely massive black holes that appear to be at the center of nearly every galaxy, meaning that there are in abundance. When using powerful telescopes to peer into the early universe we find that there are still SMBH of great mass at times so early in the universe that it becomes very difficult to explain how a black could even become that large in such a short amount of time relative to the birth of the universe. This presentation will present this topic as a whole, explain the basics of what is being talked about, describe why SMBH are an active area of research, and detail some of the varying hypotheses for how SMBH
could've formed, while also giving some information on the research I'm currently conducting and the approach I'm looking to take in this problem.

**TIME:** 4:45 pm – 5:00 pm  
**TITLE:** Modeling Accreted Black Hole Plasma from the Event Horizon Telescope (EHT) with Semi-analytical models  
**Speaker(s):** Elon Price, *Fisk University*

**Abstract:** Since the announcement of the first black hole image, the Event Horizon Telescope (EHT) collaboration has been working to perform data analysis in hopes to improve future observations (i.e. 'next generation' or ngEHT). In the image produced by EHT using the VLBI experiment, the plasma accretion disk can be seen lensed around the black hole. In this project, accreted plasma is modeled using semi-analytical descriptions rather than the computationally demanding 3D General Relativistic Magneto-HydroDynamic (GRMHD) simulations. Using the geodesics for rotating/non-rotating black holes and General Relativistic Radiative Transfer (GRRT), different semi-analytic simulations are developed including: reverse ray tracing (Python ODE solver), thin disk models, Radiatively Inefficient Accretion Flow (RIAF) models and orbiting plasma hot spots. These simulations, combined with synthetic EHT observational data, explore properties of the black hole by varying the spin parameter, inclination angle of the observer, and observational frequency (values include: 43e9, 86e9, 120e9, 230e9, 345e9, 680e9, 1000e9 in GHz). There is also exploration of thermal and nonthermal particle distributions, as well as translations to Fourier space. Results from these models can be used to probe for new array configurations for ngEHT imaging.

**Workshops**

**Saturday, November 7**

**Breakout Room:** Dr. Edward Bouchet  
**Session Time:** 5:30 pm – 7:30 pm  
**Physicists Inspiring the Next Generation**  
**Session Chair(s):** Paul Gueye, *Michigan State University*

**TIME:** 5:30 pm – 5:45 pm  
**TITLE:** PING Session: Overview  
**Speaker(s):** Paul Gueye, *Michigan State University*

**TIME:** 5:45 pm – 6:00 pm  
**TITLE:** PING 2020  
**Speaker(s):** Caley Hulbert, *FRIB*

**TIME:** 6:00 pm – 6:10 pm  
**TITLE:** The MoNA Collaboration interactive nuclear chart  
**Speaker(s):** Maya Wallach, *Michigan State University*

**Abstract:** The MoNA Collaboration is composed of primarily undergraduate institutions and has been in existence for almost two decades studying neutron rich nuclei along the drip line of the nuclear chart at the National Superconducting Cyclotron Laboratory (NSCL), soon to become the Facility for Rare Isotope Beams (FRIB) located on the campus of Michigan State University (East Lansing, MI). The Collaboration which consists of 11 institutions built two identical arrays to detect neutrons, the Modular Neutron Array (MoNA) and the Large multi-Institutional Scintillator Array (LISA). Both arrays total 288 bars consisting of 10 cm x 10 cm x 200 cm plastic scintillators. The Collaboration has studied isotopes from helium to neon thus far. An interactive nuclear chart that also incorporates
sound based on the proton and neutron numbers of the isotopes is being developed. We will present the status of this project.

**TIME: 6:10 pm – 6:20 pm**  
**TITLE:** Time-to-digital converter calibration for LISA  
**Speaker(s):** Grace Townley, *East Lansing High School*

**Abstract:** Experiments with rare isotope beams help further our understanding of particle interactions, nuclear structure, medical radiation treatments/imaging, and nuclear energy. The MoNA Collaboration studies the nuclear structure of neutron-rich and neutron-unbound nuclei by conducting invariant-mass spectroscopy experiments that involve large arrays of plastic scintillator detectors to measure neutrons emitted in the decays of neutron-unbound systems. These detector arrays provide position and time-of-flight measurements that allow the momenta of neutron decay daughters to be reconstructed. Time-to-digital converters (TDCs) are used to measure the neutron time-of-flight from the reaction target to the detector. The method for calibrating the TDCs will be presented along with the results of the calibration.

