SCIENTIFIC SESSIONS, WORKSHOPS AND POSTERS

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

Thursday, November 4
Session Time: 12:15 pm – 2:15 pm
Auditorium – Opening Virtual Luncheon Session
Speaker: Dr. David Spergel, Simons Institute

BIO: David Spergel is the President of the Simons Foundation and the Charles Young Professor of Astronomy Emeritus at Princeton University. Spergel’s contribution to helping to establish the standard model of cosmology and measure the age, shape and composition of the universe has been recognized with the Breakthrough Prize in Physics, the Shaw Prize, the APS Heinemann Prize and membership in the National Academy of Sciences. Spergel has been the primary mentor for over 35 doctoral students and is one of the founders of the NSBP/Simons Foundation scholars program. His mentorship work has been recognized by the NSBP mentoring award of excellence and Princeton University’s Presidential Distinguished Scholar Award.

Thursday, November 4
Session Time: 4:00 pm – 5:00 pm
Auditorium – BIG SCIENCE HOUR #1
Hosted by: NSBP Presents: DOE/BNL Electron Ion Collider

Thursday, November 4
Session Time: 5:00 pm – 5:30 pm
Auditorium – EIC Q&A
Thursday, November 4

Session Time: 5:30 pm – 6:30 pm
Topic: Informal Chat Hour

Thursday, November 4
Session Time: 5:30 pm – 6:30 pm

Title: HBCU’s: Future in Physics I
Location: Dr. Edward Bouchet & Dr. Elmer Imes

Thursday, November 4
Session Time: 5:30 pm – 6:30 pm

Title: Survey Sessions
Hosted by: Dr. Darnell Cole, University of Southern California
Location: Dr. Willie Hobbs Moore & Hn Katherine Johnson

Thursday, November 4
Session Time: 5:30 pm – 6:30 pm

Title: Special Seminar
Speaker(s): Dr. Tracy Slatyer, Massachusetts Institute of Technology
Location: Dr. Shirley Jackson & Dr. Jim Gates

Thursday, November 4

Breakout Room: Dr. Willie Hobbs Moore
Session Time: 11:00 am – 12:15 pm
Astronomy and Astrophysics (ASTRO)
Session Chair(s): Dara Norman, NSF’s NOIRLab

TIME: 11:00 am – 11:15 am
TITLE: Building a Bridge Between Simulations and Observations in the Era of Large Astronomical Datasets
Speaker(s): Arielle Phillips, University of Notre Dame

Abstract: We have developed a framework to study the intergalactic medium (IGM), the circumgalactic medium (CGM) and embedded galaxies in the context of the cosmic neighborhood they evolve in. In particular, the formation, evolution, and chemical composition of galaxies are influenced by their interactions with the CGM and therefore the local cosmic environment. The CGM is in turn embedded in the IGM which is composed of an extensive network of clusters, filaments, and sheets of galaxies with vast empty expanses (voids) between them. Our set of computational tools includes a modified computer vision algorithm that identifies these structures in large-scale simulations and tracks them over time. We also study the effect of dark matter and dark energy models on the various components of the cosmic web, embedded gas, and therefore on the evolution of galaxies. We discuss the recent insights we have gained using this framework on the neighborhood history of galaxies and the
effects of dark energy models on the Lyman-alpha forest. The prospects for using this computational framework to build a bridge between simulations and observations in the coming era of large astronomical datasets will also be addressed.

**TIME:** 11:15 am – 11:30 am  
**TITLE:** Multicomponent multiscatter capture of dark matter  
**Speaker(s):** Caleb Levy, *Colgate University*

**Abstract:** In recent years, the usefulness of astrophysical objects as Dark Matter (DM) probes has become more and more evident, especially in view of null results from direct detection and particle production experiments. The potentially observable signatures of DM gravitationally trapped inside a star, or another compact astrophysical object, have been used to forecast stringent constraints on the nucleon-Dark Matter interaction cross-section. Currently, the probes of interest are: at high red-shifts, Population III stars that form in isolation, or in small numbers, in very dense DM minihalos at z=15-40, and, in our own Milky Way, neutron stars, white dwarfs, brown dwarfs, exoplanets, etc. None of those objects are truly single-component, and, as such, capture rates calculated with the common assumption made in the literature of single-component capture, i.e. capture of DM by multiple scatterings with one single type of nucleus inside the object, are not accurate. In this paper, we present an extension of this formalism to multi-component objects and apply it to Pop III stars, thereby investigating the role of He on the capture rates of Pop III stars. As expected, we find that the inclusion of the heavier He nuclei leads to an enhancement of the overall capture rates, further improving the potential of Pop III stars as Dark Matter probes.

**TIME:** 11:45 am – 12:00 pm  
**TITLE:** Testing MOND gravity with Breakthrough Starshot  
**Speaker(s):** Jonathon Miller, *Case Western Reserve University*

**Abstract:** Modified Newtonian Dynamics (MOND) is a modified theory of gravity that is highly successful in explaining galaxy dynamics without invoking dark matter. Here we propose tests of MOND gravity in the solar system via the Breakthrough Starshot Project that aims to launch interstellar probes at relativistic speeds. We determine the deviation of radial starshot trajectories from the Newtonian prediction caused by MOND effects and we discuss the prospects of detecting these deviations from Doppler telemetry data.

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**Thursday, November 4**

**Breakout Room:** Dr. Jim Gates  
**Session Time:** 11:00 am – 12:15 pm  
**Earth and Planetary Systems Sciences (EPSS) – 1.A**  
**Session Chair(s):** Lynnae Quick, NASA & Alex Evans, *Brown University*

**TIME:** 11:00 am – 11:30 am  
**TITLE:** Moapa Valley (CM1): The Black Box of the CM Parent Asteroid  
**Speaker(s):** Jasmine Bayron, *The American Museum of Natural History (AMNH)*

**Abstract:** The asteroid (101955) Bennu is the target of the OSIRIS-REx asteroid sample return mission and has surface material that is spectrally similar to highly altered Mighei-like (CM) meteorites. The details of the hydrothermal system that was active within the CM chondrite parent body is still poorly understood, but it this
process that produces the most abundant minerals in both the CM chondrites and Bennu’s surface. Moapa Valley (CM1) is a rare, unheated example of the CM group that is among its most highly altered members and contains a wealth of information about the hydrothermal alteration process that occurred within the parent asteroid.

TIME: 11:30 am – 11:45 am
TITLE: The Volatile Inventory of Planetesimals
Speaker(s): Myriam Telus, The University of California, Santa Cruz

Abstract: Planetesimals are the building blocks of terrestrial planets and their early atmospheres. Meteorites provide a link for understanding how the bulk compositions of planetesimals influence the compositions of exoplanet atmospheres. We have developed a novel experimental approach to precisely determine the composition of gases released during meteorite outgassing in order to constrain the initial composition of planetary atmospheres – an important constraint for interpreting chemical signatures from exoplanet atmosphere observations (Thompson et al., 2021). From our first study, we determined that if a planet’s bulk composition is similar to that of CM chondrites, its initial outgassed atmospheric composition is expected to be water-rich with significant amounts of CO, CO2, H2, and H2S. We also expect significant amounts of Na, S, and Zn. We do not observe detectable changes in the Fe, Ni, Mn, or Co concentrations, which are also predicted to outgas under these conditions. Although our experiments do not achieve equilibrium conditions, our results are generally consistent with model predictions and provide an experimentally determined boundary condition for the lower-temperature or lower-pressure paths, approximately simulating the initial heating phase during planet formation.

TIME: 11:45 am – 12:00 pm
TITLE: Phosphorous from Asteroids to Planetesimals
Speaker(s): Tarisa Ross, North Carolina Central University

Abstract: Elemental phosphorus is one of the most important biogenic compounds to life on earth; and we are running out. It comes from the center of oxygen rich stars per a process called nucleosynthesis and is spread throughout the interstellar medium on the solar winds produced after a star goes supernova. These molecules accrete into pebbles and cosmic dust particles, to become the core of protostars and other planetary bodies. As the pebbles accrete, they form protoplanets that are susceptible to collision, distributing essential elements amid planetary bombardment. Phosphorus was delivered to earth through the bombardment period of planetary formation, and through the accretion of micrometeorites present-day. This study will explore the phosphorus content distribution to earth from the bombardment period, as well as the current dust particles collected through modern era accretion. These measurements will be taken with the Scanning electron microprobe and compared with previous studies conducted on the subject.

TIME: 12:00 pm – 12:15 pm
TITLE: Defending the Planet from Asteroid and Comet Impacts
Speaker(s): Lindley Johnson, NASA Headquarters

Abstract: NASA’s Planetary Defense Coordination Office (PDCO) has been formally tasked with the responsibility for quantifying the potential hazard posed by near-Earth asteroid and comet impacts (National Near-Earth Object Preparedness Strategy and Action Plan). A key component of NASA’s planetary defense strategy is to conduct mock exercises that simulate hypothetical impact scenarios. The objective of the exercises is to help plan effective strategies for responding to near-Earth object impacts by simulating the entire process from initial discovery of a
potential impactor through planning and execution of a mitigation technique. These tabletop exercises bring together scientists specializing in asteroid and comet detection, orbit determination, characterization, and impact modeling with policy makers, communications professionals, spacecraft engineers, experts in disaster response and emergency management, and their counterparts within the international community. To date, the PDCO has led nearly a dozen exercises in an effort to improve plans and coordination for responding to potential Earth impacts.

Thursday, November 4

Breakout Room: Dr. Shirley Jackson
Session Time: 11:00 am – 12:15 pm
NASA Special Event (NASA)
Session Chair(s): TBA

TIME: 11:00 am – 11:15 am
TITLE: NASA’s Biological and Physical Sciences Division: Opportunities for Physicists
Speaker(s): Devon Griffin, NASA

Abstract: We are currently in the beginning stages of our next decadal survey. In anticipation of the recommendations, we are focusing on two areas that are of interest to physicists: The first is quantum science, where we are currently focusing on cold matter investigations enabled by NASA’s Cold Atom Laboratory (CAL) aboard the International Space Station (ISS). CAL will be operational through 2027 and will be followed by NASA-funded investigators participating in the Bose-Einstein Condensate Cold Atom Laboratory (BECCAL), which the Deutsches Zentrum für Luft- und Raumfahrt (DLR) is currently building for ISS operations beginning in 2027. We plan to expand this area in later years by using technology currently under development to conduct space-based tests of the Einstein Equivalence Principle, as well as looking for dark matter and dark energy signatures. Our second area of physics emphasis is soft matter systems, where we will fund investigations studying self organization of non-equilibrium dynamical systems, which have both practical application for new materials, as well as enabling fundamental understanding of artificial life and non-equilibrium thermodynamics.

TIME: 11:15 am – 11:30 am
TITLE: NASA Biological and Physical Sciences Division: Transformative Space Science for Fundamental Research and Exploration.
Speaker(s): Diane Malarik, NASA

Abstract: The Biological and Physical Sciences Division (BPS) leads NASA’s physical sciences and space biology research. The mission of BPS is to 1) pioneer scientific discovery in and beyond low Earth orbit to drive advances in science, technology, and space exploration to enhance knowledge, education, innovation, and economic vitality and 2) enable human spaceflight exploration to expand the frontiers of knowledge, capability, and opportunity in space. To accomplish its mission and scientific goals, BPS administers two scientific Programs, Physical Sciences and Space Biology. The Space Biology Program uses model organisms to investigate how biological systems are affected by and acclimate to the space environment. The Physical Sciences Program manages research in physical sciences and fundamental physics, investigating physical phenomena in the absence of gravity and fundamental laws of the universe. In addition, the Programs conduct applied research, which contribute to the basic understanding underlying space exploration technologies. BPS fundamental research and technology development is conducted using a wide range of ground-based space analog systems, such as drop towers and space radiation exposure facilities, and spaceflight platforms, including the International Space Station and free-flyer satellites. It currently is expanding its science to the Moon to conduct enabling research for sustained life on the Moon and future Mars missions. BPS periodically releases NASA Research Announcements for competitive research funding opportunities. In addition, it participates in NASA’s Established Program to Stimulate Competitive Research (EPSCoR), which provides research funding opportunities for underrepresented colleges and
universities, and it is active in the NASA Post-Doctoral Program and various undergraduate and graduate internship opportunities. The principal NASA Field Centers that implement BPS science strategies and projects are Ames Research Center, Glenn Research Center, Jet Propulsion Laboratory, Kennedy Space Center, and Marshall Space Flight Center. Also, BPS and its Field Centers collaborate and partner with other NASA Centers, across NASA Headquarters Directorates and Divisions, other government agencies, academic institutions, and commercial industry.

**TIME:** 11:30 am – 11:45 am  
**TITLE:** What's New and Good Under the Sun  
**Speaker(s):** Kelly Korreck, NASA

**Abstract:** NASA Heliophysics research studies a vast system stretching from the sun to Earth to far beyond the edge of the planets. Studying this system—much of it driven by the sun’s constant outpouring of solar wind—not only helps us understand fundamental physics and how the universe works, but also helps protect our technology and astronauts in space. NASA seeks knowledge of near-Earth space, because—when extreme—space weather can interfere with our communications, satellites, and power grids. The study of the sun and space can also teach us more about how stars contribute to the habitability of planets throughout the universe. Mapping out this interconnected system requires a holistic study of the sun’s influence on space, Earth, and other planets. NASA has a fleet of spacecraft strategically placed throughout our heliosphere—from Parker Solar Probe at the sun observing the very start of the solar wind, to satellites around Earth, to the farthest human-made object, Voyager, which is sending back observations on interstellar space. Each mission is positioned at a critical, well thought-out vantage point to observe and understand the flow of energy and particles throughout the solar system—all helping us untangle the effects of the star we live with.

**TIME:** 11:45 am – 12:00 pm  
**TITLE:** Opportunities with NASA’s Astrophysics Division  
**Speaker(s):** Hannah Jang-Condell, NASA

**Abstract:** The Astrophysics Division operates a wide range of space missions for astrophysical observations. This includes major flagship observatories, like the Hubble Space Telescope, the Chandra X-ray Observatory, and the upcoming James Webb Space Telescope. Smaller but still innovative Explorer missions like the Transiting Exoplanet Survey Satellite (TESS) and the Neil Gehrels Swift Observatory complement the Astrophysics strategic missions. NASA even launches experiments on platforms such as CubeSats, balloons, and sounding rockets, bringing opportunities to lead a NASA mission within reach of individual investigators at universities. All of these missions together account for much of humanity's accumulated knowledge of the heavens. Data from all NASA Astrophysics missions are stored in the NASA Astrophysics Archives, and are available to the public.

**Thursday, November 4**

**Breakout Room:** Dr. Willie Hobbs Moore  
**Session Time:** 2:15 pm – 3:45 pm  
**Astronomy and Astrophysics (ASTRO) – 1**  
**Session Chair(s):** Dara Norman, NSF’s NOIRLab
**Abstract:** Recent radio observations of inflowing and outflowing plasma in the vicinity of supermassive black holes are linked to phenomenological models via general relativistic magnetohydrodynamic simulations through a methodology called “Observing” Jet/Accretion flow/Black hole (JAB) Systems. For M87, HARM jet simulations are viewed from Very Large Array (43 GHz) to Event Horizon Telescope (230 GHz) scales to replicate the observed collimation and magnetic field configuration, while serving as the basis for a self-similar, stationary, axisymmetric force-free jet model used to generate polarization maps and spectra. This model varies plasma content from ionic (e-p) to pair (e-e+). Emission at the observed frequency is assumed to be synchrotron radiation from electrons and positrons, whose pressure is set to relate to the local magnetic pressure through parametric prescriptions. Polarization maps and spectra are found to be observationally distinguishable through positron effects such as decreasing intrinsic circular polarization and Faraday conversion. For Sagittarius A* in our Galactic Center, we include a turbulent heating electron temperature model exponential in the plasma beta (gas-to-magnetic pressure ratio). Intensity map movies simulating hourly timescales show that these models can be classified into at least four types: 1.) thin, asymmetric photon ring with best fit spectrum; 2.) coronal boundary layer with thin photon ring and steep spectrum; 3.) thick photon torus with flat spectrum; and 4.) extended outflow with flat spectrum. These models may be distinguishable by the Event Horizon Telescope.

**Abstract:** Relativistic (astrophysical) jets have been of peak interest in the astronomy and astrophysics community for their uniquely dynamic nature and incredible radiative power; emanating from supermassive black holes and similarly accreting compact dense objects. The nature of such highly complex energetic emission mechanisms from these systems, which feature event horizons, has been studied extensively over the last few decades. The current consensus on relativistic jet formation states that accelerated outflow at velocities comparable to the speed of light are generated by a complex relationship between the accretion disk of the system and the frame-dragging effects of the rotating massive central object. This talk will focus on methodologies in extending Blandford-Znajek-type energy-momentum emission theory for high-energy relativistic jet outflow from supermassive black holes. With a modification in the magnetic field representations and employing a causally-connected description of the ergosphere/event horizon boundary of the Kerr black hole in curved spacetime, this work seeks to explore how the vertical nature of Kerr black holes induces relativistic outflow. It is widely known that two critical ingredients for relativistic jet formation are: strong poloidal/toroidal magnetic fields intrinsic to the accretion disk and the dragging of inertial frames by the black hole. A principle component to this work will focus on the causally-connected coupling of the magnetic fields of relativistic particles to the global gravitational field (spacetime curvature) of the Kerr black hole. The limitations of standard Blandford-Znajek emission mechanisms will also be discussed.

