CUWiP at NYC 2018
Abstract book for student talks and posters
January 14th, 2018

Parallel student talks

9:45 – 11:00 am

Session 1: Particle physics

Location: 424, Pupin Hall, Columbia University

1. An Investigation of the Measurement of Jet Shape Dependence on Jet Mass using Pythia

Esha Rao[1], Sevil Salur[1]
1. Rutgers University-New Brunswick

Multiple jet variables, such as jet shape and jet mass, have been utilized to study jet quenching in relativistic heavy ion collisions at RHIC and LHC. For this study, Monte Carlo simulations at RHIC energies are produced and jet shape and jet mass variables are constructed for anti-kt jets.This study shows that jet shape and jet mass are convoluted variables.

2. Research with the CMS Experiment at the Large Hadron Collider

Rebecca Kowalski[1], Eva Halkiadakis[1], Marc Osherson[1], Alejandro Gomez Espinosa[1]
1. Rutgers University

The overall project is performing an analysis searching for new particles using data taken with the CMS detector at the LHC at CERN with the Rutgers high energy physics team. The first step involves a Monte Carlo simulation study to be compared later on with data taken with CMS. The analysis investigates various variables and parameters, for multiple types of particle background noise, and specific decay signals, to see if their distinctive behaviors would result in a sensitive search for new particles.

3. Diagnostic Evaluation of NuMI Hadron Monitor Ion Chambers

Bernadette Haig[1], Katsuya Yonehara[2]
1. Fordham University, 2. Fermi National Accelerator Laboratory

The performance of the NuMI Hadron Monitor ion chambers was evaluated. Possible sources of ion chamber performance degradation are discussed, based upon analysis of Monitor data. The quality of the signal is reviewed, and it is concluded that the Monitor still functions for its main tasks. Repair is not possible, but replacement of the Hadron Monitor during the 2017 summer shutdown was not deemed necessary. Lastly, a diagnostic apparatus for potential impurity of the helium gas inside the chamber has been designed and installed. A vacuum chamber is connected to the Hadron Monitor exhaust line to collect gas samples. These samples are analyzed by a GCMS (gas chromatograph-mass spectrometer).

4. Studying the Quark Gluon Plasma Through RpA Analysis

Maine Christos[1], Manuel Calderon De La Barca[2]
1. Rutgers University-New Brunswick, 2. University of California, Davis

The CMS experiment at the Large Hadron Collider (LHC) offers the possibility of studying the Quark Gluon Plasma (QGP) by measuring the rates of suppression of mesons made of heavy-flavored quarks. In this analysis, we attempt to study the suppression caused by Cold Nuclear Matter (CNM) effects through an RpA analysis. We compare the rates of suppression of the Upsilon meson in proton-proton (pp) and proton-lead (pPb) collisions and calculate fits that are used to obtain the yields and then correct for efficiency and acceptance in each collision system. From these quantities, we can then quantify the amount of suppression we observe by calculating the nuclear modification factor (RpA).

Session 2: Biophysics

Location: 325, Pupin Hall, Columbia University

1. Place Fields to Grid Fields: A Model of Firing Fields Associated With Spatial Navigation

Hannah Ford[1], Merideth Frey[1], Philip Ording[1], Drew Cressman[1]
1. Sarah Lawrence College

Place cells and grid cells are located in the mammalian hippocampus and entorhinal cortex, respectively, and are responsible for integrating spatial information used to navigate space. More specifically, place cells are associated with information pertaining to an animal's position within an environment and fire in a localized field with one (or a few) firing points, depending on the size of the environment an animal traverses. Grid cells rely on an animal's orientation and fire in a triangular (or hexagonal) array created by multiple firing peaks for each specific cell. These cells are theorized to map to each other to give a more detailed representation of an environment and assist in helping an animal navigate through space. This model relies on the physiological connections these neurons make during a synapse to update synaptic weight of those involved. In theory, the firing field of a place cell is associated with the nodes of the firing field of a grid cell, and this model presents computer-simulated results to explain this mechanism.

2. Decline of long-range temporal correlations during sustained wakefulness in the human brain

Kimberlyn Bailey[1], Christian Meisel[2], Peter Achermann[3], Dietmar Plenz[2]
1. University of the District of Columbia, 2. National Institute of Mental Health, 3. University of Zurich

Sleep is crucial for daytime functioning, cognitive performance and general well-being. These aspects of daily life are known to be impaired after extended wake, yet, the underlying neuronal correlates have been difficult to identify. Accumulating evidence suggests that normal functioning of the brain is characterized by long-range temporal correlations (LRTCs) in cortex, which are supportive for decision- making and working memory tasks. Here we assess LRTCs in resting state human EEG data during a 40- hour sleep deprivation experiment by evaluating the decay in autocorrelation and the scaling exponent of the detrended fluctuation analysis from EEG amplitude fluctuations. We find with both measures that LRTCs decline as sleep deprivation progresses. This decline becomes evident when taking changes in signal power into appropriate consideration. In contrast, the presence of strong signal power increases in some frequency bands over the course of sleep deprivation may falsely indicate LRTC changes that do not reflect the underlying long-range temporal correlation structure. Our results demonstrate the importance of sleep to maintain LRTCs in the human brain. In complex networks, LRTCs naturally emerge in the vicinity of a critical state. The observation of declining LRTCs during wake thus provides additional support for our hypothesis that sleep reorganizes cortical networks towards critical dynamics for optimal functioning.

3. Improving Current Models of Prosthetic Hands Using Three Dimensional Printing

Marissa Vaccarelli[1], Stephen Holler[1], Vassilios Fessatidis[1]
1. Fordham University

Exploring the rapidly expanding field of prostheses, which restore lost mobility, this project uses SolidWorks and 3-D printing to modify the current designs of the e-NABLE Raptor Hand and Flexy Hand to create a more flexible prosthetic hand, providing the user with a greater range of movement that is as human-like as possible. Research the ever-growing field of prosthetics is particularly important because the demand for functional yet comfortable prostheses has skyrocketed, as there are currently 1.9 million amputees in the United States. Birth defects, severe diabetes, bone cancer and traumatic accidents are the leading causes for limb prostheses. Additionally, there is also a high demand for prosthetic devices due to the Veterans Administration: the VA Healthcare system has an estimated 40,000 individuals obtaining care to regain their lost mobility. Aside from clinical use, prostheses also serve the industrial community; implementing such would prevent factory workers from losing limbs while working in hazardous conditions. For this project, individual two part fingers fist were constructed, followed by a palm, fixed wrist and forearm. The preliminary circuitry on breadboards and servo mini motors were stored in the forearm, attached to the individual fingers via string in internal canals. The Arduino code enabled motor rotation, providing independent finger movement and gripping for the user. Future work includes improving three dimensional printed hand as well as the circuitry and Arduino code, in conjunction with implementing muscle sensors, pulse monitors and temperature readers to the prosthetic.