**TIME: 6:20 pm – 6:30 pm**  
**TITLE:** Time-to-digital converter calibration for MoNA  
**Speaker(s):** Rachel Lee, *Okemos High School*

**Abstract:** The purpose of my project is to study the half-life of 26O once emitting 2 neutrons using invariant mass spectroscopy. A beam is directed to the segment target where it meets the Sweeper magnet that bends the charged 24O fragments inside the Sweeper focal plane box, which contains a thin timing scintillator. The neutrons continue along their general direction until they interact with the plastic scintillator comprising the MoNA/LISA arrays which are arranged in 17 layers with each layer consisting of 16 bars stacked on top of eachother. My contribution was analyzing the TDC calibrations to convert the units of measurement into nanoseconds by finding a trendline from the TDC channel peaks.

**TIME: 6:30 pm – 6:40 pm**  
**TITLE:** Visualization and interpolation of field mapping data  
**Speaker(s):** Xavier Sykes, *Phoebus High School*

**Abstract:** The MoNA Collaboration utilizes a large-gap (14 cm) high-field (4 T) Sweeper dipole magnet in invariant mass studies of neutron-unbound states. For the invariant mass reconstruction, charged particles need to be tracked through the magnetic field of the Sweeper. 2D planar maps of the vertical component of the magnetic field were measured across the gap when the magnet was commissioned using an array of seven Hall probes placed at different vertical positions. The collected data is being analyzed to generate a 3D field map. Techniques to visualize and interpolate the measured field map will be presented and discussed.

**TIME: 6:40 pm – 6:50 pm**  
**TITLE:** A study of the range of 12B and 14B isotopes inside the CsI of the new MoNA Si-CsI telescope  
**Speaker(s):** Na’Imah Patterson, *Hampton High School*

**Abstract:** The MoNA Collaboration recently conducted an experiment to study neutron-unbound states of 13Be. The experiment used a 76 MeV/u 14Be beam incident on a beryllium target placed in front of a newly constructed detector telescope to identify the charged fragments produced during the reaction process. The telescope consists of a series of silicon detectors and a caesium iodide (CsI) detector. We have studied the maximum distance travelled (i.e., range) inside the CsI by the 12B and 14B particles. The results of this research will be presented and discussed.

**TIME: 6:50 pm – 7:00 pm**  
**TITLE:** Analysis of a GEM detector simulation output using python  
**Speaker(s):** Yiwei Wang, *Haslett High School*
Abstract: A gaseous electron multiplier (GEM) detector is a type of ionization chamber used in nuclear and particle physics for radiation detection. Ionizing radiation incident on the detector volume liberates electrons from the gas atoms. An electric field causes the electrons to drift to a copper-coated Kapton foil that has been perforated with a high density (50-100 per mm$^2$) of small holes roughly 50 microns in diameter. A large potential difference is applied between the upper and lower copper coatings on the foil; this results in a large electric field inside the holes. Electrons that drift into the holes are accelerated into collisions with other gas atoms thus causing further ionization. Electrons drift to a collection electrode where they produce a measurable charge that is proportional to energy deposited by the incident radiation. This project focuses on analyzing the output from a Monte Carlo simulation of the electron motion and interaction with the gas atoms to determine the number of electrons that readout electrode.

TIME: 7:00 pm – 7:10 pm
TITLE: Detector thickness study for a new GPM neutron detector
Speaker(s): Kaitlyn Hua, Holt High School

Abstract: Over the past two decades, the MoNA Collaboration has established itself as a leader for studying neutron rich nuclei along the drip line using the MoNA-LISA (Modular Neutron Array/Large multi-Institutional Scintillator Array) neutron detector consisting of 288 bars of 10 cm x 10 cm x 200 cm plastic scintillators. This work is occurring at the National Superconducting Cyclotron Laboratory (NSCL) located on the campus of Michigan State University (East Lansing, MI). NSCL is being replaced by the Facility for Rare Isotope Beams (FRIB) which is expected to start operation in 2022 with more energetic beams. To address the MoNA-LISA position precision limitation for FRIB, the Collaboration is studying a next generation neutron detector that will couple new scintillators with gas electron multiplier (GEM) detectors. The design and performances of such detector is underway and we will present some results from this study.