**Abstract:** Because early Universe black holes (BHs) grew to massive sizes of 10^9 M☉ in less than 1 Gyr of cosmic time, BH seeding models face stringent constraints. A feasible seeding model must allow rapid
growth and sustain it for reasonable timescales. In order to constrain the parameter space of possible seeding criteria, we use an approach that combines the advantages of a full cosmological simulation with the flexibility of semi-analytic modeling. Using galaxy halo catalogs from the cosmological magneto-hydrodynamical IllustrisTNG simulation, we construct semi-analytic, post-processing models that produce BH formation and merger histories under a wide range of seeding criteria. Specifically, we vary the maximum gas metallicity and the minimum gas and total halo mass for seed formation, and we also consider seeding probabilities less than unity. With this approach, we are able to trace the BH population over cosmic time for many possible seeding scenarios. We find that our models are most sensitive to gas mass, emphasizing the importance of gas-based seeding criteria. The lowest metallicity models produce a much smaller BH density when host mass is varied, compared to gas mass. Several combinations of the seeding criteria in our TNG models produce BH number densities comparable to observations at z=0. When seeding is restricted to high-mass halos, imposing an additional restriction to star-forming halos has little impact on the BH population. Our work provides an efficient means of comparing BH seeding criteria within a large cosmological simulation, and additional comparisons with higher-redshift data will further constrain the parameter space of possible seed models.

TIME: 3:30 pm – 3:45 pm
TITLE: Modeling Innermost Flow Geometry of SgrA* for next generation EHT
Speaker(s): Elon Price, Auburn 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 the hopes of improving future observations (i.e. `next generation' or ngEHT). In the image produced by EHT using Very Long Baseline Interferometry (VLBI), the 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 Magnetohydrodynamic (GRMHD) simulations. Using the geodesics for rotating/non-rotating black holes and General Relativistic Radiative Transfer (GRRT), different methods and advances are developed including: reverse ray tracing using a Python Ordinary Differential Equation (ODE) solver as well as thin disks and plasma shells described by Radiatively Inefficient Accretion Flow (RIAF) models using Fortran. 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 (43, 86, 120, 230, 345, 680, 1000 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 new array configurations for ngEHT.

Thursday, November 4

Breakout Room: Dr. Jim Gates
Session Time: 2:15 pm – 3:45 pm
Session Chair(s): Lynnae Quick, NASA & Alex Evans, Brown University

TIME: 2:15 pm – 2:45 pm
TITLE: Drivers of Recent Marine Heatwaves in the Southern Ocean
Speaker(s): Earle Wilson, California Institute of Technology

Abstract: During the austral summers of early 2017 and 2020, the ice-free Southern Ocean experienced record-breaking highs in sea surface temperature (SST), ending a surface cooling trend that persisted for much of the
preceding two decades. These marine heatwave (MHW) events were remarkable both in terms of their magnitude, with peak zonally-averaged SST anomalies exceeding 0.6 degC, and spatial extent, spanning almost all longitudes of the Southern Ocean. Even though these events drastically altered the heat content of the upper ocean and likely caused major disruptions to local ecosystems, their initiation mechanisms remain unclear and little is known about how frequently they may reoccur in the future. Using an observationally-based mixed layer heat budget analysis, we find that these recent MHWs were mainly facilitated by an anomalous shoaling of the mixed layer, which trapped heat near the surface and amplified the effect of atmospheric heating. This shoaling was due to a sustained period of weak circumpolar winds that coincided with strongly negative phases of the Southern Annular Mode. Thus, we propose that these events were mainly due to internal atmospheric variability, which weakened surface winds and caused the ocean mixed layer to shoal during periods of maximum atmospheric heating. Further, if the Southern Ocean mixed layer shoals in a warming climate as many models project, we postulate that these MHWs will become more severe in the future.

TIME: 2:45 pm – 3:15 pm
TITLE: Estimates of tropospheric ozone over the tropical Atlantic Ocean: field, remote sensing, and modeling approaches
Speaker(s): Jonathan Smith, National Oceanic and Atmospheric Administration (NOAA)

Abstract: Lightning nitrogen oxides (LNOx) and biomass burning constituents are two important sources of tropospheric ozone in the Equatorial Atlantic Ocean. Ozonesondes launched in the NASA Southern Hemisphere Additional Ozonesondes (SHADOZ) Network in 2006 and the NOAA AEROSE field campaigns show the 10 – 80 ppbv increases in ozone throughout the troposphere in 2006 and 2010. NASA satellite retrievals Ozone Monitoring Instrument (OMI) and EUMETSAT Infrared Atmospheric Sounding Interferometer (IASI) retrievals detect enhanced tropospheric ozone in this region. Ground observations from the Carbon Cycle Greenhouse Gases Group (CCGGG) carbon monoxide data show the plumes of biomass burning smoke at Ascension Is. And the Worldwide Lightning Location Network (WWLLN) observed over 300K+ mostly cloud to ground lightning flashes in the Western and Central parts of the African continent and the adjacent Atlantic Ocean. The chemistry version of the Weather Research and Forecasting Model (WRF-Chem) is employed to estimate the contribution of these two ozone sources and to compare the model within situ and satellite observations. Model estimates suggest that over the Equatorial Atlantic Ocean, biomass burning contributes 30 + ppbv ozone to the lower troposphere, and the LNOx contributes 10-20 ppbv ozone to the upper troposphere. High temporal and spatial geostationary lightning observations with more expansive fields of view (i.e., NASA/NOAA Geostationary Lightning Mapper and the upcoming EUMETSAT Meteosat Third Generation – Lightning Imager) will provide more accurate estimates of the LNOx contribution to tropospheric ozone. From this data, I hope to understand better the relationships between LNOx production efficiency and lightning flash characteristics.

TIME: 3:15 pm – 3:30 pm
TITLE: Atmospheric Escape from Pluto
Speaker(s): Orenthal Tucker, NASA Goddard Space Flight Center

Abstract: Observations of Pluto’s upper atmosphere by the New Horizons (NH) spacecraft revealed that current understanding of its thermal structure is incomplete (Young et al., 2018, Icarus). Fits to the NH density data indicate the upper atmosphere possesses a temperature of ~65 - 69 K (Young et al., 2018), which is ~10 – 20 K lower than model-based estimates carried out before the mission (pre-NH) (Tucker et al., 2012, Icarus). The decrease in temperature from the stratopause (T ~110 K) up into the lower thermosphere (T ~69 K) remains an open question. Further puzzling are observations of X-ray intensities of ~100 – 400 MW from Pluto’s corona by the Chandra X-Ray space telescope during the NH encounter (Lisse et al., 2016, Icarus). This intensity is comparable to emissions observed from Jupiter Family Comets and indicative of outflow rates on the order of ~1027 – 1028 molecules/s. However, at the NH derived exobase temperatures of 65 – 69 K thermal escape of N2 and CH4 is modest in comparison, e.g. of order 1022 – 1025 molecules/s (e.g., Young et al. 2018).
TIME: 3:30 pm – 3:45 pm
TITLE: NASA Activities: How to Get Involved!
Speaker(s): Nicole Zellner, NASA Headquarters

Abstract: There are multiple ways that people can get involved in NASA activities across the Science Mission Directorate, which includes the Heliophysics, Astrophysics, Planetary Science, Earth Science, and Biological and Physical Sciences divisions. While anyone can submit a proposal for funding, there are also paid professional development opportunities at NASA that span all career stages, from undergraduate to senior-career researcher/professor. For example, NASA’s Office of STEM Engagement offers internship positions for undergraduate and graduate students throughout the academic year and over the summer. Additionally, proposal review panels require subject matter expertise from scientists in most fields, no matter the type of institution. Proposal topics include scientific research and data analysis, instruments design, technology development, participating scientist on a NASA mission or spacecraft, virtual institutes, and mission planning and implementation, among other topics as listed in the annual Release of Research Opportunities in Space and Earth Science (ROSES). Advanced graduate students are also able to contribute to the proposal review process, in the role of Executive Secretaries, who are responsible for keeping the discussion on task and the panel running smoothly. Finally, positions supported by the Intergovernmental Personnel Act (i.e., IPA positions) allow opportunities for active researchers/professors to take a leave in service from their institutions in order to work at NASA so that they can learn about the way NASA “works” from the inside. Duties include assisting in and leading review panels as Program Officers, organizing workshops, and other activities as desired.

Thursday, November 4

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

TIME: 2:15 pm – 2:45 pm
TITLE: State of CMMP Theory
Speaker(s): Trevor Rhone, Rensselaer Polytechnic Institute

Abstract: TBA

TIME: 2:45 pm – 3:15 pm
TITLE: Predicting outcomes of catalytic reactions using machine learning
Speaker(s): Trevor Rhone, Rensselaer Polytechnic Institute

Abstract: Predicting the outcome of a catalytic reaction is of relevance to high-throughput screening of chemical reactions for industrial applications. High-throughput screening can significantly reduce the number of experiments needed to be performed in a huge search space, which saves time, effort and expense. In this talk we show that machine learning can be used to accurately predict the outcomes of catalytic reactions on the surface of oxygen-covered and bare gold in a database. Our machine learning models exploit a chemical space representation of the molecules in the database. Studying the catalytic reactions in this chemical space may provide insights into their behavior. Furthermore, our approach provides a framework for performing high-throughput screening of chemical
reactions, as well as venues for pursuing the inverse design of industrially relevant molecules. Our machine learning framework complements chemical intuition in predicting the outcome of several types of chemical reactions. In some cases, machine learning makes correct predictions where chemical intuition fails. We achieve up to 93% prediction accuracy for a small data set of less than two hundred reactions.

TIME: 3:15 pm – 3:30 pm
TITLE: Accurate Description and Prediction of Properties of Materials for the Materials Genome Initiative (MGI)
Speaker(s): Diola Bagayoko, University of San Diego

Abstract: A brief review of the seminal article by Hohenberg and Kohn leads to two conditions that have to be met by electronic structure calculations in order for their results to represent the physics content of DFT. One of these conditions is often the verifiable attainment of the absolute minima of the occupied energies, i.e. the ground states. Using the second Hohenberg Kohn theorem, we show that results of calculations that employ a single basis set do not necessarily represent DFT findings. We illustrate this fact with over 200 calculated band gaps that are much smaller than corresponding, measured ones. In contrast, we list results from our calculations that strictly adhered to the aforementioned conditions and whose results are in excellent agreement with experiment – without invoking self-interaction correction or an adjustment for the derivative discontinuity. We prove that the derivative discontinuity, incidentally, does not apply to solutions of the Kohn-Sham equation! We describe two crucial steps in our calculations that add to or complete DFT in practice. Some implications of our findings for academia, industry, and program package developers will be discussed. In particular, program packages capable of using exponential or Gaussian functions in the radial parts of functions in basis sets can easily implement the generalized minimization of the energy functional that is needed for results possessing the full, physical content of DFT and that agree with experiment. With such accurate, computational results, the objectives of the Materials Genome Initiative (MGI) were within reach. Acknowledgments: This work was funded in part by the National Science Foundation (NSF) and the Louisiana Board of Regents, through LASiGMA [Award Nos. EPS- 1003897, NSF (2010-15)-RII-SUBR] and NSF HRD-1002541, the US Department of Energy – National, Nuclear Security Administration (NNSA) (Award Nos. DE-NA0001861 and DE- NA0002630), LaSPACE, and LONI-SUBR.

TIME: 3:30 pm – 3:45 pm
TITLE: First Principles Investigations of Formation Energies and Structures of Fe3+ Impurity and Fe3+ + VCd Complex in strongly confined CdSe Quantum Dot
Speaker(s): George Kurian, Florida A&M University

Abstract: Solitary dopant or defect in semiconductor is the basis of the emerging field of optoelectronics known as solotronics. It has been shown that the spin of a single magnetic ion impurity can be manipulated optically. Among the magnetic ions, Fe3+ has been proposed as a primary candidate for design of quantum dots (QDs) for solotronics because of its zero nuclear spin. In this work, we performed density functional theory calculations to determine the optimal parameters for colloidal synthesis of single FeCd 3+ over FeCd 2+ in CdSe of 1 nm in radius. We also investigated Fe3+ plus Cd vacancy complex (FeCd 3+ + VCd − ). Transition energy level (TEL) calculations show FeCd 3+ to be a deep – level donor and VCd − to be a shallow acceptor. Charge difference plots show the charge of the ionized electron is localized around both FeCd 3+ and FeCd 3+ + VCd − . Tetrahedral symmetry is retained at FeCd 3+ site. Based on relative positions of TELs of FeCd 3+ and VCd − in the HOMO – LUMO (HL) gap, formation energies, localized charge distribution around both FeCd 3+ and FeCd 3+ + VCd − , and tetrahedral symmetry at FeCd 3+, FeCd 3+ + VCd − in CdSe is a plausible candidate for optical manipulation of its spin state. The large localized magnetic moment of FeCd 3+ is suitable for spin-memory device.
Thursday, November 4

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

**TIME:** 2:15 pm – 2:30 pm  
**TITLE:** Search for heavy fermionic partner of the top quark with charge 5/3 in the single leptonic channel using CMS Run 2 Data  
**Speaker(s):** Farrah Simpson, Brown University

**Abstract:** With the discovery of the Higgs boson in 2012 by the CMS and ATLAS experiments, searches for new heavy particles (such as vector-like quarks) have ensued in hope of solving the hierarchy problem. In this talk, I will be discussing the search for the X5/3, a strongly interacting fermionic partner of the top quark with charge +5/3. Left-handed and right-handed coupling of the X5/3 to W bosons are considered separately. The search is conducted using the CMS Run 2 datasets collected in 2017 and 2018. Data was collected with the CMS detector at a luminosity of 41.5 fb⁻¹ (59.97 fb⁻¹) in 2017 (2018) and a center-of-mass energy of sqrt(s) = 13 TeV. The search looks for events with pair production of an X5/3 and its antiparticle which subsequently decay to a top and W boson. To enhance signal separation, the search is constructed to only look for events where one W decays to a lepton and neutrino, while the other three W bosons decay hadronically. Limits on the cross section will be presented and compared to previous results.

**TIME:** 2:30 pm – 2:45 pm  
**TITLE:** Reconciling Historical Mass Spectrometry with Theo  
**Speaker(s):** Byron Daniel, Carnegie Mellon University

**Abstract:** By analyzing the kinematics of tritium beta decay, one can directly measure the neutrino-mass scale. Since modern tritium-based experiments use a molecular source and molecular excitations modify the beta spectrum, one must also understand these “final-state” excitations precisely in order to properly analyze the spectral shape. Historical mass spectrometry measurements disagreed with theory. The Tritium Recoil-Ion Mass Spectrometer (TRIMS) experiment is a coincidence time-of-flight mass spectrometer designed to test the theory used in the neutrino-mass analysis. The TRIMS measurements for the probabilities of bound HHe⁺ ions and bound THe⁺ ions resulting from the beta decay of HT and T2 respectively are in agreement with the theoretical predictions. We have identified the source of the original discrepancy and will discuss the reconciliation of the various experimental results. This work was supported by DOE Nuclear Physics Awards No. DE-SC00193204 and No. DE-FG-97ER41020.

**TIME:** 2:45 pm – 3:00 pm  
**TITLE:** PHENIX Results on Jet Modification Measured via pi  
**Speaker(s):** Anthony Hodges, Georgia State University

**Abstract:** In ultra-relativistic heavy-ion collisions, energy densities become high enough that the colliding nuclei melt into a hot, dense state of matter known as the Quark Gluon Plasma (QGP). The QGP is a state of free quarks and gluons (partons), which are ordinarily bound inside hadrons such as protons and neutrons at normal length and energy scales. Additionally, in the initial stages of these collisions, incoming partons may undergo a collision with a large momentum transfer, known as a hard scattering. These hard-scattered partons then traverse the QGP and lose energy before fragmenting into a collimated spray of hadrons, called a jet. Because of QGP-induced energy
loss, the final-state jets that are measured in heavy-ion collisions are modified relative to jets in proton-proton collisions where no QGP is formed. Thus, comparing jets in heavy-ion collisions and proton-proton collisions allows one to quantify properties of the Quark Gluon Plasma through which one can study quantum chromodynamics (QCD) under extreme conditions.

TIME: 3:00 pm – 3:15 pm
TITLE: NoTORious Neutrinos
Speaker(s): Mu-Chun Chen, University of California Irvine

Abstract: The discovery of non-zero neutrino masses has provided arguably the most compelling evidence for Physics beyond the Standard Model. Their observed small masses hint at Physics at a very high energy scale, and thus offers a unique window into the theory that underlies the Standard Model of Particle Physics. In this talk, I will describe how the pattern of neutrino masses may be closely connected to the intricate mathematics of modular symmetries.

TIME: 3:15 pm – 3:30 pm
TITLE: Data Analysis of sPHENIX Minimum Bias Detector
Speaker(s): Kolby Davis, Howard University

Abstract: The PHENIX detector is one of two main detectors used to track high-energy collisions at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. Designed as an apparatus dedicated to nuclear data analysis, these detectors have expanded our collective knowledge about the quark-gluon plasma (QGP). An upgrade to PHENIX, called sPHENIX, will enable far better measurements of upsilon production and heavy flavored jets. sPHENIX will incorporate full hadronic calorimetry to measure jets extremely well, as well as precision tracking to measure the Upsilons. This experiment will have completed all integration and testing by January 2023, when it will first start taking data. Currently, a group including Howard University is working on the minimum bias detector (MBD). The MBD is a subsystem of sPHENIX that acts as the primary trigger for collisions. Using the original beam-beam counter (BBC) from PHENIX, the MBD will be positioned slightly further away to account for magnetic field interference. The MBD will also locate the z-vertex position of the collisions, and the measure the centrality. For the MBD to be integrated into the detector, new electronics boards had to be designed, and new software must be developed. We write programs using C++ source code that will parse through massive datasets. This program will also allow users to monitor test pulses and LED signals from varying electrical channels to confirm overall functionality. We will use this program over the next 2 years for testing and calibration. At the beginning of data-taking, this program, and sPHENIX, will be used to conduct the extraordinary experimentation studying the QGP matter that dominated the early universe, one-millionth of a second after the Big Bang.