4. Humpback Whale (Megaptera novaeangliae) Song and Non-Song Social Calls in the New York Bight

Julia Zeh[1], Melinda Rekdahl[2], Howard Rosenbaum[2], and the Bioacoustics Research Program at Cornell University
1. Columbia University, 2. Wildlife Conservation Society

The New York Bight is an ecologically and commercially important area, both because it is a large shipping port and a valuable habitat for marine mammals such as humpback whales (Megaptera novaengliae). However, no data regarding humpback whale presence or behavior in the New York area has been reported previously. This study provides an overview of the seasonal patterns in humpback whale vocalizations recorded in 2008 and 2009 in the New York Bight. These acoustic recordings are the result of a study done by Cornell University's Bioacoustics Research Program in conjunction with Department of Environmental Conservation. Of 6305 hours of recordings from a Marine Autonomous Recording Unit (MARU) from offshore Long Island, 538 hours, or 8.53%, contained one or more detections of humpback whale song. Hours with humpback whale song detections were highest in April 2008 and January 2009. Significantly fewer social sounds were recorded (0.25%) and social calls were recorded only in March, April, May and November 2008. This distribution of humpback whale song indicates an apparently year-round presence of the species in the New York Bight. Furthermore, the appearance of peak singing behavior in New York during the winter breeding season indicates a poor understanding of humpback whale migratory behavior and habitat use in New York. Future studies should address the potential for overwintering humpback whales in the area, as has been suggested for other populations in the North Atlantic. Additionally, the seasonality of singing behavior has implications for our understanding of humpback whale song function and its connection with hormonal activity in males. An understanding of the ecology of the New York Bight and humpback whale use of the habitat is important as we look forward to the conservation of these animals with respect to prospective offshore wind and oil energy development and increased observance of unusual mortality events in north Atlantic humpback whales.

Session 3: Applied physics

Location: 313, Pupin Hall, Columbia University

1. Microhexcavity Plasma Panel Detectors

Alexis Mulski[1], Daniel S. Levin[1], Yan Benhamou[2], John W. Chapman[1], Achintya Das (2), Erez Etzion[2], Claudio Ferretti[1], Peter S. Friedman[3], Meny Raviv-Moshe[2], David Reikher[2], Nicholas Ristow[1]

1. University of Michigan - Ann Arbor, 2. Tel Aviv University, 3. Integrated Sensors, LLC

Plasma panel detectors are a variant of micropattern gaseous detectors that are sensitive to ionizing radiation. They are motivated by the design and operation of plasma display panels and are intended for research, commercial, and medical applications. The detectors consist of arrays of electrically and optically isolated pixels defined by metallized cavities embedded in a dielectric substrate. The microhexcavity plasma panel detector is the newest generation of these detectors and consists of a close-packed array of millimeter sized hexagonal pixels. The fabrication, staging, and operation of these detectors is described. Initial tests with the microhexcavity detectors operated in Geiger mode yield Volt-level signals from ionizing radiation. The response of the microhexcavity to low-energy beta sources, efficiency measurements with cosmic ray muons, rate stability, and timing measurements are reported.

2. Properties of large amplitude Alfvén waves in a magnetized, order-unity β laboratory plasma

Christina Migliore[1], Troy Carter[2], Steve Vincena[2], Shreekrishna Tripathi[2], Seth Dorfman[2]

1. Northeastern University, 2. University of California, Los Angeles

Alfvén waves play an important role in magnetized plasmas in the laboratory, e.g. in fusion plasmas, and in space and astrophysical settings, e.g. in the solar wind. The Large Plasma Device (LAPD) at UCLA as been used to study the linear and nonlinear properties of these important waves, however in a low-beta plasma (β ~ 1 x 10^-4). A new LaB6 cathode source has been installed in LAPD, allowing the generation of much higher pressure plasmas; with lowered magnetic field, magnetized plasmas with β ~ 1 can be generated. We will report on measurements of the properties of Alfvén waves in increased β LAPD plasmas, in particular dispersion and damping.

3. GKP Codes and Quantum Error Correction

Gabrielle Roberts[1], Steven Touzard[1], Michel Devoret[1]

1. Yale University

GKP codes for quantum error correction were proposed in a famous paper by Gottesman, Kitaev, and Preskill in 2001. An ideal GKP quantum state consists of a Dirac comb of equally spaced position eigenstates. This comb can be used to encode a quantum bit: the logical zero state and the logical one state are shifted a half period off from each other. In practice, it is impossible to create infinite Dirac-delta states since they are non-normalizable. However, an approximate form involving squeezed states or coherent states is experimentally realizable. In this work, we simulate these states in a cavity quantum electrodynamics context to help try to figure out how to implement quantum gates (ie computer operations) using these codes.

4. Spectroscopic Investigation of Tunneling Mediated Proton Transfer

Nasim Mirzajani[1], Lidor Foguel[1], Zac Vealey[1], Patrick H. Vaccaro[1]

1. Yale University

Hydrogen bonding and the related process of proton transfer have proven to be a ubiquitous phenomenon in chemistry and biology. A subset of these interactions is Low Barrier Hydrogen Bonding (LBHB) characterized by incredible strength and short distance between donor and acceptor atoms. Intramolecular proton transfer in 6-hydroxy-2-formylfulvene (HFF) serves as a simple model to investigate LBHB. The geometrical equivalence of the proton donor and acceptor sites in HFF provides a symmetric double minimum potential surface on which quantum mechanical tunneling of the proton induces bifurcation of all rovibronic features. The magnitude of this splitting is directly proportional to the rate of proton-transfer and reflects the motion of the proton and the displacement of other heavy atoms in the molecular framework. Laser-induced fluorescence and dispersed-fluorescence are two of the experimental techniques we use to probe the ground and excited electronic states in combination with quantum-chemical calculations. We have found HFF to have the largest vibrationless ground-state tunneling splitting ever reported which corresponds to an ultrafast proton transfer time of 100 fs. Weakly bound HFF complexes with water and benzene derivatives are made in situ in a molecular beam to study the effects of π-stacking and microsolvation on intramolecular proton-transfer dynamics. The proton tunneling speed in the ground-state of HFF makes the observation of these effects, common in many environments within materials science and biology, such as within the DNA helix, easier to observe.