TIME: 7:10 pm – 7:20 pm
TITLE: Study of rare isotope beams for cancer therapy
Speaker(s): Isyss London, Kecoughtan High School

Abstract: Hadron (e.g., proton, neutrons, heavy ions) beams in Radiotherapy have many biological and physical advantages in comparison to traditional beams such as electrons and photons. Within the past decades, many researchers have found promising results in the use of radioisotopes. For instance, one important advantage in hadron therapy is the possibility of accurately measuring delivered doses in real-time by monitoring the nuclear decay of the isotopes. These advantages have been at the forefront of cancer research, further expanding clinical modalities for cancer patients of various classifications. We first performed a comprehensive review of how the graphs change as a function of protons and how the graph changes as a function of neutrons. In our second study, we determined how the graph’s dosage and energy can be influenced by an ion’s atomic makeup. We will present and discuss the results obtained from this study. The Facility for Rare Isotope Beams (FRIB) under construction at Michigan State University will provide rare-isotope beams of high intensities. Ion sources are currently being used to deliver heavy ion rare-isotope beams to accelerator systems for nuclear physics. The current work will provide the foundation for the possible development of an ion source optimized for the delivery of rare isotope beams for hadron therapy and hence the treatment of various diseases.

Breakout Room: Dr. Willie Hobbs Moore
Session Time: 5:30 pm – 6:30 pm
APS EP3
Session Chair(s): Theodore Hodapp, American Physical Society

Description: EP3: How can we help shape physics departments of the future?

Abstract: To assist physics departments and faculty as they improve undergraduate education, the American Physical Society, in collaboration with the American Association of Physics Teachers, is developing a comprehensive guide for program improvement and evaluation, drawn from research findings and community knowledge. Scheduled for release in late 2020, the guide weaves principles that promote diversity, inclusion, ethics,
and career readiness throughout and provides concise advice and help with assessment on nearly all aspects of undergraduate education. This session will review guide principles and solicit your opinions on issues critical for shaping the physics department of the next generation.

Acknowledgments: This material is based upon work supported by the American Physical Society and the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Breakout Room: Dr. Willie Hobbs Moore  
Session Time: 6:30 pm – 7:30 pm  
International Engagement  
Session Chair(s): Dereje Seifu, Morgan State University

Description: Ethiopian Physics Society in North America (EPSNA)  
Abstract: The Ethiopian Physics Society in North America (EPSNA) is a 12 years old professional society in North America. EPSNA is a non-profit organization that promotes physics and STEM education and research in Ethiopia in collaboration with the Ethiopian Physical Society (EPS). Some activities EPSNA is engaged in include providing competitive awards to physics students in Ethiopian universities. The award is announced during the annual EPS conference. EPSNA has recently launched a mentoring program for STEM students to prepare them for graduate education. The program includes giving application guidance and helping with fees to cover GRE, TOEFL, and graduate school applications. EPSNA is affiliated with the African Physical Society and the National Society of Black Physicists (NSBP). In the past, members of EPSNA have played active roles in supporting physics in Africa, organizing sessions on physics in Africa at the American Physical Society March meeting. Members of EPSNA have also actively participated in many other physics events in Africa. Some of our recent international engagement include disseminating the African Physical Society newsletter on our medium and organizing a summer school pilot programs. EPSNA has grown in maturity, and we look forward to future collaboration with NSBP and other professional organizations in Africa to serve physics and related areas.

Breakout Room: Dr. Elmer Imes  
Session Time: 5:30 pm – 7:30 pm  
National Laboratory Panel Discussion (BNL, ANL, SLAC, FNAL, NIST, & INL)  
Session Chair(s): Sekazi Mtingwa, TriSEED Consultants, LLC

Panelist: Kevin Evans-Lutterdolt, Brookhaven National Laboratory; Dorian Bohler, SLAC Laboratory; Meridith Brusas, Argonne National Laboratory; Sandra Charles, Fermilab; William Ratcliff, NIST; Krzysztof Gofryk, Idaho National Laboratory; and Dr. Bernadette Hence, U.S. Department of Education

Description: Research and Training Opportunities at the National Labs

Abstract: The National Labs are at the forefront of almost every STEM research discipline. Moreover, they provide many opportunities for faculty and students to obtain access and/or training in the utilization of the latest state-of-the-art facilities, from advanced light sources to the infrastructures that produce nuclear isotopes for medical and other applications. This Virtual Roundtable will engage and facilitate interactions of faculty and students with representatives from Argonne, Brookhaven, Fermilab, NIST, SLAC, and Idaho National Lab. The Roundtable will also feature Program Manager, Dr. Bernadette Hence, who will discuss how the Department of Education supports HBCUs who send students to the national laboratories.