TIME: 3:30 pm – 3:45 pm
TITLE: The COHERENT experiment at Oak Ridge National Lab
Speaker(s): Rex Tayloe, Indiana University

Abstract: The COHERENT collaboration operates an array of detectors in the ORNL Spallation Neutron Source (SNS) "Neutrino Alley" to search for coherent elastic neutrino nucleus scattering (CEvNS) and other low-energy rare scattering processes. Our goal is to precisely measure CEvNS (and other channels) to further understanding on a wide variety of questions in astro-, particle, and nuclear physics. This ongoing experiment will be presented along with a description of internship opportunities for undergraduate or graduate students.
Thursday, November 4

Breakout Room: Dr. Shirley Jackson
Session Time: 2:15 pm – 3:45 pm
Medical Physics (MED) & Chemical and Biological Physics (CBP) – 1
Session Chair(s): Christopher Njeh, Indiana University

TIME: 2:15 pm – 2:45 am
TITLE: The Future of Physics is in Texas! From astrophysics to FLASH-RT
Speaker(s): Julianne Pollard-Larkin, The University of Texas, MD Anderson Cancer Center

Abstract: This talk will cover the advancements in multiple aspects of Physics being investigated in institutions and labs throughout Texas. The bulk of the lecture will focus on the field of Medical Physics in particular. Medical Physics is a specialty utilized to detect and treat malignancies as well as study the impact of radiation with matter. A major new development in Medical Physics and Radiation therapy happens to be FLASH ultra-high dose radiotherapy. FLASH is a technique of radiotherapy that requires at least 40 Gy/sec radiation beam delivery and has an unusual effect seen in several endpoints of causing less lethality in normal tissues compared to conventional radiotherapy delivered in .01 Gy/sec. This offers the Radiation therapy community a unique new tool to improve our therapeutic window and potentially offer better outcomes for our cancer patients. By the end of the lecture, the participant should be familiar with the powerhouses of our Physics research community in Texas from several different domains.

TIME: 2:45 am – 3:15 pm
TITLE: TBA
Speaker(s): Oluwaseyi Michael Oderinde, Reflexion Medical Inc

Abstract: TBA

TIME: 3:15 pm – 3:45 pm
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: TBA

Friday, November 5

Friday, November 5
Session Time: 12:15 pm – 2:15 pm
Auditorium – Opening Virtual Session
Speakers: Cora Dvorkin, Harvard University

BIO: Dr. Cora Dvorkin is an Associate Professor in the Department of Physics at Harvard. She is a theoretical cosmologist and has made theoretical contributions to the study of dark matter, focusing on a broad range of observational probes. She has pushed the frontiers of sub-GeV dark matter using CMB and large-scale structure
data. She has also pioneered the use of machine learning techniques to find dark matter subhalos in gravitational lensing systems. Dvorkin is the Harvard Representative at the newly NSF-funded Institute for Artificial Intelligence and Fundamental Interactions (IAIFI)'s Board. She has been awarded the 2019 DOE Early Career award and has been named the "2018 Scientist of the year" by the Harvard Foundation for "Salient Contributions to Physics, Cosmology and STEM Education". She has also been awarded a Radcliffe Institute Fellowship and a Shutzer Professorship at the Radcliffe Institute. In 2012, she was given the "Martin and Beate Block Award", awarded to the best young physicist by the Aspen Center for Physics.

Friday, November 5
Session Time: 4:00 pm – 5:30 pm

Auditorium – Summer 2021 Scientific Research
Speakers: Simons-NSBP Simons Scholars
Moderator: Kasey Wagoner, Simons Foundation

TIME: 4:05 pm – 4:15 pm
TITLE: Phosphorus in Asteroids to Planets
Speaker(s): Tarisa Ross, North Carolina Central University

Abstract: Elemental phosphorus is one of the most important biogenic compounds to life on earth; and we are running out. It comes from the center of oxygen rich stars per a process called nucleosynthesis and is spread throughout the interstellar medium on the solar winds produced after a star goes supernova. These molecules accrete into pebbles and cosmic dust particles, to become the core of protostars and other planetary bodies. As the pebbles accrete, they form protoplanets that are susceptible to collision, distributing essential elements amid planetary bombardment. Phosphorus was delivered to earth through the bombardment period of planetary formation, and through the accretion of micrometeorites present-day. This study will explore the phosphorus content distribution to earth from the bombardment period, as well as the current dust particles collected through modern era accretion. These measurements will be taken with the Scanning electron microprobe and compared with previous studies conducted on the subject.

TIME: 4:15 pm – 4:25 pm
TITLE: Searching for the ISW-tSZ cross correlation
Speaker(s): Keduse Worku, Yale University

Abstract: Probes of the Cosmic Microwave Background (CMB) have provided great insight into the early universe and more recent cosmological events. Two important late time contributions are the Integrated SachsWolfe (ISW) and the thermal Sunyaev–Zel’dovich (tSZ) effects, both occurring in the same gravitational potential wells. By determining the ISW-tSZ cross correlation, we can gain insight into this probe of dark energy. We present a prirmiary set of cross spectra with data from the Planck satellite. Our results suggest strong Galactic foreground contamination. Future foreground mitigation techniques include the use of galaxy cluster catalogues to mask low redshift clusters and the use of Planck maps which more accurately model foreground sources.

TIME: 4:25 pm – 4:35 pm
TITLE: Independent constraints on cosmological and astrophysical parameters using UV luminosity functions at Z~6
Speaker(s): Aaron Kebede, Lehigh University
Abstract: Luminosity functions are generally recognized to be well defined mechanisms to describe the abundance of matter in a given set. For galaxies, they describe the abundance in, say, a given cluster. In this talk, we show and describe our attempt to derive independent constraints for cosmological and astrophysical parameters from the luminosity of galaxies in the CAMELS simulation at $Z \sim 6$ using machine learning algorithms and statistical methods.

TIME: 4:35 pm – 4:45 pm
TITLE: ASE - PySCF Interface for Electronic Structure Calculations
Speaker(s): LaToya Anderson, Brooklyn College

Abstract: A growing number of material scientists use open-source software to study the electronic structure to improve upon materials such as semiconductors, solar panels, and batteries. Quantum Espresso, a highly cited software package, is used to perform electronic structure calculations yet is challenging to compile due to its software requirements. By building an interface or connection between the Python-based Simulations Chemistry Framework, or PySCF, and the Atomic Simulations Environment, or ASE, it will remove many of the computational challenges while providing a suite of software tools needed to perform materials science research.

TIME: 4:45 pm – 4:55 pm
TITLE: Noise Characterisation for Telescope Optics
Speaker(s): Refilwe Tanah Bua, Pomona College

Abstract: The Simons Observatory is constructing a telescope designed to measure the polarization of Cosmic Microwave background radiation, which will hopefully provide evidence of cosmic inflation and subvert the current problems we have with the standard model of the universe. We are in the process of validating it in a lab at UCSD and my focus was on finding imperfections in the telescope that generate unwanted signals. By creating a curve-fitting function, we could pick out unwanted signals if they weren’t in a specific range and create a peak finding algorithm that looked for these signals at specific frequencies. From there, we used previously collected data to compare the peaks we had to what we would expect from different sources of noise, including magnetic, thermal and radio frequencies. From there, we would collect more data using a magnetometer, orienting it at different positions around different components of the telescope, such as the cryocooler and the detectors and resonators, to match the peaks we would find from the magnetic field lines to the different properties our peaks had to confirm that some of the lines were magnetic from the cryocooler motor while the rest were caused by flux-ramp lines. The study is still ongoing, as we plan to get more accurate dimensions of the peaks, so we can incorporate them in simulations that model the data the telescope plans to collect to determine to what extend they will affect our data analysis.

TIME: 4:55 pm – 5:05 pm
TITLE: Theories of Neural Plasticity and Learning
Speaker(s): Carlton Smith, University of Florida

Abstract: It is widely accepted that the neural system performs some variation of dimensionality reduction, the process of reducing the large number of components that make up a data sample to a smaller, more computationally manageable, and more representative number of components. However, exactly what algorithm the brain employs to perform this task is currently up for debate. In this presentation, algorithms of neural plasticity and learning are presented. Comparisons between biological neurons and networks and their artificial counterparts...
are drawn. Algorithms that perform dimensionality reduction – principal component analysis/Oja’s algorithm (PCA) and similarity matching (SM) – their various implementations and performances in online and offline settings, and their biological plausibility are discussed. Finally, the benefits of participating in the Simons-NSBP Scholars Program are showcased along with ongoing research being conducted as a part of the Saxena Lab of Neural Control.

**TIME:** 5:05 pm – 5:15 pm  
**TITLE:** Predicting SARS-CoV-2 Viral Load from Gene Expression Data Using Machine Learning  
**Speaker(s):** Bridgett Gilford, University of Florida

**Abstract:** The relationship between gene expression and viral infection was studied to determine whether, based on human gene expression alone, a patient will test COVID-19 positive or negative. Using machine learning algorithms, a classification model was constructed to transform the gene expression into binary data and then from that, predict COVID-19 positivity (virus detected) or negativity (virus not detected). Furthermore, RNA seq. data and cycle threshold values were also used to predict viral load, or the amount of virus in a person's system at a particular time of infection. A LASSO regression model was therefore constructed to predict the viral load. Finally, following the results of the LASSO regression model, 48 genes were isolated that showed the highest feature significance. These genes were among those that are most predictive of COVID-19 infection, two of which were LY6E and IFI44L that were also associated with previous COVID-19 studies.

**TIME:** 5:15 pm – 5:30 pm  
**TITLE:** How to join the Simons-NSBP Scholars Program  
**Speaker(s):** Kasey Wagoner, Simons Foundation

**Abstract:** The Simons-NSBP Scholars Program is a unique summer research experience for undergraduate members of the National Society of Black Physicists. In addition to unparalleled research experiences, our Scholars participate in several programs that provide them career advice and exposure to leading scientists. Scholars participate in research projects and career programming in astrophysics, cosmology, quantum physics, biophysics and neuroscience.

Friday, November 5

Session Time: 5:30 pm – 6:30 pm

**Auditorium – BIG SCIENCE HOUR #2**  
**Hosted by:** NSBP Presents: NASA’s Dragonfly Mission to Titan  
**Speaker(s):** Lynnae Quick, NASA; Elizabeth Turtle, John Hopkins Applied Physics Laboratory; Alice Cocoros, John Hopkins Applied Physics Laboratory; Melissa Trainer, NASA Goddard Space Flight Center; Jorge Nunez, John Hopkins Applied Physics Laboratory; Adrian Hill, John Hopkins Applied Physics Laboratory

**Abstract:** Saturn's largest moon, Titan, is an unusual world with a dense atmosphere, abundant complex carbon-rich material on its surface, and a liquid-water ocean in its interior. The Cassini-Huygens mission revealed Titan to be surprisingly Earth-like, with active geological processes and opportunities for organic material to mix with liquid water on the surface. Such characteristics make Titan a singular destination to seek answers to fundamental
questions about the origins of life: What makes a planet or moon habitable? What chemical processes led to the development of life?

NASA's Dragonfly Mission is a large rotorcraft lander that will take advantage of Titan's dense atmosphere and low gravity to fly from place to place to measure the compositions of surface materials and observe Titan's geology and atmosphere. Aerial mobility enables Dragonfly to explore many diverse landing sites as it travels up to ~180 kilometers during its 3.3-year mission. Dragonfly will investigate the habitability of this extraterrestrial environment and chemical processes that may be similar to those that supported the development of life on Earth.

A panel of Dragonfly Team Members will present an overview of the Dragonfly mission to explore Titan, and their work on the mission, which is currently in its development phase. Time will also be set aside to field questions.

**Friday, November 5**

**Session Time: 6:45 pm – 7:30 pm**
**Topic: Informal Chat Hour**

**Friday, November 5**

**Session Time: 6:45 pm – 7:30 pm**
**Title: HBCU's: Future in Physics II**
**Location: Dr. Edward Bouchet & Dr. Elmer Imes**

**Friday, November 5**

**Session Time: 6:45 pm – 7:30 pm**
**Title: NASA Dragonfly Mission to Titan Follow-up**
**Location: Willie Hobbs Moore & Hn Katherine Johnson**

**Friday, November 5**

**Session Time: 6:45 pm – 7:30 pm**
**Title: Light Sources**
**Location: Dr. Shirley Jackson**

**Friday November 5**

**Session Time: 6:45 pm – 7:30 pm**
**Title: Survey Sessions**
**Hosted by: Dr. Darnell Cole, University of Southern California**
**Location: Dr. Jim Gates**
Friday, November 5

Breakout Room: Dr. Shirley Jackson
Session Time: 11:00 am – 12:15 pm
Physics Research Education (PER) - 2
Session Chair(s): Juan Burciaga, Colorado College

TIME: 11:00 am – 11:45 am
TITLE: The 2021 Inclusive Curriculum in Physics Workshop
Speaker(s): Sara Frederick, Vanderbilt University

Abstract: The 2021 Inclusive Curriculum in Physics Workshop Series is a three part series organized and led by the National Society of Black Physicists, the National Society of Hispanic Physicists, and the American Association of Physics Teachers. The series leverages the expertise of equity, diversity and inclusion (EDI) experts from within the physics community and from outside the physics community as well as an organizing team of physics students, faculty and STEM professionals at different stages of their studies and careers.

Friday, November 5

Breakout Room: Dr. Jim Gates
Session Time: 11:00 am – 12:15 pm
Earth and Planetary Systems Sciences (EPSS) – 2.A
Session Chair(s): Lynnae Quick, NASA & Alex Evans, Brown University

TIME: 11:00 am – 11:15 am
TITLE: Digging Iceland Geology for Mars Analog Research Science (DIGMARS): 2021 Inaugural Field Expedition of Lake Sandvatn, Iceland
Speaker(s): Kennda Lynch, Lunar and Planetary Institute

Abstract: While the Mars Science Laboratory (MSL) Curiosity rover continues to provide growing evidence of an ancient paleolake within Gale crater, the Mars 2020 Perseverance rover is now exploring Jezero crater and beginning to seek signs of ancient life within those paleolake deposits. Further, in 2022 the ExoMars Rover will begin its journey to explore the potential paleolake basin of Oxia Planum. All these missions seek to understand the ancient habitable environments within martian paleolake systems and their potential for preserving biosignatures of past life. Terrestrial analog studies are essential components of the search for life on Mars and other planets as these studies assist in expanding our understanding of the limits of life here on Earth and our understanding of what possible habitable environments could exist on other planets. Through the Curiosity rover’s investigations of the ancient fluvial (river) and lacustrine (lake) environments in Gale crater, it has become clear that groundwater within martian paleolake systems has had a significant influence on diagenesis and habitability. However, very little information exists for terrestrial studies of the influence of groundwater on lacustrine sediments, specifically in basaltic terrains. Hence, these systems are very poorly understood from a mineralogical, geochemical, and biological perspective. The goal of the DIGMARS Project is to, for the first time, study the influence of groundwater discharge on the mineralogy, geochemistry, and microbial ecology of lacustrine sediments in basaltic terrains. This presentation will provide an overview of the project and a review of the first field season to Lake Sandvatn, Iceland.

TIME: 11:15 am – 11:30 am
TITLE: Review: Modern Mars’ geomorphological activity, driven by wind, frost, and gravity
Speaker(s): Serina Diniega, NASA/Jet Propulsion Laboratory
Abstract: Extensive evidence of landform-scale martian geomorphic changes has been acquired in the last decade, and the number and range of examples of surface activity have increased as more high-resolution imagery has been acquired. Within the present-day Mars climate, wind and frost/ice are the dominant drivers, resulting in large avalanches of material down icy, rocky, or sandy slopes; sediment transport leading to many scales of aeolian bedforms and erosion; pits of various forms and patterned ground; and substrate material carved out from under subliming ice slabs. Due to the ability to collect correlated observations of surface activity and new landforms with relevant environmental conditions with spacecraft on or around Mars, studies of martian geomorphologic activity are uniquely positioned to directly test surface-atmosphere interaction and landform formation/evolution models outside of Earth. This presentation will be a summary of a review paper, published in Geomorphology. In that paper, we outlined currently observed and interpreted surface activity occurring within the modern Mars environment, and tied this activity to wind, seasonal surface CO2 frost/ice, sublimation of subsurface water ice, and/or gravity drivers. Open questions regarding these processes were outlined, and then measurements needed for answering these questions were identified. We also discussed how many of these martian processes and landforms may provide useful analogs for conditions and processes active on other planetary surfaces, and thus modern Mars presents a natural and powerful comparative planetology base case for studies of Solar System surface processes, beyond or instead of Earth.

TIME: 11:30 am – 11:45 am
TITLE: Exploring the Solar System with NASA’s Planetary Science Division
Speaker(s): Joan Salute, NASA Headquarters

Abstract: The Planetary Science Division (PSD), one of five divisions in NASA’s Science Mission Directorate, has a fleet of almost 40 missions that are currently in operation or development stages. The targets of these missions span the full breadth of our Solar System—from Mercury all the way out to past Pluto in the Kuiper Belt. This talk will be a broad overview of the PSD mission portfolio, and will cover highlights from current missions, such as Mars2020 and the OSIRIS-REx asteroid sample return mission, as well as upcoming missions that are set to launch in late 2021—Lucy and DART. An overview of PSD’s different mission classes (i.e., Flagship/Strategic, New Frontiers, Discovery, SIMPLEx) and how mission priorities are established will also be included. Opportunities for involvement on current/future missions will also be discussed.