Session 4: Astronomy

Location: 414, Pupin Hall, Columbia University

1. DA 495: An Aging Pulsar Wind Nebula with Possible TeV Gamma Ray Counterpart

Anna Coerver[1], Kaya Mori[2], Charles Hailey[2], Eric Gotthelf[2], Reshmi Mukherjee[1], Michelle Hui[3], Brenda Dingus[4], Jordan Goodman[5]

1. Barnard College, Columbia University, 2. Columbia University, 3. Marshall Space Flight Center, NASA, 4. Los Alamos National Lab, 5. University of Maryland

A pulsar wind nebula is created when a high-mass star collapses and forms an isolated neutron star surrounded by a relativistic particle wind. DA 495 is thought to be such an object, although no pulsations have been detected. DA 495 was first detected in the radio band and is characterized by an annular radio morphology with a radio emission dip in the center. It has been theorized that the wind nebula has an unusually high magnetization of 1.3 mG, and the age of the PWN has been estimated from the 1.3 GHz energy break to be approximately 20 kyr. With such a high wind magnetization, one would expect synchrotron radiation to fall off fairly quickly, yet NuSTAR (the Nuclear Spectroscopic Telescope Array) detected hard X-rays at energies greater than 10 keV, and a study of the Galactic Plane by the HAWC very-high-energy (VHE) gamma-ray telescope revealed a source coincident with DA 495 at energies greater than 10 TeV. This source was also detected at TeV energies by the VERITAS gamma-ray telescope. DA 495 was detected in the X-ray up to 10 keV by both Chandra and XMM-Newton X-ray telescopes before NuSTAR performed follow-up observations of the region in June 2017. DA 495 is one of the first TeV sources observed by the NuSTAR-HAWC-VERITAS Galactic Legacy collaboration. We carried out spectral and imaging analysis of both NuSTAR and Chandra data on DA 495 and will present results of our study of DA 495.

2. Exploring the Effect of Stellar Magnetic Activity on Exoplanet Detection

Katherine Melbourne[1], James Jenkins[2]
1. Yale University, 2. Universidad de Chile

Offering potential habitability and the possibility of harboring life, exoplanets are often discovered using the Radial Velocity (RV) technique. This method detects changes in the velocity of a star's motion caused by the gravitational pull of a planet orbiting that star. My research examines a potential method of improving current RV analyses by disentangling stellar magnetic activity noise from our RV data. The increase in RV precision expected as an outcome of this research will allow for the detection of smaller, Earth-sized planets.

3. Magneto-Optical Materials for Faraday Isolators in Future Gravitational-Wave Detectors

Valerie Avendano[1], Rodica Martin[1]
1. Montclair State University

The first detection of gravitational waves in September 2015 by the Laser Interferometer Gravitational-Wave Observatory (LIGO), followed by five other detections to the current date, opened a new field of gravitational-wave astronomy. To observe events that are further into space or too weak for the current gravitational-wave detectors, much more sensitive detectors are required. Among the ways of increasing the sensitivity, higher laser power, cooling of the mirrors, and exploring new materials and wavelengths are being considered. One of the critical components of the interferometer is the Faraday Isolator. Faraday Isolators are optical devices that prevent the back-reflection of the laser beam from propagating back toward the source and resonating between optical surfaces in its path. Their operation is based on the rotation of the polarization of the laser beam passing through a magneto-optical element placed in a magnetic field, and is proportional to the strength of the field, the length of the crystal, and the Verdet constant of the magneto-optical element. The Faraday Isolators in future gravitational-wave detectors will see higher optical powers and will most likely operate at longer wavelengths, therefore new materials with low absorption and high Verdet constant need to be investigated. In this talk, I will present measurements of Faraday rotation in Y3F5O12 (YIG), as well as the absorption in the spectral region of 1 - 2 micrometers. I will also compare it with the Terbium Gallium Garnet (TGG), which is the magneto-optical material used currently in the detector. Additionally, I will discuss other promising candidate materials and methods to improve the performance of the Faraday Isolators, such as cooling the magneto-optical elements.

4. Simulating Pulsar Signals to Search for Low-Frequency Gravitational Waves

Michele Henkel[1], Jeffrey Hazboun[2]
1. University of Connecticut, 2. University of Texas, Rio Grande Valley

Gravitational waves, a product of Einstein's theory of general relativity, have become an important tool for understanding how gravity behaves at some of the largest scales. The merging of supermassive black holes in the centers of galaxies provides information about the most extreme gravity fields in the Universe but such events are unobservable by Earth-based observatories due to their immensely low frequencies (f~10^−7 – 10^-9 Hz). Pulsar timing arrays (PTAs) exploit the regularity of millisecond pulsars (MSPs) by searching for minute changes in their signals' times of arrival (TOAs) and are sensitive to supermassive black hole binaries (SMBHB). Due to a series of effects on the pulsar signals as they traverse the galaxy, it often becomes difficult to precisely measure their TOAs. To combat this we are developing a pulsar signal simulator to individually characterize each effect on the signal and verify how the effect manifests in the observed signals. In this talk, I will discuss the simulation of signal dispersion due to the interstellar medium (ISM) as well as simulations of gravitational waves.

Session 5: Astronomy & Space physics

Location: 307, Pupin Hall, Columbia University

1. Near Infrared Observations of the Solar Atmosphere

Darci Collins[1], Katie Lee[1], Angela Des Jardins[1]
1. Wesleyan University, 2. Montana State University

On August 21, 2017, people across America were able to view the total solar eclipse. This gave us a unique opportunity to view the outer atmosphere of the sun. In order to view the solar atmosphere in infrared, we launched a balloon above 99% of the earth's atmosphere with an infrared filter camera attached. We were able to view the corona and chromosphere without the earth's atmosphere blocking the transmission of infrared light.

2. The High-Energy X-ray Spectra of Two Recently Discovered X-ray Transients in the Galactic Center

Shifra Mandel[1], Chuck Hailey[1], Kaya Mori[1], Ben Hord[1]
1. Columbia University

Two new X-ray transients were discovered in 2016 near the Galactic Center when they were detected in outburst by the Swift X-ray telescope. Continuous monitoring of the Galactic Center by Swift, combined with the known short (<~ 5 year) recurrence time of neutron star LMXBs, strongly suggest that these new transients are black hole binary candidates (BHC), bringing the number of suspected black hole binaries near the center of The Milky Way to three. We will present 3-79 keV NuSTAR spectra of these sources that further support a black hole binary interpretation. These new BHC, combined with at least one other previously discovered BHC near the Galactic Center, hint at a potential substantive black hole population in the vicinity of the SMBH Sgr A*.