Breakout Room: Katherine Johnson  
Session Time: 5:30 pm – 6:30 pm  
Women in Physics  
Session Chair(s): Jami Valentine-Miller, U.S. Patent and Trademark Office
**Description:** This will be a panel discussion that features women discussing their paths through physics education and into a career. Valuable information will be provided.

**Panelists:**

- Brenitra Mosley Moore (*Manager of Technology Consulting, Security and Privacy at Protiviti Management Consulting Firm*)
- Kelly Nash (*Professor of Physics and Astronomy and Associate Dean for Faculty Affairs at the University of Texas at San Antonio*)
- Nia Imara (*John Harvard Distinguished Science Fellow at the Harvard-Smithsonian Center for Astrophysics*)
- Simone Hyater-Adams (*Education & Diversity Programs Manager at American Physical Society (APS]*)
- Tonisha Lane (*Assistant professor of Higher Education at Virginia Tech who studies the experiences and outcomes of underrepresented groups in science, technology, engineering, and mathematics (STEM]*)

**Breakout Room: Katherine Johnson**

**Session Time:** 6:30 pm – 7:30 pm

**LGBTQ+**

**Session Chair(s):** Jessica Esquivel, *Fermilab*

**Description:** This will be a panel discussion on the issues relevant to the LGBTQ community. It will include everything from how to navigate careers and mentoring relationships, to how to be empowered while pursuing a degree.

**Breakout Room: Dr. Shirley Jackson**

**Session Time:** 5:30 pm – 6:30 pm

**Student Council**

**Session Chair(s):** Farrah Simpson, *Brown University*

**Description:** Undergraduate and graduate NSBP student members are invited to join the NSBP Student Council for a networking mixer where you can wind down and meet (or reconnect) with other NSBP student members across the globe. Enjoy music and virtual games as we bond over shared academic, professional and personal experiences as students of physics.

**Breakout Room: Dr. Shirley Jackson**

**Session Time:** 6:30 pm – 7:30 pm

**Undergraduate to Grad Transition**

**Session Chair(s):** Joshua Burrow, *University of Dayton*

**Description:** In this virtual panel workshop we will be discussing each of our experiences with graduate school. We will showcase the perspectives (do’s and don’ts) of current graduate students in their third year and beyond. A variety of topics will be covered including but not limited to (1) surviving the coursework and passing the quals, (2) joining a group and publishing your research, (3) landing a fellowship or scholarship, and (4) tips for building networks with professionals and colleagues. To provide an engaging virtual atmosphere we certainly welcome other graduate students to share their experiences to help provide future graduate students multiple perspectives. This session is designed for undergrad and early grad students to help clarify what are the expectations as a graduate student and developing researcher in physics or related fields.
Breakout Room: Dr. Jim Gates  
Session Time: 5:30 pm – 6:30 pm  
Physics Education Research - 1.A  
Session Chair(s): Chandralekha Singh, University of Pittsburgh  

TIME: 5:30 pm – 6:30 pm  
TITLE: Research-Based Tools and Tips For Learning and Teaching Quantum Mechanics  
Speaker(s): Chandralekha Singh, University of Pittsburgh  

Abstract: 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 workshop is suitable for both instructors and students learning quantum mechanics. This work is supported by the National Science Foundation.