TIME: 11:45 am – 12:00 pm
TITLE: Lunar Science and Exploration in the Era of LRO
Speaker(s): Noah Petro, NASA Goddard Space Flight Center

Abstract: The Lunar Reconnaissance Orbiter (LRO) has been mapping the Moon and its environment for over 12 years. Initially planned to operate for up to two years, data from the mission has revolutionized our understanding of the Moon as well as its place in the solar system. From providing context for past landed missions to discovering new features and impact craters forming during the mission, LRO’s data serves many purposes. Our data is crucial for understanding the scientific context of the Moon, and is key for planning missions.

TIME: 12:00 pm – 12:15 pm
TITLE: The Near-Earth Object Surveyor Mission
Speaker(s): Amy Mainzer, University of Arizona

Abstract: NASA’s Near-Earth Object (NEO) Surveyor mission is designed to identify asteroids and comets that most closely approach the Earth, and to measure their orbits well enough to be able to find them again at their next apparition. The NEO Surveyor consists of a 50-cm telescope that will collect images in two channels (4.6 and 8 microns) that cover a 1.7 x 7.1 deg field of view simultaneously. The channels were selected to maximize sensitivity
to NEOs and to allow determination of their effective spherical diameters and other physical properties such as visible albedo and thermal inertia. The observatory will find the majority of near-Earth asteroids larger than 140 m in diameter during its 5-year mission. NEO Surveyor responds to a Congressional law directing NASA to catalog such objects since an impact from an object in this size range could pose a severe regional hazard. The mission is currently in its preliminary design phase, with launch scheduled for early 2026.

Friday, November 5

Breakout Room: Dr. Willie Hobbs
Session Time: 11:00 am – 12:15 pm
Astronomy and Astrophysics (ASTRO) – Session
Session Chair(s): Dara Norman, NSF’s NOIRLab

TIME: 11:00 am – 11:15 am
TITLE: Creative Astronomy
Speaker(s): Joann Roberts, University of California Davis

Abstract: Being an LA can include but not be limited to tutoring, as tutoring typically supports one-on-one exchanges between students and tutors. LAing demonstrates more collaboration with the instructor and a classroom of students. In the Fall 2020 semester, I collaborated with Dr. Mel Sabella as an LA for his basic astronomy course at Chicago State University. This particular interaction helped us to better support students engaging in the topic of astronomy by way of many activities that induced learning astronomy through both creativity and in relation to current events, both in parallel with and in support of the course’s learning objectives and outcomes. Some of these activities included the use of Google Sky Maps for evening observations, students creating and naming constellations and exoplanets of their own, facilitating discussions from POC scientists in TED talks, influencing feedback from my poetry about astronomy and life, and how science connects to society by way of the current telescope controversy in Hawaii. In addition to completing the final, students submitted written samples of poetry based on what they learned in the course and their overall experiences. Just as creativity can serve as a bridge between science and self-reflection/expression, so is also true in that LAs serve as a bridge between instructors and students. This is why the instructor and learning assistant collaboration is vital toward classroom effectiveness and the learning success of students.

TIME: 11:15 am – 11:30 am
TITLE: Static Liquid Positions in Toroidal Propellant Tan
Speaker(s): Don-Terry Veal, Morgan State University

Abstract: Without the influence of gravity, trivial phenomena can become immensely complex. A grand oversight in the study of space travel is rocket fuel’s static positioning while experiencing microgravity. Precision is sacrificed when overlooking such a factor and can offset a spacecraft’s guidance, navigation, and control. Tank designs, and frankly spacecrafts, cannot be optimized until total comprehension of all variables is accounted for. Using the Surface Evolver software to model the fuel and its tank provides a deeper understanding of how the stable state of the fuel will sit while in orbit. Numerically modelling a tank and its fuel grants a precise and accurate measurement of surface energy for applications in spacecraft design. The essential variables to investigate are the liquid fuel’s volume and contact angle to then conclude which tank topology yields the lowest energy state, allowing the selection of the most optimal solution. Results highlight potential problems and solutions of toroidal propellant tanks to be addressed in tank design. Future propellant management devices need to incorporate static fuel positioning to deviate risk, guarantee safety, and eliminate assumptions. Although the irregular movement of fuel in weightless motion (slosh) is an expanding topic, the stable state of fuel is equally as important, if not more.
Abstract: Solar coronal mass ejections (CMEs) commence as violent magnetic storms that release massive amounts of plasma and magnetic energy into the solar corona and interplanetary medium. It is difficult to measure the magnetic energy and cumulative heating energy within the CME’s total energy budget. The well-known coronal heating problem is a hot topic that often eclipses the CME heating problem, but a few studies have been proving that the cumulative heating energy is a significant component of the CME energy budget that is just as misunderstood as the heating of the ambient corona. We determine the heating and energy budget for CME observations from the space-based UltraViolet Coronagraph Spectrometer (UVCS). We study the single-slit UVCS measurements of localized plasma within the CME, which was imaged serendipitously at multiple heights in the corona. With this unique set of spectra from a coronagraph spectrometer, we use plasma diagnostics to evaluate the velocity, temperature, density, and ionization state of the CME core’s plasma at multiple coronal heights. We then model the plasma temperature’s evolution as a function of height and find that the cumulative heating energy is comparable to the kinetic energy of the CME’s core, which travels at approximately 250 km/s at heights near 3.0 solar radii. Therefore, the CME’s unknown heating mechanism has enough energy to significantly affect the CME’s eruption and evolution. To understand which parameters might influence the unknown heating mechanism, we constrain our model heating rates with the observed data and compare them to the rate of heating generated within a similar CME that was constructed by the MAS code’s 3D MHD simulation. This 3D simulation of a slow-velocity CME agrees with the physical conditions that we derived for the observed CME—proving the MAS code’s ability to reproduce real CME events. The rate of heating from the simulated CME agrees with our observationally constrained heating rates when we assume a quadratic power law to describe a self-similar CME expansion. Furthermore, the heating rates agree when we assume a heating parameterization that accounts for the CME flux rope’s magnetic energy being converted directly into thermal energy. Thus, these two assumptions together are valid for generating realistic heating rates in the CME core. This result serves as a useful clue for understanding the true nature of the CME heating problem. This also serves as a case study for how useful the future missions of multi-slit coronagraph spectrometers, such as UVSC Pathfinder and LOCKYER, will be for CME heating studies.

Abstract: Jovian planet formation has been shown to be strongly correlated with host star metallicity, which is thought to be a proxy for disk solids. Observationally, previous works have indicated that short-period planets preferentially form around stars with solar and super solar metallicities. Given these findings, it is challenging to form planets within metal-poor environments, particularly for hot Jupiters. Although previous studies have conducted planet searches for hot Jupiters around metal-poor stars, they have been limited due to small sample sizes, which are a result of a lack of high-quality data making hot Jupiter occurrence within the metal-poor regime difficult to constrain until now. We construct a large sample of halo stars using 2D kinematic information using Gaia DR2 data. With this large sample of halo stars observed by TESS, we constrain the upper limit of hot Jupiter occurrence within the metal-poor regime (-2.0 ≤ [Fe/H] ≤ -0.6). Placing the most stringent upper limit on hot Jupiter occurrence, we find the 1-σ upper limit to be 0.18 % for radii 0.8 - 2 RJupiter and periods 0.5 – 10 days.
**Friday, November 5**

**Breakout Room:** Dr. Shirley Jackson  
**Session Time:** 2:15 pm – 3:45 pm  
**Medical Physics (MED) & Chemical and Biological Physics (CBP) – 2**  
**Session Chair(s):** Christopher Njeh, *Indiana University*

**TIME: 2:15 pm – 2:45 pm**  
**TITLE:** The New Era of Radiation Therapy: From Conventional to 4D and Beyond  
**Speaker(s):** Christopher Njeh, *Indiana University*

**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 factor 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: 2:45 pm – 3:00 pm**  
**TITLE:** Magnetic nanoparticle biosensing efficacy  
**Speaker(s):** Gabrielle Moss, *Thayer School of Engineering at Dartmouth College*

**Abstract:** Functionalized magnetic iron oxide nanoparticles can be utilized for both in vitro and in vivo biosensing applications. The iron oxide nanoparticle can be functionalized with an antibody, lending the nanoparticle an affinity for the antigen of interest. When in the presence of the target antigen, the nanoparticles will agglutinate, forming clusters. Using AC magnetic susceptibility measurements, we can determine whether the nanoparticles are clustered versus dispersed in solution. Cluster formation indicates the presence of the target antigen. Since it is the nanoparticle agglutination that enables antigen detection, the present research aims to advance understanding of agglutination dynamics. A standard model used when investigating agglutination is biotinylated iron oxide nanoparticles for targeting streptavidin. Researchers have shown that biotinylated iron oxide nanoparticles can successfully detect the presence of streptavidin in solution. Being that a biological sample, specifically that of blood, contains a variety of plasma proteins, to reach clinical significance the functionalized nanoparticles must be able to detect the antigen of interest in the presence of non-targeted spectator biomolecules. To investigate the detection capability of biotinylated nanoparticles in the presence of both targeted and non-targeted molecules, our group performed clustering experiments with the addition of monomeric streptavidin. Monomeric streptavidin has high biotin affinity, but unlike streptavidin, does not cause nanoparticle clustering being that it only has one biotin binding site. Monomeric streptavidin acts as a good model for plasma proteins, because they too will adhere to the nanoparticle surface decreasing the number of available binding sites for target binding and cluster generation. The presence of monomeric streptavidin can decrease streptavidin-biotin nanoparticle cluster formation by over 90%. Our results suggest that the non-specific binding of plasma proteins to the nanoparticle surface in a biological sample may render the functionalized nanoparticles unable to detect the presence of the targeted antigen. Our work will aid in the
development of an iron oxide nanoparticle-based biosensor capable of detecting a targeted antigen in the presence of spectator biomolecules.

**TIME: 3:00 pm – 3:15 pm**
**TITLE:** Janus particles swimming along liquid boundaries
**Speaker(s):** Baseemah Rucker, *City College of New York*

**Abstract:** Janus particles are asymmetric particles with different surface compositions on each hemisphere, giving each side a different surface property. The Janus particles in focus are silica particles half coated with platinum. When these particles are placed in a solution of hydrogen peroxide, the platinum reacts with the hydrogen peroxide and produces water and oxygen, acting as a fuel to propel the particles forward in the solution. This self-motile, chemical motorized particle has potential applications for use in drug delivery, wastewater treatment, surface imaging techniques and sensors.

**TIME: 3:15 pm – 3:45 pm**
**TITLE:** Using Volumetric Modulated arc Therapy for Total Body Irradiation
**Speaker(s):** Colin Huang, *Indiana University*

**Abstract:** TBA

**Friday, November 5**

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

**TIME: 2:15 pm – 2:30 pm**
**TITLE:** Geologic Mapping of Resurfacing Features on Europa
**Speaker(s):** Kierra Wilk, *Brown University*

**Abstract:** There is ample evidence which suggests that Jupiter’s moon Europa is geologically active, with previous investigations suggesting that a subset of domical features on the icy moon may be cryovolcanic in origin. Cryovolcanism, the eruption of water phases or other aqueous solutions that would otherwise be frozen solid at the normal temperature of an icy satellite’s surface, has likely played a role in the resurfacing of Europa in recent geologic time. Although several of these domes have been classified as extrusive cryovolcanic domes, they have not been extensively investigated, which warrants a re-examination of cryolava domes on Europa. Here we mapped domical features characterized by their lobate shape and relatively smooth surfaces. These domes are distinct from the surrounding terrain and have been interpreted to have formed via the axisymmetric flow of viscous fluids onto Europa’s surface. For each identified dome, the location, area, and geologic context was compiled. Pinpointing the spatial distribution of these domes and their geologic context will provide insights into regions of recent geological activity on Europa and into Europa’s cryovolcanic evolution.

**TIME: 2:30 pm – 2:45 pm**
**TITLE:** The Paradox of the Lunar Core Dynamo
**Speaker(s):** Alex Evans, *Brown University*
**Abstract:** Magnetizations within lunar rocks indicate that the ancient Moon produced an internally generated magnetic field. Yet the long-lived field intensities inferred for the ancient Moon are unsustainably high and cannot be reconciled with the small lunar core size, requiring three orders of magnitude more energy than deemed possible. Here, we demonstrate that the solution to this mystery may be the prolonged dripping of cool, dense material initially emplaced at shallow depths. Such a scenario would simultaneously explain both the high magnitude and large-scale variability in field intensities preserved by lunar rocks.

**TIME:** 2:45 pm – 3:15 pm  
**TITLE:** Radiophysical Properties of Venus Highlands  
**Speaker(s):** Martha Gilmore, Wesleyan University

**Abstract:** Magellan radar data reveal distinct patterns in radar emissivity with altitude that are likely to be due to the presence of minerals with a high dielectric constant. Variations in the presence and altitude of these minerals is a function rock type, atmospheric composition and age, or a combination of these. We mapped all major volcanoes and coronae, tesserae and mountain belts and find that minerals with high dielectric constants are common features on at altitudes above 6053 km and associated with individual geologic units at low altitudes. This implies that the minerals involved in this reaction are widespread and common in these terrains. We propose that some terrains on Venus are compatible with the presence of ferroelectric compounds in their rocks, where varying altitude of the emissivity signatures could be due to different minerals, a subtle variation of the composition or local differences in the atmospheric composition or temperature. The emissivity pattern observed in all terrains within Ishtar Terra and large coronae in eastern Aphrodite Terra are more consistent with the presence of semiconductor minerals. We also find that the emissivity signatures of some volcanic edifices are consistent with relatively recent and less weathered lava flows, that are regions associated with 4 of the 10 presumably active hotspots that are among the most likely sites for recent or current volcanic activity on Venus.

**TIME:** 3:15 pm – 3:30 pm  
**TITLE:** Role of Physics in Air Quality Research  
**Speaker(s):** Solomon Bililign, North Carolina A&T University

**Abstract:** Poor air quality resulting in “air pollution is slashing years from billions of people’s lives around the world and is a greater threat to life expectancy than smoking, HIV/AIDS or war” and disproportionately impacts low income and minority neighborhoods. Air quality research is highly interdisciplinary involves experimental laboratory and field (ground, aircraft, and satellite) research and theoretical research involving modeling. Physics plays a broad role, contributing directly to atmospheric and environmental projects and indirectly through basic research, providing technological spin-offs from research programs, and helping to educate a technically literate population capable of responding to environmental issues. Basic physics has played a central role and where it is crucial for further progress. This talk highlights work in our lab at NCAT devoted to the use of several spectroscopic techniques applied to the understanding the role of biomass burning (wildfire and domestic) emissions aerosol nanoparticles on climate, weather, air quality and health. We investigate the role of photochemical aging, burning conditions, morphology, relative humidity on the optical and chemical properties of these particles and how these changes impact air quality and health.
Abstract: Ultracool dwarfs stars and brown dwarfs (M < 0.1 Msun) comprise a significant proportion of stars in the Milky Way. Deep samples of ultracool dwarfs have the potential to constrain the formation history and evolution of low-mass objects in the Galactic system, but well-characterized spectral samples have until recently been limited to the local volume (d< 100pc). Aganze et al. (2021) reported the discovery of 164 M, L, and T dwarfs out to distances of ~1 kpc identified from the Hubble Space Telescope WFC3 Infrared Spectroscopic Parallel Survey and the 3D-HST surveys. Here, we analyze this sample and model the observed luminosity function using population simulations to place constraints on scaleheights and population ages. Our simulations incorporate various parameterizations of the underlying mass function and star formation history, and account for stellar and substellar evolution, stellar multiplicity, multiple stellar populations, and Galactic structure. Our star counts are generally consistent with a power-law mass function and constant star formation history for ultracool dwarfs, with vertical scale-heights of 420±100 pc for late M dwarfs, 200±170 pc for L dwarfs, and 200±170 pc for T dwarfs. These scaleheights correspond to disk population ages of 6.6±1.9 Gyr for late M dwarfs, 2.9±1.1 Gyr for L dwarfs, and 2.9±2.2 Gyr for T dwarfs, consistent with prior simulations and predicting that L-type dwarfs are on average a younger and less dispersed population. These measurements will improve considerably with future spectral samples from the James Webb Space Telescope, Euclid, and Nancy Grace Roman Space Telescope missions, enabling a more robust assessment of the formation and evolutionary history of the Milky Way’s lowest mass stars.

TIME: 2:30 pm – 3:00 pm
TITLE: Protoplanetary Disks: Insights from Microphysics
Speaker(s): Diana Powell, Harvard-Smithsonian Center for Astrophysics

Abstract: In this talk I will discuss new insights into fundamental properties of protoplanetary disks from the microphysical perspective. I will first report on a new set of models that reconcile theory with observations of protoplanetary disks and create a new set of initial conditions for planet formation models. The total mass available in protoplanetary disks is a critical initial condition for understanding planet formation, however, the surface densities of protoplanetary disks still remain largely unconstrained due to uncertainties in the dust-to-gas ratio and CO abundance. In our new modeling, we make use of resolved multiwavelength observations of disks in the millimeter to constrain the aerodynamic properties of dust grains, allowing us to infer total disk mass without an assumed dust opacity or tracer-to-H2 ratio. These models are then combined with models of the microphysics of cloud formation in planetary atmospheres to show that the observed depletion of CO in well-studied disks is consistent with freeze-out processes and that the variable CO depletion observed in disks can be explained by the processes of freeze-out and particle drift.