3. Sources of systematic uncertainties in Spectral Energy Distribution fitting: stellar libraries and metallicity

Anastasia Spiridonova[1], Viviana Acquaviva[1]
1. City College of New York, CUNY

Spectral Energy Distribution (SED) fitting is widely used to measure the physical properties of galaxies, such as stellar masses, stellar ages, amounts of dust, and metallicity. The main idea is simple yet powerful: to compare templates to data in order to find which model parameters best resemble the observations. However, many hidden sources of systematic uncertainties arise from the way the stellar populations are modeled. The building blocks of the models are synthetic stellar population libraries, which are used to build composite spectra of galaxies with different ages and star formation histories. We compare two commonly used sets of templates, the Bruzual and Charlot 2003 models, and the Flexible Stellar Population Synthesis models, and show that they induce significant differences in the model spectra. Then, we show the effect of varying stellar metallicity, which is often set as a constant in SED fitting, on the model spectra. Our final goal is to provide an estimate of the systematic bias stemming from these differences on the estimates of the physical properties of galaxies.

4. Numerical Analysis of Periodic Motion of Electrodynamic Tethered Dumbbell Satellite Systems

Grace Genszler[1], Geoffrey Collins[1]
1. Wheaton College

Electrodynamic tethers (EDTs) offer an alternative solution to space system propulsion and attitude control. However, the electromechanical issue of induced vibrations in EDTs remains one of the major challenges. A theoretical model of an EDT dumbbell satellite system is proposed as a way to examine the effects of control feedback loops that work to dampen the induced vibrations. The MATLAB numerical model considered in this study utilizes Lagrange's Equations as a method to obtain the equations of motion for the system in a low Earth orbit and the rotation about the system's center of mass. It can be shown the motion of the system in orbit and in rotation can be described through a set of second order non-linear ordinary differential equations. To approximate the positions of the two satellite masses, Runge-Kutta fourth-order method is used. Progress made thus far has yielded the positive result of the numerical simulation showing stable patterns of motion. Current work now includes benchmarking against orbital data of previous EDT missions as a way to confirm numerical model accuracy. Subsequently, the model will be used to look at vibrations in the tether and dampening methods of control.

Session 6: Condensed Matter

Location: 224, Pupin Hall, Columbia University

1. Monte Carlo Simulations of Topological Magnetic Materials

Morgan Daly[1], Jiadong Zang[1], Jie-Xiang Yu[1], Wentao Hou[1]
1. University of New Hampshire

Magnetic skyrmions are nanometer sized topologically stable spin textures that can emerge in magnetic materials. Skyrmions' small size, stability, and manipulability by small electric currents could generate significant improvements in the development of memory devices and information storage. The behavior of skyrmion materials has been well modeled by considering the Heisenberg interaction forcing neighboring spins to be parallel, the Dzyaloshinkii-Moriya interaction forcing neighboring spins to be perpendicular, and the Zeeman interaction from the external magnetic field. Competition between these three interactions results in the emergence of the skyrmion phase at finite field and low temperature. We performed Monte Carlo simulations on a 2D square lattice and observed an upturning of topological charge at elevated temperatures. This discovery of emergent topology at high temperatures is the first of its kind, opposing the expectation of nontrivial topology existing only at low temperatures.

2. High – Temperature Superconductivity of NbTi

Klea Dhimitri[1], Jospeh Yuan[1], William Mayer[1], Kaushini Wickramasinghe[2], Javad Shabani[3]
1. CUNY - Hunter College, 2. University of Marlyand, 3. New York University

Superconductivity is an essential ingredient for a qubit to operate a computation without being prone to errors. Nb is a desirable superconductor on its own due to its high transition temperature at 9 K . Alloys like NbTi are of interest because superconductivity is present in the alloy at high magnetic fields up to 15 Tesla. Sputtering various compositions of NbTi to find the optimal composition that maintains superconductivity in the presence of a large magnetic field. Samples were measured by a Physical Property Measurement System (PPMS). Further research on NbTi could be useful for fabricating novel devices.

3. The Synthesis and Characterization of SnTe Nanowires

Julia Wei[1], Pengzi Liu[1], Judy Cha[1]
1. Yale University

Predicted in 2011, topological crystalline insulators (TCI) are novel materials that insulate in bulk and conduct electricity on their surfaces and edges. We study the cubic crystalline form of tin telluride (SnTe), a compound that exhibits TCI properties. In particular, we focus on SnTe nanostructures because their high surface-to-volume ratio boosts the effect of surface states and enables transport measurements. Results from our ongoing optimization of the synthesis of SnTe nanowires via two methods, chemical vapor deposition and chemical vapor transport, will be shown. We have also characterized the topography and composition of the nanowires using scanning electron microscopy and energy-dispersive X-ray spectroscopy. In the future, we will fabricate electrodes on the nanowires in order to measure the electrical transport properties.

4. Infrared Nano-Optics of Quantum Materials

Amara Jaeger[1], Amara Jaeger[1], Maria MacArdle[1], Dmitri Basov[2]
1. Barnard College, Columbia University, 2. Columbia University

Dr. Basov's lab uses infrared spectroscopy beyond the diffraction limit of light to analyze nanoscale phenomena, whose defining features would often be otherwise invisible. The Basov group uses Scanning Near-field Optical Microscopy (SNOM) to examine quantum materials in both time-resolved and time-independent contexts. The lab works most frequently with materials such as graphene, boron nitride, and oxides.

Session 7: Condensed Matter

Location: 222, Pupin Hall, Columbia University

1. Investigating the electric characteristics of graphene electro-optical modulators

Sara Anjum[1], Paul Prucnal[1], Siamak Abbaslou[1]
1. Princeton University

We fabricated test samples of metallized graphene on silicon chips as a first step towards graphene electro-optical modulators and measured their resistance and capacitance to determine a ballpark figure of the maximum modulation speed that the device could achieve.

2. Topological photonics

Jingjing Pan[1], Mikael C. Rechtsman[1]
1. Pennsylvania State University

Photonic topological insulators possess robust optical properties, protecting transport of light from scattering loss due to small deformations of the system, which is usually detrimental to plasmonic devices. This study was conducted to design and realize a topological plasmonic device by exploring the states of photons at terahertz frequencies in metallic structures. Open source software packages MEEP (MIT Electromagnetic Equation Propagation, time domain method) and MPB (MIT Photonic Bands, frequency domain method) were employed to compute the band structures (dispersion relations) for various (honeycomb, Lieb and Kagome) dielectric lattices. MPB calculates band diagrams by directly solving eigenproblems derived from Maxwell equations while MEEP numerically propagates Maxwell equations in time and extract frequencies by processing the Fourier transform of the modes of light, which is further applicable to metallic materials. Consistent band diagrams with the Dirac cone present were obtained using both methods, expected to display topologically interesting properties. In particular, straining the honeycomb lattice could induce a pseudo-magnetic field near the Dirac point, promising for our further study of photonic Landau levels.