Breakout Room: Dr. Jim Gates  
Session Time: 6:30 pm – 7:30 pm  
Physics Education Research - 1.B  
Session Chair(s): Chandralekha Singh, University of Pittsburgh  

TIME: 6:30 pm – 7:30 pm  
TITLE: Inclusive Mentoring: Using Social Psychological Approaches to Improve Mentoring and Learning for All  
Speaker(s): Chandralekha Singh, University of Pittsburgh  

Abstract: One of the most critical issue facing higher education relates to how to create learning environments in which all students can thrive and excel. College mentors often de-emphasize students' motivational characteristics, e.g., their sense of belonging, self-efficacy, and views about whether intelligence is “fixed” or “malleable”. We will have participants reflect on research studies that show how mentoring and coaching students using different types of social psychological interventions can improve motivation and learning of all students. These interventions include mentors and coaches setting high expectations for students, 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 and struggling productively and giving students an opportunity to discuss their concerns with mentors and coaches. Participants will reflect on how these interventions can be adapted and implemented by mentors and coaches who are academic advisors or research advisors and implications of theory-driven mentoring and coaching interventions to enhance outcomes for all students.

Sunday, November 8  
Session Time: 2:00 pm – 4:30 pm  
Auditorium – Closing Luncheon / Poster & Presentation Awards  
Speaker: Dr. Sethuraman Panchanathan, Director of the National Science Foundation
Sunday, November 8

Workshops

**Breakout Room: Dr. Shirley Jackson**
**Session Time:** 1:00 pm – 2:00 pm  
**HBCU + MSI – Future Facilities**  
**Session Chair(s):** Paul Gueye, Michigan State University & Anja Fourie, NRAO

**Description:** Ensuring STEM graduates are equipped with the specific skills required by industry and national research facilities, has yielded partnerships between institutions of higher education and such organizations to ensure the alignment of curriculum content with their needs and the facilitation of research and training opportunities for students before graduation. In the top five reasons why such partnerships fail, however, is the lack of in-depth engagement with end-users and other stakeholders during the partnership design phase. This session will highlight existing broadening participation partnerships between HBCUs and industry and/or national research facilities to introduce discussion about each partner’s needs, and the design of authentic, intentional and targeted partnerships between organizations.

The session will allow for 5 min presentations by BNL, FRIB and NRAO, followed by 35-40 min of facilitated discussion.

**Breakout Room: Dr. Elmer Imes**
**Session Time:** 1:00 pm – 2:00 pm  
**SPS for Faculty**  
**Session Chair(s):** Brad Conrad, American Institute of Physics

**Description:** Effective Undergraduate Programs: Cohorts, Careers Curriculum, and Experimental Course Sequences

**Abstract:** As faculty aim to build thriving undergraduate programs, developing course sequences and content that both serve and recruit undergraduates for a broad array of career outcomes is vital for a successful department. Course sequences and material can be made to include tools that serve students aiming for both graduate school and careers immediately after graduation. This session aims to tie educational outcomes within course sequences to career objectives through specific examples and tools. By empowering a broad range of students to manage their career goals and objectives, departments can both self-evaluate and promote an inclusive environment for a diverse student population. The findings, results, and suggestions from a wide variety of source will be touched on and special attention will be given to comprehensive course development that compliments current education objectives and the SPS careers toolbox.

Sunday, November 8

**Breakout Room: Dr. Willie Hobbs Moore**
**Session Time:** 1:00 pm – 2:00 pm  
**Astronomy and Astrophysics (ASTRO) – 3.A**  
**Session Chair(s):** Eileen Gonzalez, Cornell University

**TIME:** 1:00 pm – 1:15 pm  
**TITLE:** New ACCESS observations of WASP-31b: No potassium in its atmosphere  
**Speaker(s):** Chima McGruder, Harvard University
Analytic Estimates of the Achievable Precision on the Physical Properties of Transiting Planets