TIME: 3:15 pm – 3:30 pm
TITLE: Spectroscopic Identification of Five K Dwarfs Younger than 1 GYR Within 30 parsecs
Speaker(s): Hodari-Sadiki James, Georgia State University

Abstract: Here we present the results of an ongoing spectroscopic study of the age and activity levels of over 1,200 K dwarf stars within 40 parsecs of the Sun and found between declinations +30° and -30° in the sky. For the initial study described here, the CHIRON echelle spectrometer on the SMARTS 1.5m telescope has been used to acquire high resolution (R=80000) spectra for 35 benchmark stars with known ages and additional 7 field K dwarfs with variable radial velocities (RVV) not obviously caused by companions.
TIME: 3:30 pm – 3:45 pm  
TITLE: A Kinematic and Spectroscopic Analysis of the Nearest K Dwarf Stars  
Speaker(s): D. Xavier Lesley, Southern Connecticut State University

Abstract: With the use of CHIRON – a high-resolution echelle spectrometer on the SMARTS 1.5m telescope at the Cerro Tololo Inter-American Observatory in Chile – we acquired spectra (R=80,000) of 42 nearby K dwarf stars. Included is a benchmark sample of 35 star systems divided into five subsets, with reliable age estimates of 20 million years to a few billion years. Seven additional K dwarf systems were selected from a sample of several hundred field stars because they have variable systemic gamma velocity (GV) measurements. These curious discoveries are compared to our benchmark set by using the measured GVs and Gaia data to determine UVW space motions through the Milky Way.

Friday, November 5

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

TIME: 2:15 pm – 2:30 pm  
TITLE: Understanding lanthanides speciation in molten salts using X-ray absorption spectroscopy  
Speaker(s): Rosemary Cortes, University of Puerto Rico

Abstract: Molten Salt Reactors (MSRs) are the leading candidates out of the six Generation IV advanced nuclear power reactor designs chosen for deployment for nuclear energy in US. MSR technology is attractive due to better passive safety, operation at atmospheric pressure, high thermal efficiency, lower spent fuel per unit energy and increased solubility of fission products in molten salts. Understanding the effect of solvent chemistry and radiation on the speciation and local structure of metals is crucial for predicting the stability and reactivity of molten salts for successful deployment of molten salt reactor (MSR) systems. We investigated speciation and radiation-induced nanoparticles in molten salts systems by utilizing synchrotron based XAS methods. Our work used the Extended X-ray Absorption Fine Structure (EXAFS) and X-ray Absorption Near-Edge Structure (XANES) to investigate local coordination environment and chemical structures of lanthanides species such as Samarium, Praseodymium, Neodymium, Holmium and Erbium in molten salt systems, in this case KCl-MgCl2 eutectic. In addition, the effect of metal concentration and temperature on changes in the local and chemical structure of metals is studied. Our experimental and computational results show that the coordination environment of most of these lanthanides doesn’t change drastically as the temperature increase. To obtain detailed picture of structural changes, we performed quantitative analyses of the EXAFS fitting procedure. These results show that the coordination number (N) vary between 5.4 and 7.3 and the distance to the neighboring atom (R) vary between 2.6 and 2.8 as expected. XAS studies will be complemented with optical ultra-violet spectroscopy. Such knowledge of speciation of metals and radiation-induced nanoparticles in molten salt environments provides a critical understanding needed to predict and control physical and chemical properties of molten salts for MSR applications. Because of this study, I have added X-Ray Absorption spectroscopy to my abilities of materials characterization techniques.
TIME: 2:30 pm – 2:45 pm
TITLE: From Freezeout to Squeezeout for Heavy Dark Matter
Speaker(s): Tracy Slatyer, Massachusetts Institute of Technology

Abstract: I will discuss the potential importance of a dark-sector phase transition in the early universe in setting the measured relic abundance, for a simple model of strongly interacting dark matter. Enhancement of the dark matter density within shrinking pockets of the high-temperature phase leads to a dramatic reduction in the late-time dark matter abundance, allowing for much heavier dark matter than in the standard thermal freezeout scenario.

TIME: 2:45 pm – 3:00 pm
TITLE: Research Opportunities in Nuclear and Plasma Science at the University of Michigan
Speaker(s): John Foster, The University of Michigan

Abstract: The University of Michigan’s Department of Nuclear Engineering offers a range of exciting research opportunities for graduate study in nuclear and plasma science. The Department’s strategic priority areas include clean energy, national defense, the environment and health as well as basic science. The Department is organized into 4 thrust areas: a) nuclear measurements, b) nuclear materials, c) nuclear fission, and d) plasma physics. Here, we highlight the research focus and representative research actively being carried out in these areas, which includes topics ranging from advanced, high temperature reactors to nuclear fusion. We conclude with a description of typical coursework and matriculation through the department along with career opportunities post-graduate.

TIME: 3:00 pm – 3:55 pm
TITLE: High Q² electron-proton elastic scattering at the future Electron-Ion Collider
Speaker(s): Allen Pierre-Louis, Stony Brook University

Abstract: Unpolarized electron-proton elastic scattering cross-section measurements at high Q² allow for improved extractions of the proton electromagnetic form factors as well as provide constraints on possible hard two-photon exchange effects. We present a detailed study of the feasibility of making these high Q² e-p elastic measurements at the future Electron-Ion Collider (EIC). The results show that e-p elastic cross sections can be obtained in the momentum transfer range of 6(GeV/c)² < Q² < 40(GeV/c)², which would be the highest-ever Q² values measured. These data will all be at virtual photon polarizations close to unity, e~1.

TIME: 3:15 pm – 3:45 pm
TITLE: Q&A
Speaker(s): Paul Gueye, Michigan State University

Friday, November 5

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

**TIME:** 2:15 pm – 2:45 pm  
**TITLE:** Chiral Phase Change Nanomaterials  
**Speaker(s):** Joshua Burrow, *University of Dayton*

**Abstract:** Chalcogenide phase change material Ge2Sb2Te5 (GST) offers a unique ability to switch between its amorphous and crystalline states rapidly and reversibly at relatively low thermal thresholds. Furthermore, each state exhibits vastly distinct complex refractive index properties, making it an ideal candidate for thin-film reconfigurable photonics. Here, we propose and explore the development of a new class of tunable phase change nanomaterials based on a bottom-up fabrication technique that allows us to grow densely packed nano-columnar thin films at the nanometer-scale with high degree of control in three dimensions. Specifically, we employ the evaporative glancing angle deposition technique to achieve cylindrical helix nanostructures ("intrinsic chiral molecules") exhibiting polarization-sensitive optical absorption due to the inherent bianisotropy. Differential absorption between left and right circular polarization (namely, circular dichroism (CD)) is measured and a broad CD artifact is observed in the ultraviolet region. Upon crystallization, we measure CD enhancement and redshift of peak CD response. To support our results, we implement rigorous numerical calculations to elucidate the origins of the large CD response and relate it to the generation of eddy-like chiral currents inside the nanorods. Our theoretical calculations and experimental results open the door towards a new type of nanochiral device for ultrafast polarization control, beam forming, and integrated spin-selective tunable devices.

**TIME:** 2:45 pm – 3:15 pm  
**TITLE:** Dynamically tunable single-layer VO2/metasurface b  
**Speaker(s):** Zizwe Chase, *University of Illinois at Chicago*

**Abstract:** Cross polarization transmission is demonstrated in a single-layer THz metadevice comprised of a two dimensional array of split ring resonators, each with a vanadium oxide (VO2) pad, integrated into one of the two capacitive gaps of the unit cell. Numerical investigations show that as the conductivity of VO2 increases the amplitude of the cross-polarization intensity decreases but maintains a wider broadband range than previously reported for single layered hybrid metamaterial (MM) devices as the VO2 transforms from the insulator to metallic phase. Concurrently, the asymmetric transmission, optically modulated by the device, is higher than that of multi-layered MM devices. The material properties of VO2, introduce a promising method that allows for an active sub-cycle dynamic tunability for THz polarization conversion with multiple modalities using optical, electrical or thermal switching which allows for an important step forward in developing compact, integrated, passive and active metadevices for polarization and wavefront control application in the THz regime.

**TIME:** 3:15 pm – 3:45 pm  
**TITLE:** Electromagnetic applications of Mxenes  
**Speaker(s):** Deng Kuol, *Drexel University*

**Abstract:** TBA
Session Chair(s): William Ratcliff, National Institute of Standards and Technology

TIME: 2:15 pm – 2:30 pm
TITLE: Vibrational Spectrum of Jammed Granular Matter
Speaker(s): Harsh Mathur, Alliance Cancer Care

Abstract: Granular matter is a far from equilibrium state of matter that is poorly understood (examples include piles of rice or sand and bead packs). As the density of a granular material is increased it transitions from a flowing state to a jammed solid state. The vibrational modes of the jammed state show some remarkable universal properties. In this talk I will describe the use of random matrix theory (which was originally developed to understand the energy levels of complex atomic nuclei) to characterize the vibrational spectrum of a jammed granular solid. The random matrix model gives a good account of universal features of the vibrational spectrum that is in agreement with realistic dynamical simulations of bead packs.

TIME: 2:30 pm – 2:45 pm
TITLE:
Speaker(s): Charles Brown, University of California Berkeley

Abstract: The band structure of a system may have points where two bands become degenerate, marking a singularity in the Bloch wave function, where it cannot be uniquely determined. Studying such singularities provides a path toward understanding the geometry and topology of the Hilbert space spanned by the Bloch wavefunctions. Previous experiments have observed effects of the Abelian Berry connection in a system with a Dirac point (a linear band-touching point with a winding number of 1), such as the accumulated pi-valued Berry phase after enclosing a Dirac point in a single path-independent loop in quasimomentum. Rather than performing an interferometric measurement, we study effects of the Berry connection by probing Dirac points in a new way. We extend this technique to study a singular quadratic band-touching point. To study this physics, we load a Bose-Einstein condensate into an optical honeycomb lattice with linear and quadratic band-touching points, then boost the quantum gas along various quasimomentum trajectories that include or exclude these singularities. We find that for trajectories that include the singularity, the subsequent evolution of the Bloch wave function after traversing the singularity depends only on the trajectory's geometry in reciprocal space, and not on the speed with which it is traversed, deviating from the usual Landau-Zener picture. Lastly, we observe, for the first time, evidence of a singularity with a winding number of 2 at a quadratic band-touching point.

TIME: 2:45 pm – 3:00 pm
TITLE: Application of the Gradient and Hessian Matrix Methods to Compute the Sensitivities of Magnetic Islands to Parameter Perturbations in Permanent Magnet Stellarators
Speaker(s): Amelia Chambliss, Princeton Plasma Physics Laboratory

Abstract: We applied methods for quantifying sensitivities of error fields to shape deviations in stellarator coils to novel permanent magnet stellarators. Using permanent magnets to produce stellarator fields offers a promising alternative to coil complexity. In the modular coil approach, small deviations in coil shape can have detrimental effects on particle and energy confinement. Permanent magnet stellarators are, however, also sensitive to source perturbations., and as a result, a detailed analysis of the possible field perturbations that can be caused by permanent magnets is necessary for device construction. We applied the gradient 1 and Hessian matrix methods 2 to permanent magnet stellarators to analyze the impact of perturbations to permanent magnet parameters including position, orientation, and magnetic moment magnitude on the production of error fields. We used the JAX automatic differentiation toolkit in Python to compute analytic derivatives of error field quantities. These methods were applied to study the sensitivity of the resonant perturbation metric, an indicator of the width of magnetic islands in the stellarator field. The shape gradient and Hessian matrix methods were applied to analyze the sensitivity of this error field quantity to perturbations of permanent magnet parameters in the MUSE permanent magnet stellarator and the
PM4Stell permanent magnet project under development at PPPL. Implications for construction methods and precision requirements will be discussed.

TIME: 3:00 pm – 3:15 pm
TITLE: Dust modification of plasma instabilities in MDPX
Speaker(s): Edward Thomas, Auburn University

Abstract: The role of charged, solid particulate matter (i.e., “dust”) in plasmas has been considered for several decades. However, beginning with observations of structures in the dust tails of comets and the Voyager observations of radial structures (“spokes”) in Saturn’s rings, the role of charged dust in the solar system led to the emergence of the field of “dusty” (alternatively, “complex”) plasmas. Since the early 1990’s there has been a complementary effort in the area of laboratory dusty plasmas that has, over almost four decades, led to the observation of numerous types of plasma and dusty plasma behavior – ranging from appearance of strongly-coupled, self-organized dusty plasma crystals to new types of collective, dust-driven modes, such as the dust acoustic and dust density waves.

TIME: 3:15 pm – 3:30 pm
TITLE: CGAPL* Updates and Upgrades to the Surface Mounted
Speaker(s): Royce James, AFIT/USCGA

Abstract: The U.S. Coast Guard Academy Plasma Lab (CGAPL) is currently operating experiments and collaborations in three main areas: fusion diagnostic development with our small Helicon Plasma Experiment (HPX), plasma waste-water investigations, and low earth orbit (LEO) space plasma investigations. Specifically, collaborations utilizing small spacecraft in near earth orbit between the U. S. Coast Guard Academy (CGA), Navy Research Lab (NRL), the U. S. Naval Academy (USNA), Old Dominion University (ODU), and the and the Air Force Institute of Technology (AFIT) have initiated scientific and engineering space based experiments. We have constructed an impedance probe payload for launch in Fall 2021 derived from the existing ‘Space PlasmA Diagnostic suite’ (SPADE) mission operating from NASA’s International Space Station. Currently both space and laboratory plasmas are investigated with AC impedance measurements using a radio frequency antenna. Plasma electron density data collected from the 3U CubeSat will however use an innovative surface mounted dipole antenna to gather the required sheath-plasma and plasma resonance information. On that same launch, a compact multispectral ‘Pixel Sensor’ with a 450 nm - 1000 nm spectral range will add to the motion and position sensors baselined in previous launches. We have designed, built, and assembled custom components while and conducted laboratory experiments in both NRL and AFRL plasma chambers comparable LEO densities. A brief summary of CGAPL experiments to include an in-depth account of our impedance probe optimization, data collection obstacles, solutions, and procedures will be reported.

TIME: 3:30 pm – 3:45 pm
TITLE: Feasibility Studies of Single Shot Collective Thom
Speaker(s): Marien Simeni Simeni, Princeton Plasma Physics Laboratory

Abstract: Miniaturization of electronic components is the currently envisaged solution for manufacturing faster, smaller and more compact electronic devices. Currently, chip components with typical feature size smaller than 10 nm are being manufactured using Extreme Ultraviolet Lithography (EUVL). The latter process relies on light sources in the soft X-ray spectral range (13.5 nm ± 1%) to achieve finer resolution features following the diffraction-limited Rayleigh criterion. In the industrial settings, the 13.5 nm photons are generated by a plasma following the
interaction of 20-30 μm diameter molten tin droplets with focused CO2 pulsed laser beams running at kHz repetition rates. Despite a relatively low conversion efficiency (5-7%) from the drive laser energy to the energy of the collected photons at 13.5 nm, EUVL has already reached the stage of industrial maturation. However, a lot remains to be known about the properties of the plasma source responsible for light generation at 13.5 nm. Especially, experimental data providing the full picture of the spatio-temporal evolution of the plasma parameters (ne, Te, Ti, Z) during the laser ablation of the tin droplet is still lacking. This is of direct interest for the purpose of improving the conversion efficiency of the industrial process. We show that such experimental measurements are feasible on a single-shot fashion using streaked collective Thomson scattering with a 15 mJ probe laser at 532 nm. The details of the feasibility study and required experimental design are thoroughly discussed.

Saturday, November 6

Session Time: 11:00 am – 12:30 pm

Auditorium – General Session

Speaker: Dr. Darnell Walton, Corning Inc.

BIO: Dr. Donnell Walton is the director of the Corning Technology Center Silicon Valley. In this role, he leads research and business development efforts to match Corning’s existing and emerging capabilities and opportunities in the western United States, in particular, the Silicon Valley region of California. Walton joined Corning in 1999 as a senior research scientist in Science & Technology, where he performed and led research in optical fiber amplifiers and lasers. In 2004, Walton led Corning’s research and development efforts to a world leadership position in high-power (kW) fiber lasers. Then in 2006, he managed the Silicon on Glass (SiOG) platform expansion project, which demonstrated nondisplay applications of SiOG including imagers and photovoltaics. In 2008, Walton joined the Corning® Gorilla® Glass team as a senior applications engineer, where he extended the Gorilla Glass value proposition to form factors larger than handheld devices. In 2010, Walton was appointed manager of worldwide applications engineering for Gorilla Glass. Prior to joining Corning, Walton was a physics professor at Howard University in Washington, D.C., where he won the National Science Foundation’s Young Investigator (CAREER) Award. Walton earned a Ph.D. in applied physics from the University of Michigan, Ann Arbor after graduating summa cum laude with bachelor’s degrees in physics and electrical engineering from North Carolina State University. He completed the Stanford Executive Program at the Graduate School of Business in 2019. He serves on the board of the National Society of Black Physicists, the research advisory board of the IBM-HBCU Quantum Center and the corporate affiliate boards at the Universities of California in Santa Barbara and San Diego. Walton has authored or co-authored 22 U.S. patents and more than 60 technical reports.

Saturday, November 6

Session Time: 2:30 pm – 3:30 pm

Auditorium – Virtual Luncheon

Speaker: Ms. Farrah Simpson, NSBP Student Representative, Brown University

BIO: Farrah Simpson is currently pursuing her physics doctoral degree at Brown University. Her research is in High Energy Experiment and focuses on Beyond Standard Model Physics. She performs a search for a Vector Like Quark that is the heavy fermionic partner of the top quark. She also performs methods of silicon strip detector quality assurance for upgrades to the High Luminosity LHC. She hails from the island of Jamaica and completed her undergraduate degree in Applied Physics at Columbia University in the City of New York. She is passionate about teaching and mentorship. She currently serves as the Student Representative on the board of the National
Society of Black Physicists and a mentor leader in the NSBP and Harlem Gallery of Science Mentoring Program. She is co-leader of the Women in Physics group at Brown and a member of the USCMS DEI committee. In her spare time, she enjoys running, ballet dancing and reading Caribbean history books.