3. Characterization of Indium Tin Oxide (ITO) PET Films for the Development of an Image Quality Tool (IQT)

Lindsay Gray[1], Angel Yam[1], Barry Smith[1], Peter Smith[1], James Weatherall[1], Jeffrey Barber[1], Joseph Greca[1], Duane Karns[1], Kevin Yam[1]

1. Ramapo College of New Jersey

To ensure the safety of travelers worldwide, airports use active millimeter wave Advanced Imaging Technology (AIT) systems to detect potential threats such as explosives. There is a need for an Image Quality Standard (IQT) to quantitatively guarantee the functionality of the AIT systems. Through the establishment of an IQT standard, it can be assured that an AIT is functioning the same when manufactured, pre- and post-certification, and at any point throughout its lifetime. Our research proposes Indium Tin Oxide (ITO) coated polyethylene terephthalate (PET) films as an IQT standard for the range of 60-90 GHz, which overlaps with the frequency range of AIT systems currently in use. Five ITO-PET films of various resistivities are evaluated using free space reflection measurements. These films show stability over the 60-90 GHz range and an inverse relationship between surface resistivity and reflectivity is established. This stability confirms the potential for ITO-PET films to act as a standard in evaluating the functionality of IQT systems.

4. Charge State Readout of Nitrogen Vacancy Centers in Diamond

Olivia Long[1], Haimei Zhang[2], Nathalie de Leon[1]

1. Princeton University, 2. Wellesley College

Nitrogen vacancy (NV) centers are naturally-occurring defects in diamond consisting of a substitutional nitrogen atom and an adjacent vacancy in the diamond's carbon lattice. The electronic spin state of NV centers can be optically detected and initialized under laser excitation. Moreover, NV centers have long spin coherence times on the millisecond timescale at room temperature. This makes them attractive candidates for quantum nanoscale sensing. However, NV centers can exist in two different charge states, leading to errors in initialization and readout. Since ionization dynamics can be drastically different near the diamond surface, we explore the ionization process between NV- and NV0 for shallow NV centers within 10 nm of the surface. Using two lasers to provide different excitation energies, we selectively excite both charge states (532 nm green laser) or just NV- (589 nm orange laser) to distinguish between the two states. The ratio of the charge states at equilibrium will differ depending on the individual NV center. To determine the ratio of a given NV, we use a laser pulse sequence to first excite both states. Then, we use the orange laser to selectively excite NV-. From the fluorescence data, we can determine the ratio of the two different states, and we achieve single shot readout of the charge state. Further work includes analyzing different NV centers and possibly correlating the ratios with other NV characteristics. Ultimately, a deeper understanding of the conversion between NV- and NV0 may allow us to engineer an environment for optimal nanoscale sensing capabilities.

Poster Session

11:00 am – 12:00 pm
Location: Carleton Commons, Mudd Building, Columbia University

1. An information-theoretic approach to study fluid-structure interactions

Maxwell Rosen[1], Peng Zhang[2], Sean Peterson[3], Maurizio Porfiri[1]
1. New York University, 2. Stony Brook University, 3. University of Waterloo

The question of causality is pervasive to fluid-structure interactions, where it finds its most alluring instance in the study of fish swimming in coordination. How and why fish align their bodies, synchronize their motion, and position in crystallized formations are yet to be fully understood. Here, we posit a model-free approach to unveil causality in fluid-structure interactions through the information-theoretic notion of transfer entropy. We demonstrate our approach on a system of two tandem airfoils in a uniform flow, where the pitch angle of one airfoil is actively controlled while the other is allowed to passively rotate.

2. Implementation of a Feedback System for a Parity-Time (PT) Symmetric Pair of Musical Strings

Kaylyn Holmes[1], F M. Ellis[1]
1. Wesleyan University

Parity-time (PT) symmetry is a specific physical behavior in non-Hamiltonian structures in which a system of two oscillators—one exhibiting a value of gain and the other a loss of equivalent magnitude—are coupled together while being separated by a physical distance. The resulting behavior in a PT-symmetric system exhibits a theoretically predicted yet unintuitive asymmetrical wave pattern of pseudo-Hamiltonian amplitude interference in conjunction with exact cancellation of the gain and loss elements in the system. PT-symmetric systems and their behavior have been and are currently being examined both theoretically and experimentally in mediums including electronic circuits and light pulses. Here, we have designed, modeled, and tested the behavior of the individual oscillators needed to form a PT-symmetric system of musical strings. We have constructed a musical string affixed to an electronic feedback system that allows the string to drive itself at its resonant frequency. The feedback circuit has both inherent and adjustable amplitude gain and phase shift for the voltage output by a piezoelectric pick-up to be manipulated before being output by a second transducer that magnetically excites the string. Our experimental results indicate that our configuration of the feedback system yields the highest amplitude and resultant contribution of the fundamental frequency (f1) relative to the higher harmonics of the string (f2 and higher), which agrees with both the simulations of the electronic circuit and mathematical modeling of the electronic and electromagnetic equations for the feedback loop. We are currently modeling the nonlinear nature of the feedback system based on a model for the magnetic drive transducer that excites the string. Upon completing the theoretical model of the complete feedback system, we will replicate the setup with an identical string with an inverted phase in order to implement the loss for a PT-symmetric system.

3. Vertical Axis Wind Turbine Generator Subsystem

Amanda Prescott[1], David Allard[1], Darla Earl[1], L.Dion, S.Park[1], E.Benjamin[1], S.Blackburn[1]
1. University of Massachusetts - Dartmouth

This novel approach to an atypical sail-driven wind turbine is primarily distinguishable by the vertical axis structure as well as the induction generator. The generator subsystem for this vertical axis wind turbine is being designed and constructed to maximize the power output through variable wind speeds at ground-level. The goal is to produce 2.3kW of power through a 3-phase AC system, making use of Neodymium magnets and specially designed coils to fit the production needs. The generator is being designed with modular properties to fit the power needs of the consumer. The version 1 design is close to completion as proof of concept, undergoing significant testing on a full-scale prototype structure. Version 2 is currently in the design process, working towards an improved power output. Preliminary results from version 1 testing will be shown.

4. Joining of Low-module Thermoplastics for Dental Implants

Mayumy Cordova Lozano[1], Rafael Niyazov[1]
1. CUNY Borough of Manhattan Community College

Polymeric materials, such as thermoplastics have been used in various biomechanical devices and, in particular, for a creation of low cost and high quality dental implants. The purpose of the conducted research is to find a new composite thermoplastic with a higher strength by joining different specimens through the welding process. Welding of thermoplastics is usually involving a local heat at the interface of the polymer to enable the melting and intermolecular diffusion in order to provide a high strength bond. The focus of this investigation is to weld thermoplastics, such as polycarbonate (PC), high density polyethylene (HD-PE) and acetal (POM) by using ultrasonic. Then, the maximum strength of the welded specimens will be tested by using Z-3 tensile test machine.