Abstract: Currently, the best way to study the atmosphere of exoplanets is through transmission spectroscopy. This is the process of observing the planet as it passes in front of its host star at different wavelengths in order to determine the differences in relative transit depth caused by the different absorbers at a given wavelength. We present a new optical (400-950nm) transmission spectrum of the hot Jupiter WASP-31b (M=0.48M_{J}; \ R = 1.54R_{J}; \ P = 3.406 \text{ days}), obtained by combining four transits observed with IMACS on the Baade Telescope at Las Campanas Observatory, Chile. In our analysis we investigate the presence of clouds/hazes in the upper atmosphere of this planet, as well as contribution of stellar activity on the observed features. In addition, we search for absorption features by the alkali elements Na I and K I, with particular focus on K I, for which there were two contradicting observational results. Observations with HST/STIS detected K I whereas the VLT/FORS2 (low resolution) and VLT/UVES (high resolution) observations did not. The K I feature is particularly important because the detection of K I can be contaminated by Earth's O2 telluric features, making it paramount to investigate if the inconsistency is because of a disadvantage with ground-based telescopes or ineffective systematic corrections. We find that our observations support the other ground-based claims of no K I feature, emphasizing the importance of proper systematic corrections even with space-based observations. We then combine VLT's, Baade's, and HST/WFC3's data to further constrain the optical to inferred features of the planet. These observations were made as part of ACCESS (Arizona-CfA-Catolica-Carnegie Exoplanet Spectroscopy Survey), which aims at providing the largest uniform sample of visible transmission spectra of giant exoplanets. We expect ACCESS will also play a key role in providing optical exoplanet transmission spectra in the JWST era.

TIME: 1:15 pm – 1:30 pm
TITLE: Detecting exoplanet atmospheres: Achieving high spectrophotometric precision on ground-based telescopes
Speaker(s): Jason Williams, University of Southern California /Carnegie Observatories

Abstract: We've designed an experimental platform/long-slit spectrograph hybrid called the Henrietta to measure the molecular content of exoatmospheres from the ground and demonstrate routine high-precision (~100 ppm) spectrophotometry in the infrared. Henrietta addresses three issues that are consistent roadblocks to high achieving high precision spectrophotometry in the infrared. To address the infrared sky background, we observe at a spectral resolution of R >= 1000, to cleanly subtract the night-sky lines which contribute to ~98% of the infrared sky background. To reduce the effects of atmospheric scintillation (turbulence), we will primarily employ the conjugate-plane photometric technique, that has been shown to reduce scintillation noise by a factor of 2 for a small reduction in throughput. We have taken special care to understand and reduce inter and intra-pixel quantum efficiency (QE) variations. Henrietta will incorporate a diffuser to spread the light over a handful of pixels, broadening the PSF and obtaining a better sample of the inter-pixel QE variations present in IR detector arrays. To combat the intra-pixel effects, we have designed the instrument to incorporate a 'sinusoidal' field that places an overdetermined interference fringe on our detector. Due to this signal being completely determined by a few parameters, this will allow us to probe the subpixel structure of the detector arrays and calibrate out a significant portion. Finally, to aid us in instrument design and the development of a noise budget, we have developed an end-to-end time domain simulation of our instrument. In total, this work will provide a clear 10-year technological pathway to do precise exoatmospheric observations from the ground and enable the detection of hundreds of exoatmospheres using a 1-meter telescope.

TIME: 1:30 pm – 1:45 pm
TITLE: Analytic Estimates of the Achievable Precision on the Physical Properties of Transiting Planets
Speaker(s): Romy Rodriguez-Martinez, Ohio State University

Abstract: Using Purely Empirical Measurements we present analytic estimates of the fractional uncertainties on the mass, surface gravity, radius, and density of a transiting planet, using only empirical or semi-empirical measurements. We express these parameters in terms of transit photometry and radial velocity (RV) observables and find that the surface gravity of the planet depends only on empirical transit and RV parameters, such as the planet's period, the transit depth, the RV semi-amplitude of the host star, the transit duration, and the ingress/egress duration. On the other hand, the planet mass and density depend on all these quantities, as well as on the stellar radius. We generically find that, for any given system, there is a hierarchy of achievable precisions on the planetary parameters, such that the planetary surface gravity is more accurately measured than the planet density, which in turn is more accurately measured than the planet mass.
Abstract: The development of the University of the Virgin Islands’ Gamma-Ray Experiment for Astrophysical Transients (UVI-GREAT) continues to make great progress. In the near future this 3U CubeSat will aid in the detection and localization of short duration Gamma-ray Bursts. My task focused on determining the energy resolution of various radioactive sources. One of the well-known sources that I started with was Cesium-137. To begin my task, I created an algorithm that identified the peak energy values from laboratory data measured on an oscilloscope. Then, I created a histogram of those peak energy values, (representing spectral peaks in the data) and fitted that histogram with a Gaussian curve. The next steps in my work in this area are to find the energy resolution of our laboratory data by determining the Full Width at Half Maximum (FWHM) of the histogram peak(s). Once my algorithm successfully measures the FWHM of photo-peaks in these data, this process can then be replicated with data from other radioactive sources and the result will determine the energy resolution of our instrument.