Saturday, November 6

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 – 1:30 pm
TITLE: Synchrotron and optical probing of mixed halide perovskites for photovoltaics
Speaker(s): Deidra Hodges, Florida International University

Abstract: The methylammonium lead iodide CH3NH3PbI3 (MAPbI3) perovskites have attracted a lot of attention as a possible absorber material for thin film solar cells due to their bandgap energy, high optical absorption coefficients and low-cost solution-processing deposition approaches. MAPbI3 perovskite solar cells have evolved with transformative potential with laboratory efficiencies greater than 20%. Perovskite absorber materials are very inexpensive to synthesize and simple to manufacture, making them an extremely commercially viable option. Perovskites of compositional variations ABX3 can yield a range of crystal structures, phases and stabilities. The Goldschmidt’s Tolerance Factor is a reliable figure of merit or empirical index to forecast the formation of preferred and stable structures and phases with ABX3 mixed halide perovskite tolerance factors in the range of 0.9 to 1. Here, we probe perovskites of compositional variations ABX3 with tolerance factors in the range of 0.9 to 1.0, and a large effective ionic radius greater than 200 pm. We report on the structural and optical properties of these perovskites. Photovoltaic (PV) devices were fabricated using these high tolerance factor perovskites. We report we have achieved power conversion efficiencies (PCEs) greater than 21% using the high tolerance factor perovskites investigated. The high tolerance perovskites were also characterized using synchrotron X-ray absorption near edge structure (XANES) spectroscopy at the National Synchrotron Light Source (NSLS) II at Brookhaven National Laboratory (BNL). XANES was used to probe the electronic structure of the high tolerance factor perovskites investigated.

TIME: 1:30 pm – 2:00 pm
TITLE: A simple high-yield solution for the practical fabrication of x-ray transmission mirror optics
Speaker(s): David Agyeman-Badu, Cornell University

Abstract: Although the concept, first demonstration and potential applications of x-ray transmission mirrors (XTM) were initially described over 30 years ago [1], there have been conspicuously few implementations in the literature. This absence is largely due to the unsolved challenge of XTM fabrication: namely, that the comparatively thick frame that mechanically supports the thin, reflecting membrane does not itself block the transmitted beam. In this presentation, we show how to solve this challenge by employing a microfabrication approach together with a novel differential-deep reactive ion etch (d-DRIE) technique that we developed. By using this method, a robust XTM frame was fabricated such that it secures the thin film membrane without blocking the transmitted beam. Specifically, we have fabricated delicate XTM optics with high yields, which consist of 300 nm thick silicon nitride membrane windows that are 2 mm wide, and 75 mm long on silicon substrates.

TIME: 2:00 pm – 2:30 pm
TITLE: Nature of the Phase Transitions and Structural Symmetries Leading to Hybrid Improper Ferroelectricity in Ca3X2O7
Speaker(s): Trevor Tyson, NJIT

Abstract: Detailed structural and optical measurements reveal that the tilt and rotation distortion relative to the high symmetry phase driving ferroelectricity in the Ca3X2O7 system (X=Mn and Ti) condense at different temperatures. The condensation of the rotation and tilt distortions at distinctly different temperatures is unexpected. Experimental results, combined with DFT simulation of the atomic force constants, suggest that this loss of a polar state is driven by the relative strength of the A-O bonds to the X-O bonds. Raman measurements under isotropic pressure are used to assess the stability of the tilt and rotational distortions. This work is supported by NSF Grant No. DMR-1809931.

Saturday, November 6

Breakout Room: Dr. Shirley Jackson
Session Time: 1:00 pm – 2:30 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.

Saturday, November 6

Breakout Room: Dr. Willie Hobbs Moore
Session Time: 1:00 pm – 2:30 pm
Astronomy and Astrophysics (ASTRO) – 3.A
Session Chair(s): Dara Norman, NSF’s NOIRLab

TIME: 1:00 pm – 1:15 pm
TITLE: Constraining A Galaxy Cluster Merger, ACT-CL J0034.4+0225
Speaker(s): Peter Doze, Rutgers, The State University of New Jersey

Abstract: From the Atacama Cosmology Telescope (ACT) survey, a galaxy cluster with a high signal-to-noise was brought to our attention. We took X-ray observations with Chandra which revealed a merger like state between two clusters of galaxies. The interesting morphology lead us to study ACT-CL J0034.4+0225 in several different ways; including confirming the merger state, calculating the mass, and performing a strong lensing study. Ultimately, we compare ACTCL J0034.4+0225 with parameterized N-body simulations to conclude that the merger is near first pericenter with an approximate mass ratio (1:1 to 1:3) between the two clusters.

TIME: 1:15 pm – 1:30 pm
TITLE: Radial Migration & Mixing in the Galactic Disc: Close Encounters between Sagittarius and the Milky Way
Speaker(s): Christopher Carr, Columbia University
Abstract: The ongoing merger with the Sagittarius dwarf spheroidal galaxy (Sgr) points to an important disruption in the relatively quiescent history of the Milky Way, but its consequences for stellar migration in the disc remains poorly understood. Using a collisionless N-body simulation of a Milky Way-like galaxy with an interacting satellite on a Sgr-like orbit, we characterize the response of circular orbits in the disc to pericenter passages of Sgr and compare that evolution to similar orbits during the extended phases of secular evolution between impacts. As a tool for making this comparison, we demonstrate that the impulse approximation can reasonably estimate the global changes in radial velocities, radial action, and angular momentum (azimuthal action) for orbits in the disc for a single pericenter passage. It is most successful at reproducing the change in angular momentum for stars in the outer disc where the crossing time exceeds the encounter time. We find that the encounter produces correlated responses in the increase in the maximum radial excursion, \( R_{\text{max}} \) (or, equivalently, radial action), and changes in guiding radius \( R_g \) (azimuthal action) of orbits. These changes are most readily seen in the outer disc, perturbing it in a largely outside-in fashion. This stands in contrast to the secular phase, where the active sites of angular-momentum exchange overlap with resonances from transient spiral structure. We lastly explore consequences in chemistry, identifying signatures in the metallicity properties of the solar annulus resulting from migration induced by Sgr's most recent disc crossing. We find that the primary signature of Sgr-induced migration is the relocation of metal-poor stars born on circular orbits to highly eccentric orbits in the inner galaxy, leading to a correlated structure in metallicity azimuthal variation and maximum radial excursion in the solar annulus.

TIME: 1:45 pm – 2:00 pm
TITLE: Leveraging Spectroscopy for Dark Energy Surveys
Speaker(s): Justin Myles, Stanford University

Abstract: Large photometric galaxy surveys enable a broad range of science applications in astrophysics and cosmology, but suffer from challenges arising from the difficulty in constraining galaxy redshift. I will discuss two projects that leverage spectroscopic observations for a small subset of galaxies observed in the Dark Energy Survey (DES) to improve the utility of photometric datasets for cosmological experiments. First, I will describe the new methodology used for the DES Year 3 weak lensing source galaxy redshift calibration and the resulting DES Y3 cosmology constraints. Second, I will show results using archival spectroscopy of redMaPPer galaxy clusters to measure the impact of projection effects on these clusters and comment on how this measurement relates to the DES Year 1 cluster cosmology results.

TIME: 2:00 pm – 2:15 pm
TITLE: PetroFit: A Python Package for Computing Petrosian
Speaker(s): Robel Geda, Princeton University

Abstract: PetroFit is an open-source Python package, based on Astropy and Photutils, that can calculate Petrosian profiles and fit galaxy images. It offers end-to-end tools for making accurate photometric measurements, estimating morphological properties, and fitting 2D models to galaxy images. Petrosian metric radii can be used for model parameter estimation and aperture photometry to provide accurate total fluxes. Correction tools are provided for improving Petrosian radii estimates affected by galaxy morphology. PetroFit also provides tools for sampling Astropy-based models (including custom profiles and multi-component models) onto image grids and enables PSF convolution to account for effects of seeing. These capabilities provide a robust means of modeling and fitting galaxy light profiles. We have made the PetroFit package publicly available on GitHub (PetroFit/petrofit) and PyPi (pip install petrofit).

TIME: 2:15 pm – 2:30 pm
TITLE: Solar Metallicity in the M82 Central Starburst from Far-Infrared Spectroscopy  
Speaker(s): Imani Dindy, McNair Scholars Program Oklahoma State University

Abstract: The starburst galaxy M82 is the prototypical example of a galaxy driving a massive supernova-driven outflow from its nuclear regions, and its proximity to the Milky Way makes it a popular target for multiwavelength observations. However, because the nuclear starburst is heavily dust-obscured, observations at optical wavelengths cannot penetrate all the way to the outflow launching region. Utilizing observations of far-infrared fine-structures lines of [OIII] and [NIII] from SOFIA/FIFI-LS and Herschel/PACS, we measured the metallicity of the M82 starburst using the results of previous modeling work. We find roughly solar metallicity for the ionized gas, ~3x higher than some previous X-ray estimates. We expect our method to be robust against the very high dust obscuration in the starburst, setting the stage for future work to determine the metal enrichment of the galactic outflow.

Saturday, November 6

Breakout Room: Hn. Katherine Johnson  
Session Time: 1:00 pm – 2:30 pm  
Cosmology, Gravitation, and Relativity (CGR) – 3.A

Session Chair(s): Hume Feldman, University of Kansas

TIME: 1:00 pm – 1:20 pm  
TITLE: Independent constraints on cosmological and astrophysical parameters using UV luminosity functions at Z~6  
Speaker(s): Aaron Kebede, Lehigh University

Abstract: Luminosity functions are generally recognized to be well defined mechanisms to describe the abundance of matter in a given set. For galaxies, they describe the abundance in, say, a given cluster. In this talk, we show and describe our attempt to derive independent constraints for cosmological and astrophysical parameters from the luminosity of galaxies in the CAMELS simulation at Z~6 using machine learning algorithms and statistical methods.

TIME: 1:20 pm – 1:40 pm  
TITLE: Adaptive Time-Stepping for Binary System Evolution  
Speaker(s): Thummim Mekuria, Pomona College

Abstract: In this project, adaptive time-stepping algorithm (“Stair Leapfrog”) was developed to numerically solve the equations of motion for a binary star system. Solving these equations of motion plays an important role in simulating the gravitational waveforms emitted by the binary as it approaches coalescence. These waveforms are produced for the purposes of serving as the theoretical templates against which signals from space-based gravitational wave detectors, such as LISA, can be compared.

TIME: 1:40 pm – 2:00 pm  
TITLE: Galaxy Cluster Statistics in Modified Gravity  
Speaker(s): Marcell Howard, University of Pittsburgh

Abstract: General relativity (GR) is our most beautiful and accurate description of gravity to date, but empirical data hints that GR may be limited in scope/predictability as evidenced by the existence of the dark sector as well as the late time acceleration of the universe. To address some of these perceived deficiencies, theories that modify Einstein’s equations usually called modified theories of gravity have been introduced. In order to test these theories on large scale structures such as galaxy clusters, it’ll be necessary to use various statistics that will act as our
cosmological observables. We shall show that the mean pairwise velocity is a good statistic that we can use to discriminate between different modified gravity models, particularly when compared to more orthodox measures such as the halo mass function and the power spectrum.

**TIME:** 2:00 pm – 2:30 pm  
**TITLE:** Combinatorial Gravity  
**Speaker(s):** Kassahun Betre, San Jose State University

Abstract: TBA

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**Saturday, November 6**

**Breakout Room:** Dr. Edward Bouchet  
**Session Time:** 1:00 pm – 2:30 pm  
**Condensed Matter and Material Physics (CMMP) – 3.A**  
**Session Chair(s):** William Ratcliff, National Institute of Standards and Technology

**TIME:** 1:00 pm – 1:30 pm  
**TITLE:** The State of CMMP expt.  
**Speaker(s):** Divine Kumah

Abstract: TBA

**TIME:** 1:30 pm – 2:00 pm  
**TITLE:** Designing high-performance superconductors with nanoparticle inclusions: comparisons to strong pinning theory  
**Speaker(s):** Serena Eley, Colorado School of Mines

Abstract: The current carrying capacity $J_c$ of type-II superconductors is severely limited by dissipation from the motion of vortices, magnetic flux lines that appear inside these materials upon exposure to sufficiently high magnetic fields. Incorporating nanoparticle inclusions into superconducting films is a well-established route for boosting $J_c$ because defects can trap vortices. However, these inclusions reduce the overall superconducting volume and can strain the interlaying superconducting matrix, which can detrimentally reduce the critical temperature $T_c$. Consequently, an optimal balance must be achieved between the nanoparticle density $n_p$ and size $d$. Determining this balance requires garnering a better understanding of vortex-nanoparticle interactions, described by strong pinning theory. Here, we map the dependence of the critical current on nanoparticle size and density in $(Y0.77Gd0.23)Ba2Cu3O7−δ$ films in magnetic fields up to 35 T, and compare the trends to recent results from time-dependent Ginzburg-Landau simulations. We identify consistencies between the field-dependent critical current $J_c(B)$ and expectations from strong pinning theory. Specifically, we find that that $J_c(B) \propto B^{−\alpha}$, where $\alpha$ decreases from 0.66 to 0.2 with increasing density of nanoparticles and increases roughly linearly with nanoparticle size $d \xi / (normalized to the coherence length). At high fields, the critical current decays faster ($\sim B^{−1}$) suggestively that each nanoparticle has captured a vortex. Lastly, we reveal that the dependence of the rate of thermally activated vortex motion (creep rate, $S$) on nanoparticle size and density roughly mirrors that of $\alpha$, and compare our results to low $T$ nonlinearities in $S(T)$ that are predicted by strong pinning theory.
**TIME: 2:00 pm – 2:15 pm**
**TITLE:** Transport Properties of MnSb2Te4 Ferromagnetic Lay
**Speaker(s):** Candice Forrester, *The Graduate Center (CUNY)*

**Abstract:** Magnetically doped topological insulators like MnSb2Te4 have gained renewed attention due to the prediction of quantum anomalous hall effect (QAHE). The addition of Manganese opens a gap in the Dirac cone which allows the observation of QAHE. However, due to typical high bulk conductivities, it is difficult to study this phenomenon. In this work, we investigate the transport properties for a set of Mn-doped Sb2Te3 samples grown by molecular beam epitaxy. We observe a strong relationship between the bulk background doping and the percent of septuple layers, which in turn depend on the incorporation of Manganese in the crystal. Modified growth conditions, such as an annealing step and higher growth temperatures, reduced bulk doping and increased mobilities.

**TIME: 2:15 pm – 2:30 pm**
**TITLE:** High-Throughput Calculations of Two-Dimensional Ma
**Speaker(s):** Joshua Quinton, *Rensselaer Polytechnic Institute*

**Abstract:** Two-dimensional manganese bismuth telluride (MnBi2Te4) is a material with intriguing magnetic and topological properties. High-throughput first-principles calculations are used to systematically examine a large body of related hypothetical materials generated by combinatorial substitution of atomic sites within the crystal structure of manganese bismuth telluride. Using density functional theory (DFT), properties of these materials may be calculated, such as formation energy, magnetic moment and magnetic order. These data may guide experimental efforts by identifying possible novel materials with desirable properties. Data analytics techniques, including machine learning, may also prove successful in identifying meaningful trends across this collection of data.
TITLE: ASTRO Culture and Climate Discussion Session  
Speaker(s): TBA

Abstract: TBA

Saturday, November 6

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

TIME: 3:30 pm – 3:45 pm  
TITLE: Applying Machine Learning in Materials Discovery  
Speaker(s): Naman Parikh, North Penn High School

Abstract: Two-dimensional (2D) materials are promising materials for various applications in electronics and engineering due to their unique properties, so various computational methods have been developed in recent years for the discovery of 2D materials. A significant step in materials discovery is the calculation of new materials’ properties such as magnetic properties, conductivity, stability, etc. However, calculating such properties from first principles can be time-consuming and computationally expensive. Using a data set of 2D materials with the same crystal structure, we develop machine learning algorithms to predict the thermodynamic properties of candidate materials with the same crystal structure but varying chemical composition. We train the algorithms using readily available chemical descriptors such as mean atomic radius and number of valence electrons, and perform simple hyper parameter tuning. The resulting model is able to map the descriptors to the property of interest, providing a method for predicting new materials’ properties that is significantly quicker and more efficient computationally than first principles calculations. We also look at the importance of each descriptor to gain physical insight into the materials and their properties.

TIME: 3:45 pm – 4:00 pm  
TITLE:  
Speaker(s): Akin Morrison, University of Virginia

Abstract: Topological order refers to phases of matter originating from long-range quantum entanglement whose characterization goes beyond the Landau symmetry breaking paradigm. There have been many studies on topologically ordered phases in two spatial dimensions, such as fractional quantum Hall states, however there has been a growing interest in developing a theoretical understanding of 3d topological order. The objective of our project is to study a class of Hamiltonian models for a 3d topological ordered phase where its ground state degeneracy is described by membrane-networks, each of which consists of membranes of 2d topological orders joined together by strong backscattering interactions that gap the chiral edge modes along the interfaces from the minimum energy. Renormalization group flow arguments suggest the existence of anomalous membrane-network models that cannot be defined globally, and the obstruction of a model to be consistent is naturally described by a higher algebraic structure, the fusion 2-category.