5. Constructing a Noise Eater

Isabelle Bunge[1], William Williams[1], Jessica Tran[1]
1. Smith College

For my senior thesis, I'm working on building a noise eater which regulates the intensity of a laser. The noise eater mainly consists of a acousto-optical modulator (AOM), photodiode, and a PID circuit. The AOM divides our beam into a dump and main beam. About 10% of the main beam is deflected to the photodiode, which creates a voltage signal proportional to the intensity of the beam. The PID circuit works to analyze this signal and, by comparing it to the desired signal (the voltage that corresponds to the desired intensity), produces a signal that is fed to an voltage controlled attenuator (VCA). The VCA, in turn, attenuates the signal fed to the AOM, so that the AOM works towards changing the amount of intensity in the dump beam in order to keep the main beam at a stable intensity. The first step of this project is building the PID circuit and constructing and testing the noise eater, which is underway at the moment. The second part of this project, which will begin next semester, is to study neural networks and attempt to replace our PID circuit with a neural network that can effectively monitor the intensity of the main beam. In the end, we hope this project can be used in our lab here at Smith College to control the intensity fluctuations of lasers in different experiments.

6. Analysis of Quasi-Axisymmetric Stellarator Model Performance

Camille Liotine[1], Michael Drevlak[2], Sofie Henneberg[2]
1. Princeton University, 2. Max Planck Institute for Plasma Physics

There are two fusion reactor models that dominate fusion research: stellarators and tokamaks. Both designs have their own benefits and caveats. Stellarators confine plasma by means of complex coil systems that can only be modeled in three-dimensional space. These coils generate external magnetic fields with twisted field lines that keep the plasma in place. This geometry makes stellarators challenging to build, but it is easier for them to achieve steady-state operation because the plasma is inherently disruption-free. Tokamaks, on the other hand, have a simpler coil design that can be modeled in two-dimensional space due to rotational symmetry. Unlike stellarators, tokamaks induce a current in the plasma that generates a poloidal magnetic field which, when combined with the toroidal field produced by the coils, twists magnetic field lines for confinement. However, this current can cause disruptions in the plasma that destroy confinement. The goal of this project is to investigate the robustness of a new quasi-axisymmetric stellarator model that combines aspects of a stellarator with those of a tokamak.

7. Study of the Performance of Coupled Micro-Optic Laser Gyroscopes

Samuel McClung[1], Christopher P. Search[1]
1. Stevens Institute of Technology

The goal of the project was to determine if coupling between lasing micro-resonators provides an advantage over the use of a single micro-resonator for use as a gyroscope. Hence, systems of one and two ring laser gyroscopes (RLG's) were modeled on MATLAB using coupled mode equations. Among two-resonator systems, both the sequential and the embedded design were examined. In particular, the project analyzed how changes in coupling between resonators and how different rotation rates affect the intra-resonator and output intensities of the lasers.

8. Study of sound resonance in a cylindrical cavity

Rachel Blow[1], Erich Gust[1]
1. Providence College

We present a study of sound resonance in a cylindrical cavity containing a gas of controlled pressure and composition. A sinusoidal sound source of variable frequency was used to excite the resonant modes between 500Hz and 10kHz and measure the resonance spectrum. The resonant frequency and quality factor of the lowest three resonant modes was measured. This procedure was repeated at absolute pressures ranging from 50 mbar to 1000mbar with air, nitrogen and neon as the gaseous medium. As expected, the frequencies of the resonant modes are nearly independent of the gas pressure. We found that the quality factor of every resonance increased with increasing pressure. However, the quality factors of different resonances changed by significantly different amounts as the pressure was varied. These results indicate that study of cavity resonances can potentially be used to analyze the transport properties of gas mixtures.

9. Characterizing the Role of Arts Education on the Physics Identity of Black People

Tamia Williams[1], Simone Hyater-Adams[2], Kathleen Hinko[2], Noah Finkelstein[2]
1. Mount Holyoke College, 2. Colorado University, Boulder

How one negotiates physics identity is crucial to gaining and maintaining membership in the physics community (Wenger, 2010). However, studies have shown that there is an exclusive culture of physics that has marginalized black people and leads them to feel that they do not fit the criteria of who a physicist is supposed to be (McGee, 2016). In parallel, there are studies that show that the arts can act as an identity mediator or coping mechanism for underrepresented groups in STEM (Mejia, 2012). In this poster we add to a methodology developed in previous studies (Hyater-Adams, 2017) to analyze interviews of four physicists and examine how arts have impacted the development of their physics identity. In this poster we present a method for understanding the intersectionality of physics and the arts, and present preliminary findings about how this has benefitted black physicists.

10. Quantum dots in 2-D TMDC materials

Sofia Mvokany[1], Shalva Tsiklauri[1]
1. CUNY Boroung of Manhattan College

In latest years, there have been a promptly increasing number of experimental and theoretical publications focusing on transition metal dichalcogenides (TMD) materials. Strong electron–hole binding in TMDs suggests that it would be possible to obtain a discrete spectrum due to trapping of excitons, halls and electrons in strong magnetic field. We assume the excitons, electrons and halls are confine in a harmonic potential in order to have a first estimation of the confinement criteria. We solved Schrodinger equation and calculated the first confined levels. We obtained an energy separation between the first two confined levels, which larger than the thermal fluctuations at lower temperature. We constructed the hypothesis of exciton confinement that helped us to determine the conditions in which a quantum dot could generated via strain field.

11. Comparing the stability of blue light emitting materials

Rahma Leil[1], Deirdre O'Carroll[1]
1. Rutgers University

High efficiency blue phosphorescent OLEDs show low device operational lifetimes due to triplet quenching, so finding materials with high stability that show high device operational lifetime is a going on research. This project aims at comparing the stability of several blue light-emitting materials : a fluorescent conjugated polymer (PFO); an organic phosphor doped into a conjugated polymer (FIrpic:PVK); and fluorescent core/shell quantum dots (CdS/ZnS). The first step was to make thin films of them. First, we made 54-nm- thick films of PFO, 12-nm-thick films of (Firpic:PVK), and acquired their Absorbance spectrum and Photoluminescence (PL) spectra. The maximum wavelength of emission for both
samples was found to be in the blue region of the spectrum. Further optimization to Firpic:PVK needs to be done before going with the PL stability measurements.