Abstract: The first step to understanding the microscopic origins of the properties of a material is to determine the crystal structure. This can be accomplished with neutron diffraction. However, there are a small number of neutron sources in the world and thus it is critical to perform measurements as optimally as possible. We use reinforcement learning to address this problem. We compare several approaches within this framework including epsilon-greedy, Q-learning, and actor-critic. We find that in toy models, it is possible to measure a significantly smaller fraction of measurements than would commonly be performed to determine structural properties with the same accuracy.

Abstract: Tensor networks, originally designed to address computational problems in quantum many-body physics, have recently been applied to machine learning tasks. However, compared to quantum physics, where the reasons for the success of tensor network approaches over the last 30 years is well understood, very little is yet known about why these techniques work for machine learning. The goal of this paper is to investigate entanglement properties of tensor network models in a current machine learning application, in order to uncover general principles that may guide future developments. We revisit the use of tensor networks for supervised image classification using the MNIST data set of handwritten digits, as pioneered by Stoudenmire and Schwab [Adv. in Neur. Inform. Proc. Sys. 29, 4799 (2016)]. Firstly we hypothesize about which state the tensor network might be learning during training. For that purpose, we propose a plausible candidate state $\Sigma$ (built as a superposition of product states corresponding to images in the training set) and investigate its entanglement properties. We conclude that $\Sigma$ is so robustly entangled that it cannot be approximated by the tensor network used in that work, which must therefore be representing a very different state. Secondly, we use tensor networks with a block product structure, in which entanglement is restricted within small blocks of n x n pixels/qubits. We find that these states are extremely expressive (e.g. training accuracy of 99.97% already for n = 2), suggesting that long-range entanglement may not be essential for image classification. However, in our current implementation, optimization leads to overfitting, resulting in test accuracies that are not competitive with other current approaches.
TITLE: Overview of the C-2W FRC Experiment

Speaker(s): James Titus, TAE Technologies, Inc

Abstract: TAE Technologies, Inc. is a privately funded company pursuing magnetic confinement fusion in an alternative manner to the more traditional methods via the tokamak and D-T reactions. This compact toroidal configuration places a field-reversed configuration inside a traditional mirror plasma which is composed mostly of well-confined energetic particles from neutral beam injection (NBI). TAE’s current device, C-2W [1], is the world’s largest compact-toroidal device with the following features: a linear and axisymmetric plasma device, voltage-switching NBI with high injection power (up to 20 MW, 15-40 kV), edge-biasing system in the end divertors, and active feedback control. In C-2W, the record-breaking advanced beam-driven FRC plasmas are dominated by fast ions and achieve total plasma temperatures greater than 3 keV for up to 30ms. Currently, we are performing experiments on the device to further our understanding of the FRC and to maximize plasma performance. This talk will cover an overview of the experimental device and experiments focused on neutral beam injection.

TIME: 1:45 – 2:00 pm
TITLE: Energy redistribution in flowing complex plasmas using the PK-4 microgravity experiment

Speaker(s): Edward Thomas, Auburn University

Abstract: The Plasmakristall-4 (PK-4) microgravity laboratory on the International Space Station (ISS) is a dc glow discharge device that produces linear, flowing complex plasmas under microgravity conditions. When micrometer-sized “dust” particles are injected into PK-4, they flow along the axial electric field until they are halted by the application of a periodic oscillation of that electric field - an action known as polarity switching. This oscillation modifies the local space potential around the dust particles and creates a change in the spatial ordering and thermal state of the dust system. A series of experiments performed using PK-4 seek to understand the redistribution of kinetic energy of the dust particles at the onset of this periodic oscillation to assess the role of gravity. Data from the ISS device is compared against experiments performed using a ground reference version of PK-4. This presentation will describe the modification of velocity distribution and the subsequent determination of the thermal properties of the dust component of the plasma and will discuss future dusty plasma research opportunities on the ISS and lunar environments. Authors acknowledge the use of joint ESA/Roscosmos “Experiment Plasmakristall-4” onboard the International Space Station.