TIME: 4:00 pm – 4:15 pm  
TITLE: ASE - PySCF Interface for Electronic Structure Calculations  
Speaker(s): LaToya Anderson, Brooklyn College
Abstract: A growing number of material scientists use open-source software to study the electronic structure to improve upon materials such as semiconductors, solar panels, and batteries. Quantum Espresso, a highly cited software package, is used to perform electronic structure calculations yet is challenging to compile due to its software requirements. By building an interface or connection between the Python-based Simulations Chemistry Framework, or PySCF, and the Atomic Simulations Environment, or ASE, it will remove many of the computational challenges while providing a suite of software tools needed to perform materials science research.

TIME: 4:15 pm – 4:30 pm
TITLE: A Grand Unification of Quantum Algorithms
Speaker(s): John Martyn, Massachusetts Institute of Technology

Abstract: Quantum algorithms offer significant speedups over their classical counterparts for a variety of problems. The strongest arguments for this advantage are borne by algorithms for quantum search, quantum phase estimation, and Hamiltonian simulation, which appear as subroutines for large families of composite quantum algorithms. A number of these quantum algorithms were recently tied together by a novel technique known as the quantum singular value transformation (QSVT), which enables one to perform a polynomial transformation of the singular values of a linear operator embedded in a unitary matrix. In the seminal GSLW’19 paper on QSVT [Gilyen, Su, Low, and Wiebe, ACM STOC 2019], many algorithms are encompassed, including amplitude amplification, methods for the quantum linear systems problem, and quantum simulation. Here, we provide a pedagogical tutorial through these developments, first illustrating how quantum signal processing may be generalized to the quantum eigenvalue transform, from which QSVT naturally emerges. Paralleling GSLW’19, we then employ QSVT to construct intuitive quantum algorithms for search, phase estimation, and Hamiltonian simulation, and also showcase algorithms for the eigenvalue threshold problem and matrix inversion. This overview illustrates how QSVT is a single framework comprising the three major quantum algorithms, suggesting a grand unification of quantum algorithms.

TIME: 4:30 pm – 4:45 pm
TITLE: Real-Time Wall Conditioning of a Superconducting Tokamak Using Boron Powder Injection
Speaker(s): Grant Bodner, Princeton Plasma Physics Laboratory

Abstract: The vacuum vessel walls of fusion experiments can act as an unpredictable fueling and impurity source which can serve to degrade plasma confinement and performance. To remedy this, wall conditioning techniques, such as Glow Discharge Boronization (GDB), are prominently deployed in both tokamaks and stellerators around the world. GDB uses a low-temperature non-magnetized plasma to deposit thin films (50-100 nm) of boron onto the plasma-facing components and typically results in the suppression of low-Z impurity sputtering and wall fueling. Unfortunately, GDB is not conducive to superconducting fusion devices as the superconducting magnetic field coils need to be operated without interruption for long durations. Therefore, alternative wall conditioning methods that can be run in the presence of a strong magnetic field are needed. To address this, PPPL has developed an impurity powder dropper (IPD) capable of dropping low-Z powders into high-temperature plasmas for real-time wall conditioning and impurity transport studies. This talk will summarize the results from the initial IPD experiments on WEST (W Environment in Steady-State Tokamak), where B powder (< 150 μm) was injected at various drop rates into WEST discharges.

TIME: 4:45 pm – 5:00 pm
TITLE: Correlations between NBI blips and ELM triggers in Tokamaks
Speaker(s): Samantha O’Sullivan, Harvard University

Abstract: In tokamaks, the power injected with neutral beam injection (NBI) is often modulated at steady frequencies, providing ‘blips’ of power fueling the plasma core. Recent observations on DIII-D suggest these NBI power blips could play a role in triggering explosive instabilities called edge-localized modes (ELMs), which are...
responsible for intense transient heat fluxes on the machine walls and help to flush particles out of the core region. Here we examine a range of DIII-D discharges to identify correlations between NBI blips and ELMs under various plasma conditions. Statistical techniques identify the plasma regimes showing the strongest correlation between these two transients, demonstrating the sensitivity of NBI-ELM triggering on plasma density, rotation, power and shape. In cases with strong NBI and ELM frequency and time correlations, we examine the experimental pedestal profiles as a function of NBI and ELM phase to shed light on the triggering method itself. We can use this information to learn about the physics of ELM triggering, potentially leading to further optimization of ELMing H-mode plasmas.

Saturday, November 6

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

TIME: 3:30 pm – 3:55 pm
TITLE: Exotic field searches with atomic magnetometers
Speaker(s): Ibrahim Sulai, Bucknell University

Abstract: Many of the outstanding questions of physics today indicate that the Standard Model of particle physics is incomplete. For example, axions and axion-like particles (ALPs) are promising dark matter candidates and they appear in many extensions of the Standard Model. Importantly, it has been shown that gradients of the scalar ALP fields can couple with spins in a manner similar to the Zeeman interaction. We report on experiments using a network of spatially separated, shielded, atomic magnetometers to detect or constrain exotic -- that is beyond the Standard Model -- spin interactions.

TIME: 3:55 pm – 4:15 pm
TITLE: Quantum Science and Tech with Ultracold Strontium
Speaker(s): Julio Barreiro, University of California San Diego

Abstract: Systems of ultracold particles with strong interactions and correlations lie at the heart of many areas of the physical sciences, from atomic, molecular, optical, and condensed-matter physics to quantum chemistry. In condensed matter, strong interactions determine the formation of topological phases giving materials unexpected physical properties that could revolutionize technology through robustness to noise and disorder. In this talk I will report on our work towards the realization of a fractional Chern insulator state using our experimental apparatus producing degenerate Fermi gases of strontium. On the other hand, systems of ultracold particles without interactions reveal matter-wave properties with enhanced interferometric sensitivity. I will discuss our ongoing efforts to trap ultracold strontium atoms on the evanescent fields of nanophotonic waveguides and nanotapered optical fibers. Fundamental studies of Casimir and Casimir-Polder physics as well as several applications, such as field sensors and matter-wave interferometers, will be possible with these platforms

TIME: 4:15 pm – 4:40 pm
TITLE: Probe of Band Structure Singularities with a Lattice-Trapped Quantum Gas
Speaker(s): Charles Brown, University of California Berkeley

Abstract: One type of ultracold-atom quantum simulator is formed by using lasers to generate a spatially periodic optical potential and allowing ultracold atoms to evolve within the potential. Such a simulator is a powerful experimental tool that provides insight into the properties of crystalline solids. Important crystalline solid properties,
such as electrical resistivity and optical absorption, are set by the crystal’s energy band structure. However, it is not only the band structure that determines the properties of a crystal. The band structure may have points where two or more bands are degenerate in energy, and where the wave function used to describe the system becomes ill-defined (i.e., singular). This means that the local geometry and global topology of the space in which the wave functions live are important for explaining material properties (e.g., quantum Hall effects and orbital magnetism).

**TIME: 4:40 pm – 4:50 pm**  
**TITLE:** Precision Measurements with Optically-levitating Nanospheres  
**Speaker(s):** Nia Burrell, *Northwestern University*

**Abstract:** Measuring short-range forces such as deviations to Newtonian gravity or Casimir forces requires precision sensitivity. Optically-levitating nanospheres in vacuum have experimentally been shown to present excellent sensitivity at the zeptonewton scale. Our experiment makes use of an optically levitating 300 nm silica sphere in vacuum. We plan to use this system to search for a Yukawa-type correction to Newtonian gravity. Furthermore, successful execution of our experiment can allow us to investigate other short-range surface-force phenomena as well.

**TIME: 4:50 pm – 5:00 pm**  
**TITLE:** Geometric squeezing of a degenerate fermi gas  
**Speaker(s):** Cedric Wilson, *Massachusetts Institute of Technology*

**Abstract:** We report on the realization of a geometrically squeezed state of a rapidly rotating atomic Fermi gas and the measurement of its Hall response. Geometric squeezing relies on the non-commutativity of orbit center coordinates in a rotating frame - analogous to magnetron motion of ions in a magnetic field. A rotating, elliptical harmonic trap realizes the squeezing Hamiltonian for guiding center motion. The Fermi gas thus shrinks down in one direction to a size limited, via Pauli exclusion, to the width of the highest occupied cyclotron mode. In the orthogonal direction it expands exponentially, at a local speed given by the local Hall drift velocity, analogous to the E x B drift of charged particles in crossed electric and magnetic fields. Our work paves the way towards studying quantum Hall physics with atomic Fermi gases.

**Saturday, November 7**

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

**TIME: 3:30 pm – 4:00 pm**  
**TITLE:** From Engineering to physics and back: a mixture of two worlds  
**Speaker(s):** Grace Townley,  

**Abstract:** Physics Inspiring the Next Generation (PING) is a pre-college program which builds self-efficacy while giving youth unique research opportunities. I was part of the PING2020 cohort during my senior year of high school. Working with the Modular Neutron Array (MoNA) Collaboration at Michigan State University, nine high school students including myself were able to observe and perform some preliminary data analysis of an invariant mass spectrometry experiment on the Be-13 isotope. We calibrated the time-to-digital converters to measure the neutron time-of-flight and presented our findings at the APS/DNP 2020. The experience not only taught us valuable computer programming skills and nuclear knowledge, but it also instilled in us confidence in our own abilities.
During the remainder of the academic year, I was able to model human cells and perform beamline projections using the G4beamline software to observe fragmentation. This Fall 2021, I will take the lessons PING taught me in order to pursue an engineering degree at the University of Michigan. PING encouraged self-efficacy in me as it has and continues to do so in others. This presentation will provide an overview of my experience and personal views about the program.

**TIME:** 4:00 pm – 4:10 pm  
**TITLE:** Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter - Pre-College students perspective  
**Speaker(s):** Carly Doran

**Abstract:** The “Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter” is held annually at the Facility for Rare Isotope Beams/National Superconducting Cyclotron Laboratory in East Lansing, MI. It includes a two-week summer program and year-round research opportunities for high school students as well as a year round research component for undergraduate students on basic and applied nuclear physics topics. The PING2021 Pre-College Students Perspectives includes oral presentations from 6 high school students from Florida, Michigan, Virginia, and New York who participated in the Summer program. The students will present results from their research and discuss their experiences in the program.

**TIME:** 4:10 pm – 4:20 pm  
**TITLE:** Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter - Pre-College students perspective  
**Speaker(s):** Jinyoung Jeong

**Abstract:** The “Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter” is held annually at the Facility for Rare Isotope Beams/National Superconducting Cyclotron Laboratory in East Lansing, MI. It includes a two-week summer program and year-round research opportunities for high school students as well as a year round research component for undergraduate students on basic and applied nuclear physics topics. The PING2021 Pre-College Students Perspectives includes oral presentations from 6 high school students from Florida, Michigan, Virginia, and New York who participated in the Summer program. The students will present results from their research and discuss their experiences in the program.

**TIME:** 4:20 pm – 4:30 pm  
**TITLE:** Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter - Pre-College students perspective  
**Speaker(s):** Claudia Miklavcic

**Abstract:** The “Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter” is held annually at the Facility for Rare Isotope Beams/National Superconducting Cyclotron Laboratory in East Lansing, MI. It includes a two-week summer program and year-round research opportunities for high school students as well as a year round research component for undergraduate students on basic and applied nuclear physics topics. The PING2021 Pre-College Students Perspectives includes oral presentations from 6 high school students from Florida, Michigan, Virginia, and New York who participated in the Summer program. The students will present results from their research and discuss their experiences in the program.

**TIME:** 4:30 pm – 4:40 pm  
**TITLE:** Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter - Pre-College students perspective  
**Speaker(s):** Sophie Miller
Abstract: The “Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter” is held annually at the Facility for Rare Isotope Beams/National Superconducting Cyclotron Laboratory in East Lansing, MI. It includes a two-week summer program and year-round research opportunities for high school students as well as a year round research component for undergraduate students on basic and applied nuclear physics topics. The PING2021 Pre-College Students Perspectives includes oral presentations from 6 high school students from Florida, Michigan, Virginia, and New York who participated in the Summer program. The students will present results from their research and discuss their experiences in the program.

TIME: 4:40 pm – 4:50 pm
TITLE: Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter - Pre-College students perspective
Speaker(s): Victoria Kishoiyian

Abstract: The “Physicists Inspiring the Next Generation (PING): Exploring the Nuclear Matter” is held annually at the Facility for Rare Isotope Beams/National Superconducting Cyclotron Laboratory in East Lansing, MI. It includes a two-week summer program and year-round research opportunities for high school students as well as a year round research component for undergraduate students on basic and applied nuclear physics topics. The PING2021 Pre-College Students Perspectives includes oral presentations from 6 high school students from Florida, Michigan, Virginia, and New York who participated in the Summer program. The students will present results from their research and discuss their experiences in the program.

TIME: 4:50 pm – 5:00 pm
TITLE: Q&A
Speaker(s): Paul Gueye, Michigan State University

Saturday, November 6

Breakout Room: Dr. Shirley Jackson
Session Time: 3:30 pm – 5:00 pm
Physics Research Education (PER) – 3.A
Session Chair(s): Juan Burciaga, Colorado College

TIME: 3:30 pm – 4:00 pm
TITLE: Trends in Physics Higher Education and Careers
Speaker(s): Brad Conrad, Society of Physics Students

Abstract: Physics and astronomy have a long history of advancing the broader Physical Sciences. As departments aim to build thriving programs, being aware of the changing landscape of higher education and current trends within graduate and undergraduate programs is vital to best serve students while preparing them for a broad array of career outcomes. Recent trends in higher education, reports on physics and astronomy students, department climate data, and society initiatives will be discussed. This talk aims to connect a program’s educational outcomes, student objectives, and department culture while providing pragmatic resources for student leaders and faculty alike.

TIME: 4:00 pm – 4:15 pm
TITLE: Creating an Interactive Simulation of Rotating Ref
Speaker(s): Ted Mburu, *Ithaca College* and Antara Sen, *Ithaca College*

**Abstract:** Non-inertial reference frames and the forces involved (Coriolis and centrifugal forces) are challenging concepts for any introductory or advanced mechanics student. Fictitious forces can often seem too abstract to imagine, and this discomfort is only exacerbated by the ever-changing Coriolis force. Thus, we have tried to combat this issue by creating a simulation of how moving objects behave in a rotating reference frame. Since the apparatus is tedious to construct, our hope is that students can engage with our simulation to get a better sense of how various parameters affect the motion of objects. Created using JavaScript, this simulation is easily accessible via browsers on computer and mobile devices.

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**Saturday, November 6**

**Breakout Room: Hn. Katherine Johnson**  
**Session Time:** 3:30 pm – 5:00 pm  
**LGBTQ+**  
**Session Chair(s): TBA**

**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.

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**Saturday, November 6**

**Workshop**

**Breakout Room: Dr. Jim Gates**  
**Session Time:** 5:30 pm – 6:30 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.

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**Saturday, November 6**

**Workshop**

**Breakout Room: Dr. Jim Gates**  
**Session Time:** 6:00 pm – 7:30 pm
Physics Education Research – 3.b
Session Chair(s): Chandralekha Singh, University of Pittsburgh

**TIME:** 6:00 pm – 6:45 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.

**TIME:** 6:45 pm – 7:30 pm
**TITLE:** Inclusive Mentoring: Using Social Psychological Approaches to Improve Mentoring and Learning for All Students
**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.

**Saturday, November 6**

**Workshop**

**Breakout Room:** Dr. Elmer Imes
**Session Time:** 5:30 pm – 7:30 pm
**Careers Beyond Academia & Entrepreneurial Programs**
**Session Chair(s):** Stephen Roberson, NSBP Administrative Executive Officer & Parsons Corporation

**Description:** This will be a panel discussion.
Abstract: A recent study of physics Ph.D graduates shows that most of the positions they are hired for are outside of academia. This session will include a panel discussion with physics professionals outside of academia that show career possibilities that are an alternative career path to an academic one.

Saturday, November 6

Breakout Room: Hn. Katherine Johnson
Session Time: 5:30 pm – 6:30 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.

Saturday, November 6

Workshop

Breakout Room: Dr. Edward Bouchet
Session Time: 5:30 pm – 7:30 pm
NASA Missions
Session Chair(s): Peter Kurczynski, NASA Goddard

Description: Presentations on current NASA Missions.

TIME: 5:30 pm – 5:50 pm
TITLE: NASA Astrophysics
Speaker(s): Ron Gamble, University of Maryland & NASA Goddard Space Flight Center

TIME: 5:50 pm – 6:10 pm
TITLE: Physics of the Cosmos
Speaker(s): Ryan Hickox, Dartmouth University
TIME: 6:10 pm – 6:30 pm  
TITLE: Cosmic Origins  
Speaker(s): Janice Lee, Gemini Observatory, NSF Noirlab

TIME: 6:30 pm – 6:50 pm  
TITLE: Exoplanet Exploration  
Speaker(s): Anjali Tripathi, NASA Jet Propulsion Laboratory

Saturday, November 6

Special Session

Breakout Room: Hn. Katherine Johnson  
Session Time: 6:30 pm – 7:30 pm  
TITLE: Beyond Seeking Vision: An NSBP Celebration of Dr. Aziza Bacchouche  
Session Chair(s): Paul Gueye, Michigan State University

Order of Speakers

TIME: 6:30 pm – 6:40 pm  
Speaker(s): Paul Gueye, Michigan State University

TIME: 6:40 pm – 6:50 pm  
Speaker(s): Stephon Alexander, Brown University

TIME: 6:50 pm – 7:10 pm  
Speaker(s): Leila Baccouche,

TIME: 7:10 pm – 7:15 pm  
Speaker(s): Jose Goity, Hampton University

TIME: 7:15 pm – 7:20 pm  
Speaker(s): Steven Avery, University of Pennsylvania

TIME: 7:20 pm – 7:25 pm  
Speaker(s): Mark Harvey, Texas Southern University

TIME: 7:25 pm – 7:30 pm  
Speaker(s): Paul Gueye, Michigan State University

Saturday, November 6

Location: Auditorium  
Session Time: 7:30 pm – 9:30 pm  
TITLE: HBCU/MSU Physics Department Chairs (By Invitation Only)
Speaker(s): Paul Gueye, DOE Awardees, Claudia Ratti, Thomas Redpath, Rodrigo N. Perez, Kolo Wamba, Mickey Chiu, Nadia Fomin, Wim Cosyn, Allena Opper, Sharon Stephenson

Please contact Dr. Gueye via email to for Zoom registration/invite link.