12. Ion and Mass Transport Characterization of (Poly(MM-co-PFSA)) for Electrochemical Energy Conversion

Brian Chen[1], Miguel A. Modestino[1], Yoshi Okamoto[1], Adlai Katzenberg[1], Minfeng Fang[1]
1. New York University

Research in electrochemical energy conversion, production, and storage has increased due to the demand for sustainable energy devices. These devices include fuel cells, redox flow batteries, and solar-fuel generators. Electrochemical energy conversion devices are composed of multiple active layers (e.g. ionomer catalyst binders) that carry out different physical functions. Major focuses on thin-film ionomer catalyst binders include the mass and ion transport properties. Thin-films are commonly comprised of perfluorinated sulfonic acid (PFSA) ionomers—the conductive properties originate from the proton-dissociation of the sulfonic acid groups, which are affected by polymer morphology. Mass transport in PFSA is dependent on the polymer free-volume, transport-molecule size, polymer morphology, and transport-particle and PFSA interactions. Nafion is the current leading PFSA ionomer for energy converters—although successful for bulk membranes, its limitations are stressed when utilized for thin-films. Under the supervision of Professors Miguel Modestino and Yoshi Okamoto, and PhD student Adlai Katzenberg, I successfully synthesized poly(perfluoro-(4-methyl-2-methlene-1,3-dioxolane)-co-perfluoro(4-methyl-3,6-dioxaoct-7-ene) sulfonic acid) (poly(MM-co-PFSA)). Our polymer is composed of the same sulfonic acid group as Nafion, while replacing a perfluoro-dioxolane for a Teflon backbone (i.e. polytetrafluoroethylene; PTFE). The combination of perfluoro-dioxolanes and Teflon for membranes promotes gas permeability and selectivity. The advantage of producing the ionomer in-house allows for a diverse study on different ratios of sulfonic acid groups to perfluoro-dioxolane. Ionomer thin-films can be characterized with high conductivity and gas permeability based on the understanding of the nanoscale and mesoscale behaviors, as well as PFSA transport properties.

13. How Does Polymer Structure Affect Fragility?

Amber Storey[1], Wengang Zhang[1], Francis W. Starr[1]
1. Wesleyan University

Polymers play important roles in our everyday lives and has become a trillion dollar industry. Therefore , it is essential to know exactly how polymer architecture can affect different characteristics of polymer glasses, such as fragility. The fragility can be a key feature to know about polymer glasses for both their production and application. However, there is still much debate on what contributes to the fragility. By studying polyethylene oxide (PEO) and polymethyl methacrylate (PMMA), polymers which have a dramatic difference in their architecture, we can see if the simulated system can match the experimental values for fragility. To do so, we used the LAMMPS software package to conduct molecular dynamics (MD) simulations of a coarse-grained bulk system of PEO and PMMA. We found the glass transition temperature, relaxation time and fragility of each system. By heating and cooling each system at fixed volume, we were able to thermodynamically find the glass transition temperature. Then it was possible to find the relaxation times of temperatures relative to the glass transition temperature. Around and below the glass transition temperature, the relaxation time becomes increasingly large. We describe the temperature dependence of the relaxation time using the Vogel–Fulcher–Tammann (VFT) equation, and from the fit parameters we extract the fragility. The results of the fit lead us to the conclusion that PEO was stronger than PMMA. By knowing how polymer structure affects fragility can advance the polymer industry and help use polymers in more effective and efficient ways.

14. Exoplanet and Kepler Object of Interest Research at Bridgewater State University

Maria Patrone[1], Martina Arndt[1]
1. Bridgewater State University

Since 2012, when the new Bridgewater State University (BSU) Observatory was completed, students have been engaged in several research projects, including observing exoplanets. This work started with trying to see if we could observe exoplanets with our new equipment from our suburban location (we can!), and has evolved into our current efforts to try to confirm exoplanet candidates. Students at all levels can participate in this work - from non majors to honors physics students, through The Bridgewater State University Experimental Astrophysics Research (BEAR) Team, supported by the Massachusetts NASA Space Grant Consortium. In this poster, we summarize the exoplanet research done at BSU and share our current efforts to help confirm exoplanent candidates.

15. Evaluating half-mass & half-light radii of galaxies at various redshift to understand cosmological mergers

Snigdaa Sethuram[1], Rachel Somerville[1], Ena Choi[2]
1. Rutgers University, 2. Columbia University

The first part in a research project whose end goal is to be able to compare simulated galaxy formation and mergers with actual data from the Hubble and other sky surveys, this poster will present plots attained from multiple simulations of cosmological galaxies under different redshift and initial conditions. Properties such as half-light and half-mass radii are compared with the the photometric properties of the galaxy in the hopes that these simulations accurately respresent data received from observational data. Using a software called Powderday alongside packages from astropy, IDL, etc., we are attempting to recreate the conditions undergone by observers in order to accurately be able to compare to real data.

16. Analyzing the Clustering of Lyman Alpha Emitting Galaxies at z=3.1

Juliette Stecenko[1], Eric Gawiser[1], Nakul Gangolli[1], Jiaoyue Yuan[1], Holly Christenson[2]
1. Rutgers University - New Brunswick, 2. Western Washington University

Lyman Alpha Emitting (LAE) galaxies are young galaxies seen in the early universe due to light emitted by their neutral hydrogen (Lyman Alpha photons). We detect and study 148 of these galaxies at a redshift z=3.1, when the Universe was 2 billion years old. LAEs are detected by criteria refined by previous research, including emission-line rest-frame equivalent width greater than 20 Å (angstroms) and small angular size consistent with being at such great distance. Our LAE candidates, from the Multiwavelength Survey by Yale-Chile (MUSYC) SDSS1030+05 field, are subjected to quality checks as implemented in the past research of LAEs using code in Interactive Data Language (IDL) and visual inspection using Smithsonian Astrophysical Observatory's SAOimage DS9, an astronomical imaging application. This project is ongoing; we have developed a refined list of LAEs and analyzed their angular clustering, and are able to apply these methods to other such catalogs. Starting soon in late 2017, almost one million LAEs will be discovered by the Hobby Eberly Telescope Dark Energy Experiment (HETDEX). By studying LAEs, we can increase our knowledge of galaxy formation and the evolution of the universe.