Sunday, November 8

Session Time: 2:00 pm – 4:30 pm
Auditorium – Closing Luncheon / Poster & Presentation Awards
Speaker: Dr. Talitha Washington, Data Science, AUCC

BIO: Dr. Talitha Washington is the Director of the Atlanta University Center Data Science Initiative and a Professor of Mathematics at Clark Atlanta University. As Director, she oversees and provides strategic direction of data science across Clark Atlanta University, Morehouse College, Morehouse School of Medicine, and Spelman College to increase the number of African Americans with expertise in data science. Washington is a former Program Director at the National Science Foundation (NSF) and a Fellow of the American Mathematical Society and the Association for Women in Mathematics

Sunday, November 8

Workshop

Breakout Room: Dr. Shirley Jackson
Session Time: 1:00 pm – 2:00 pm
Increasing Diversity in National Laboratories
Session Chair(s): Paul Gueye, Michigan State University

ABSTRACT: The Department of Energy Office of Nuclear Physics is spearheading a targeted effort to increase and diversify the nuclear workforce. A Funding Opportunity Announcement was released in the Fall 2020 (DE-FOA-0002456, “Research traineeships to broaden and diversify nuclear physics”) from which several institutions received funding to support around an extremely large number of undergraduate students from under-represented groups, especially from minority serving institutions with some starting in the Summer 2021 (first cohort) and others in the Fall 2021(2nd cohort) and spring 2022 (cohort 3). This session is dedicated to the students from the first and second cohort who will provide a brief overview of their experiences and serve as panel members for the community. + 30 MIN Q&A
Undergraduate Posters
(Check Conference Schedule for Poster Presentation Times)

ASTRONOMY AND ASTROPHYSICS (ASTRO)

POSTER BOARD 1 – ASTRO
TITLE: Searching for the ISW-tSZ cross correlation
AUTHOR: Keduse Worku, Yale University

ABSTRACT: Probes of the Cosmic Microwave Background (CMB) have provided great insight into the early universe and more recent cosmological events. Two important late time contributions are the Integrated SachsWolfe (ISW) and the thermal Sunyaev–Zel’dovich (tSZ) effects, both occuring in the same gravitational potential wells. By determining the ISW-tSZ cross correlation, we can gain insight into this probe of dark energy. We present a primilary set of cross spectra with data from the Planck satelite. Our results suggest strong Galactic foreground contamination. Future foreground mitigation techniques include the use of galaxy cluster calatogues to mask low redshift clusters and the use of Planck maps which more accurately model foreground sources.

POSTER BOARD 2 – ASTRO
TITLE: Noise Characterisation for Telescope Optics
AUTHOR: Refilwe Bua, Pomona College

ABSTRACT: The Simons Observatory is constructing a telescope designed to measure the polarization of Cosmic Microwave background radiation, which will hopefully provide evidence of cosmic inflation and subvert the current problems we have with the standard model of the universe. We are in the process of validating it in a lab at UCSD and my focus was on finding imperfections in the telescope that generate unwanted signals. By creating a curve-fitting function, we could pick out unwanted signals if they weren’t in a specific range and create a peak finding algorithm that looked for these signals at specific frequencies. From there, we used previously collected data to compare the peaks we had to what we would expect from different sources of noise, including magnetic, thermal and radio frequencies. From there, we would collect more data using a magnetometer, orienting it at different positions around different components of the telescope, such as the cryocooler and the detectors and resonators, to match the peaks we would find from the magnetic field lines to the different properties our peaks had to confirm that some of the lines were magnetic from the cryocooler motor while the rest were caused by flux-ramp lines. The study is still ongoing, as we plan to get more accurate dimensions of the peaks, so we can incorporate them in simulations that model the data the telescope plans to collect to determine to what extend they will affect our data analysis.

POSTER BOARD 3 – ASTRO
**TITLE:** Investigating NH3 Masers in W51  
**AUTHOR:** Derod Deal, *University of Florida*

**ABSTRACT:** W51, one of the brightest and most active star-forming regions in the galaxy, contains numerous ammonia masers that can potentially reveal the physics of high-mass stellar accretion. Astrophysicists theorize that the emission probes processes like outflows and accretion disks, which are important for star formation. In this presentation, I will present my ongoing research in high radio frequencies of W51 to interpret the velocities, spatial locations, and brightnesses of NH3 masers and investigate where the emission occurs in star-forming regions. Comparing the observed datasets to published findings of the emission in W51 will showcase stellar formation kinematics over time.

**POSTER BOARD 4 – ASTRO**  
**TITLE:** Building galaxies from the bottom up: how uniquely  
**AUTHOR:** Sina Babaei Zadeh, *Western University*

**ABSTRACT:** An important question in astrophysics is how to predict the future state of galaxies, and to determine if two evolving galaxies will share the same properties given their assembly history. In an attempt to answer this, we look at the EAGLE simulation (Evolving and Assembly of GaLaxies and their Environments) which contains data on about one million galaxies, and their defining properties. Our research utilizes the assembly history in order to answer this question. By analyzing and grouping similar assembly histories, we look to analyze the properties of the galaxies in a particular group to see if their likeness in assembly history can predict their likeness in other properties. Using this bottom-up approach, we hope to be able to predict the properties of galaxies like our own Milky Way in a few billion years in the future. This analysis complements the work done in the reverse direction, which attempts to predict the assembly history given the present-day properties of a particular galaxy.

**POSTER BOARD 5 – ASTRO**  
**TITLE:** A Clear View of the Primordial Universe  
**AUTHOR:** TonyLouis Verberi, *University of Toronto*

**ABSTRACT:** The Cosmic Microwave Background (CMB) is the afterglow of the big bang which forms the bedrock of precision cosmology shedding light on the origin, contents and evolution of the universe. A major challenge faced in the study of the CMB is that this radiation is contaminated by microwave light from processes such as free-free collisions, synchrotron and spinning dust emissions from our Milky Way. This project seeks to implement and compare two techniques of removing sources of foreground contamination to maps which both depend on an internal linear combination algorithm (ILC).
PHYSICS EDUCATION RESEARCH (PER)

POSTER BOARD 1 – PER
TITLE: Exploring Newton’s Second Law and Kinetic Friction
AUTHOR: Mitchell Allen, Morehouse College

ABSTRACT: Decades of improvements in microelectromechanical systems (MEMS) have enabled high performance compact sensors to become routinely integrated into smartphones. When combined with incredible touch screen displays, high-performance microprocessors for data analysis, and high-speed data transfer rates using Wi-Fi and Bluetooth, smartphones provide an unprecedented technical capability for conducting scientific investigations. The remarkable capability of smartphones to sense the world around us combined with the nearly universal availability to high school and college students has the potential to revolutionize inquiry-based learning in physics education. In recent years, there has been a growing awareness of this underutilized potential. This presentation describes a novel approach for determining the coefficient of kinetic friction, which simultaneously incorporates the opportunity for students to explore many of the foundational disciplinary core ideas in mechanics using smartphones.

CONDENSED MATTER AND MATERIAL PHYSICS (CMMP)

POSTER BOARD 1 – CMMP
TITLE: The Mechanical changes within intact biofilms...
AUTHOR: Julianne Tijani, Georgia Institute of Technology

ABSTRACT: The nature of biofilms makes them extremely difficult to eradicate both inside and outside the body. Part of the reason they are so difficult to treat is because they often differentiate into variants with slightly different properties. One of the ways these variants differ is in their production of extracellular polymeric substance (EPS). Previous research has shown there is a difference between the variants of non-intact biofilms, so our goal was to test if different levels of EPS changed the elasticity of the biofilm while it was still intact. To do this we performed a creep test and extracted the young’s modulus from the data. From this we found evidence that suggests differing levels of EPS changes the elasticity of the intact biofilm.

POSTER BOARD 2 – CMMP
TITLE: Magnetic and charge ordering in the triangular lattice extended Hubbard model at 1/3 filing
AUTHOR: Matthew Enjalran, Southern Connecticut State University

ABSTRACT: Strongly interacting frustrated many body systems represent an active field of research in the condensed matter physics community. The combination of competing interactions, lattice structure, and spin, charge, and orbital degrees can produce conditions in which new collective phases of matter emerge at low temperatures. Theoretical and numerical investigations of frustrated many body systems are difficult when one attempts to study the model Hamiltonian exactly. Therefore, the application of mean-field theory to a model Hamiltonian is typically a good starting point to study the low temperature phases of the model. We apply Hartree-Fock mean-field theory to the extended Hubbard model for interacting electrons on the isotropic triangular lattice. We focus on the special case where the average number of electrons per site is \( n = 2/3 \), or a 1/3-filled lattice. When the Coulomb interactions are restricted to electrons that reside on the same lattice site, \( U \), we observe with increasing \( U \) an evolution from a paramagnetic metal to an insulating phase with charge order and partial magnetic...
order. The transition from the metal to the insulator is first order. When nearest-neighbor interactions, $V$, are included, the ground state remains the same but the nature of the metal to insulator transition changes to second order at a weak critical value of $V$. We also discuss possible applications of more sophisticated methods to the study of our model.

**POSTER BOARD 3 – CMMP**
**TITLE:** Modelling Devices for Atom-based Silicon Quantum E
**AUTHOR:** Christopher Sherald, University of Kansas

**ABSTRACT:** The research I performed at the National Institute of Standards and Technology focused on the design and fabrication of atom-based silicon transistors. Key to the design of this electronic structure is the utilization of advanced hydrogen-lithography to place individual dopant atoms in a silicon matrix. The purpose of the devices is to shuttle single electrons across an array of silicon quantum dots. Due to the scale of the devices, tuning the capacitance, and thus potentials, of the quantum dots to facilitate electron transport, affects other nearby structures. By creating sample models using the FreeCAD software, and utilizing a capacitive modeling program, we can optimize gate and capacitive control of the device to better guide the design process.

**POSTER BOARD 4 – CMMP**
**TITLE:** Electromagnetic applications of Mxenes
**AUTHOR:** Deng Kuol, Drexel University

**ABSTRACT:** TBA

**POSTER BOARD 5 – CMMP**
**TITLE:** Overview of the C-2W FRC Fusion Experiment
**AUTHOR:** Eli Parke, TAE Technologies, Inc.

**ABSTRACT:** TAE Technologies, Inc. (TAE) pursues an alternate approach to magnetically-confined fusion, relying on field-reversed configuration (FRC) plasmas. TAE’s current experimental device, C-2W [1], is an advanced beam-driven FRC and has achieved record-breaking FRC performance parameters including steady-state sustainment for over 30 ms and total temperature $T_{tot} > 3$ keV. The superior performance of C-2W is due to several factors. 1) Neutral beams and edgebiasing systems, where higher total plasma energy is obtained by increasing neutral beam injection power (total power up to 20 MW) and applied-voltage on electrodes. 2) A feedback control system implemented to produce consistent FRC performance and reliable machine operation. The system controls magnet currents, electrode voltages/currents, fueling rates, and neutral beam energy (15 - 40 keV). It has also demonstrated stabilization of self-imposed axial instabilities. 3) C-2W divertors have demonstrated excellent electron heat confinement on open field lines via magnetic mirrors and a highly expanded field in the divertors. The energy lost per electron-ion pair is close to the ideal theoretical minimum. 4) A machine-learning framework for experimental optimization, which was developed in collaboration with Google. This presentation will provide an overview of the C-2W experimental program and highlight recent results.

**POSTER BOARD 6 – CMMP**
**TITLE:** Creating a Star on Earth: The state of US fusion
**AUTHOR:** Arturo Dominguez, Princeton Plasma Physics Laboratory
ABSTRACT: Fusion energy research is going through exciting times. A recent boom in private companies racing to be the first to commercialize fusion energy, as well as recent scientific and engineering breakthroughs have led to renewed interest in the field. In this presentation we will review the basic concepts of fusion energy, present some of the recent breakthroughs in fusion science and technology, and discuss the challenges that still lay ahead in making fusion energy in the grid a reality.

POSTER BOARD 7 – CMMP
TITLE: Ion dynamics in the sheath and presheath.
AUTHOR: Adrian Woodley, University of San Diego

ABSTRACT: Does ion flow in the presheath near plasma boundaries give rise to discrepancies between the plasma potential measured by Langmuir Probes and emissive probes?1 ADRIAN WOODLEY, Dept. of Physics & Biophysics, University of San Diego, MICHAEL SHAHIN, Dept. of Physics & Biophysics, University of San Diego, PEIXUAN LI, Dept. of Engineering-Physics, University of Wisconsin-Madison, OLIVER SCHMITZ, Dept. of EngineeringPhysics, University of Wisconsin-Madison, GREG SEVERN, Dept. of Physics & Biophysics, University of San Diego — It has recently been shown that that Langmuir probes (LPs) measure an unphysically positive plasma potential in the presheath of low temperature plasma, near conducting boundaries at which ion rich sheaths form. It has been argued heuristically that the difference between plasma potential profiles measured by LPs and emissive probes (EPs), in the presheath, is related to ion flow caused by sheath formation.

POSTER BOARD 8 – CMMP
TITLE: Shape and size effects of inertial particles in tu
AUTHOR: Theresa B Oehmke, University of Houston

ABSTRACT: Inertial, non-spherical particles in turbulent flows show interesting kinematic properties such as the difference between tumbling and spinning rates depending on size, and overall enstrophy being shape independent. While kinematics have been studied for many different types of particles in turbulent flows, to our knowledge, no dissolving non-spherical particles have been studied in turbulence. In this study, we present results for Taylor-scale rod-like and disc-like neutrally buoyant particles that dissolve in water. The water is stirred to approximate homogeneous isotropic turbulence. The particles we tested were designed to explore the shape-motion-flux relationship through a variety of surface areas, volumes, and aspect ratios. Throughout the parameter space tested, we found that between rods and discs, disc-like particles dissolved faster than rod-like particles. However, within the parameter spaces of rod-shaped particles that were tested, the rods’ dissolution rate decreased as the surface-area-to-volume ratio decreased. This suggests that the surface-area-to-volume ratio could be the governing factor characterizing dissolution rates within particles of the same shape, but not between particles of different shapes.

NUCLEAR AND PARTICLE PHYSICS (NPP)

POSTER BOARD 1 – NPP
TITLE: Temperature dependence study of GaAs band structure
AUTHOR: Ambar Rodriguez Alicea, UPRM

ABSTRACT: As of today, photocathodes based on Gallium Arsenide (GaAs) are the only option available for electron guns to produce the spin polarized electron beams required by the Electron Ion Collider and other electron
accelerators. However, these materials still possess some limitations: as bulk materials the Electrons Spin Polarization (ESP) is theoretically restricted to 50%, and in practice to around 35%. The ESP can be increased above 90% using strained structures. Yet, the Quantum Efficiency (QE), relatively high (10%) for bulk material, is drastically lowered for strained structures to 1% or less. Additionally, photocathodes are extremely vacuum sensitive and prone to be easily damaged, limiting the operational lifetime. Recent results showed that lifetime can be improved by more than one order of magnitude using robust coating, but this result in a loss of QE and ESP. The experimental investigations of new materials and structures that can replace the GaAs technology are extremely demanding. Using detailed numerical modeling of the photoemission processes can help in identifying and restricting the number of suitable candidates. To implement the temperature dependence of photocathodes in a code written for bulk GaAs, we need to know the temperature dependence of different photo-matter parameters. To this end, I’ve learned of the details of the photoemission process and how to interpret the energy band diagrams. With this knowledge I’ve run DFT simulations by modifying the lattice constant to simulate the change of temperature. Various approaches were taken to obtain results that are closer to experimental values.

PHOTONICS AND OPTICS (POP)

POSTER BOARD 1 – POP
TITLE: Reconnection Simulations for the affirmation of synchrotron induced photon distribution change
AUTHOR: Emmanuel Aneke, SLAC National Accelerator Laboratory

ABSTRACT: Pulsars are essentially magnetized spinning neutron stars that emit radiation out of its magnetic poles. They are one of the potential remnants of a supernova. Magnetic reconnection is an astrophysical phenomenon where the colliding magnetic fields accelerate a beam of particles and produce radiation. Inherently, our knowledge on reconnection is limited because all we observe are the pulses of light from them. Using macroparticle with particle in cell codes driven by supercomputers, we simulate the reconnection process. Synchrotron radiation is light emitted by relativistic charged particles experiencing a magnetic field. This is impossible to avoid in reconnection and must be taken into account. The synchrotron radiation emitted by the reconnection particles causes them to lose some of their energy by a method called synchrotron radiation cooling. By performing simulations of reconnection with various synchrotron radiation cooling parameters, different particle distributions can be generated. From then, the particle distributions can be compared to observed photon distribution data from real pulsars. This poster discusses the accuracy of macroparticle simulations of local and global reconnection. In turn, implications of integrating synchrotron radiation cooling into the reconnection simulations and how the observed photon distributions can be found analogous to the simulated values are also discussed.