17. Gravitational wave memory from core-collapse supernovae

Lita de la Cruz[1], Marc Favata[1]
1. Montclair State University

Einstein's theory predicts gravitational waves, oscillations in the geometry of spacetime. These waves are caused by massive accelerating objects like orbiting black holes, neutron stars, and the dense matter in a supernova explosion. LIGO (the Laser Interferometer Gravitational-wave Observatory) is a pair of L-shaped interferometers that have been able to detect gravitational waves from merging black holes. Core-collapse supernova are another potential source of gravitational waves. When these supernovae run out of fuel they collapse and produce powerful explosions that emit gravitational waves. Signals from these cataclysmic events are difficult to model, but one feature that several models have in common is a non-oscillating component of the signal called "memory." This component results from matter or neutrinos that are ejected asymmetrically. Analyzing existing supernovae simulations, we quantified the size of the memory and its associated timescales. This allowed us to develop a simple analytic fit to model the memory effect. This model will be used to estimate the detectability of the supernova memory signal by LIGO and other gravitational wave detectors.

18. Examining Joy's Law

Sidney Gonzalez[1], Paula Fekete[1]
1. United States Military Academy

We have analyzed sunspot data for four years, 2014-2017, from images taken by the solar telescope SDO (Solar Dynamics Observatory) a NASA mission which has been observing the Sun since 2010. The aim of the project was to verify Joy's Law, which states that a line connecting center regions of successive sunspots on the surface of the Sun have tilt angles that increase with their latitude. Studying Joy's Law is important because it provides observational evidence for the solar dynamo effect, a mechanism that generates the Sun's magnetic field.

19. Grinding Down Stars and Stellar Remnants Into Accretion Disks

Syeda Nasim[1], Gaia Fabj[1], Barry Mckernan[1], K.E. Saavik Ford[1]
1. CUNY - Hunter College

Active galactic nuclei (AGN) are powered by the accretion of matter onto supermassive black holes (SMBH). Most accretion models take the form of disks of gas around the SMBH. Stars and stellar remnants also orbit the SMBH. Orbiting objects plunging through the disk experience a drag force, and through repeated passage, orbiters can have their orbits ground-down into the plane of the disk. Using two different accretion disk models, TQM (Thompson, Quataert & Murray), and SG (Sirko & Goodman), we determine the grind-down time for stars and stellar remnants, as a function of initial inclination angle, and initial radius. Orbital grind-down time is important because stellar-mass black holes (sBH) within AGN disks are likely to merge at a higher rate than in the field. Accurate estimates of orbital grind-down time can help constrain predictions of the AGN channel for LIGO.

20. Exploring Satellite Galaxy Rotation Curves in the SAGA Survey
Danielle Rowland[1], Erik Tollerud[2], Laura Watkins[3]
1. Columbia University, 2. Yale University, 3. Space Telescope Science Institute
The Milky Way and its neighbors, known as the Local Group, have been extensively studied; however, it isn't known if they are representative of similar galaxy groups in the larger universe. The SAGA Survey seeks to find and characterize satellite galaxies around 100 host galaxies that are analogous to the Milky Way to achieve a statistically-significant sample size for comparison to the Local Group. Candidate satellites were first identified using photometry, and then confirmed using redshifts determined from fiber spectroscopy; so far this has yielded 29 satellites around 8 host galaxies. This poster will detail the process of reducing further follow-up data on these 29 confirmed satellites that used the long-slit double spectrograph at Palomar Observatory. I will describe in detail the steps of bias/flat calibration, finding a dispersion solution, subtracting sky emissions, and combining red and blue side spectra to extract a complete 1D spectrum. I will also discuss how this follow-up data uniquely allows for determination of galaxy rotation curves that will help characterize the dark matter content for each satellite.

21. Common Proper Motion on observed KOI Binary Stars
Nicole Hess[1], Elliot Horch[1], James W. Davidson[2], Mark Everett[3], Steve B. Howell[3], Patrick Thayer[1]
1. Southern Connecticut State University, 2. University of Virginia, 3. National Optical Astronomy Observatory
Binary star systems where one of the stars is an exoplanet host appear to be more common than originally expected. The Kepler mission, along with subsequent ground-based follow-up work, has revealed a number of Kepler Objects of Interest (KOIs) that have nearby stellar companions (within ~1 arcsec). Recent work on these stars has mainly focused on placing the companions on the H-R diagram and inferring if they are gravitationally bound based on whether their locations are consistent with a common isochrone. However, we have been observing these KOI double stars with speckle imaging over several years and are now in a position to assess whether these systems have components with a common proper motion, and can be seen as physically associated on that basis. We will discuss and give sample results of KOI double stars that are in fact common proper motion pairs. We compare our results with estimates of the multiplicity rate of exoplanet hosts from other methods and comment on the use of these data for constraining orbital parameters at this point, particularly inclination angle. For transit observations the inclination of the planetary orbit is already known, and the relationship between planetary and stellar orbital planes could have implications for star and planet formation.

22. Development of microfluidic attractor masses to test gravity at micron distances
Cady van Assendelft[1], David Moore[1], Fernando Monteiro[1], Sumita Ghosh[1], Adam Fine[1]
1. Yale University
While it is currently assumed that the familiar Newtonian 1/R2 law of gravity is accurate at all distance scales, many theories attempting to account for dark matter and dark energy predict that gravity could deviate from this at distances less than 100 µm. To test for these short-distance deviations we use silica microspheres held

in an optical trap and excited by microfluidic gravitational attractors, a technique that greatly improves force sensitivity with the goal of approaching the quantum limit for this measurement.

23. Inferring the Astrophysical Population of Binary Black Holes from their Mass Distribution

Osase Omoruyi[1], Alan J. Weinstein[2]
1. Yale University, 2. California Institute of Technology

LIGO's gravitational wave detections have not only proved the existence of black hole binaries but also confirmed the presence of stellar mass black holes larger than 20 solar masses. Our project aims to develop a system that will allow us to study the mass distribution of these binaries throughout space. Currently, LIGO has made 4 detections of binary black hole (BBH) mergers. However, within the next 10 years, LIGO expects this number detections to rise significantly. With these future detections in mind, our project utilizes simulated data to generate a large population of BBH systems. From our general astrophysical knowledge about black holes and nature, we expect the underlying population to fall like a power-law in the total mass of the binary black hole system, M-α, in which α is the power-law index. Using the large sample of events our simulations provide, we seek to constrain the value of the power-law index more precisely and accurately. Successfully recovering the simulated value of α, in turn, will allow us to recover the actual value of α when LIGO detects enough events to form a significant population of BBH systems. Understanding the mass distribution of binary black holes will allow us to make inferences about how black hole binaries have formed and evolved over time.

24. Shaping the solar system through planetesimal collisions

Isabella Trierweiler[1], Greg Laughlin[1]
1. Yale University

Recent discoveries of extra-solar systems have shown that our solar system is incredibly unique. In particular, we have found that our system is missing a significant amount of mass in its central regions- where our system has only a few small, rocky bodies (Mercury, Venus, Earth, Mars), other systems have planets far more massive than Earth on orbits very close to their host stars. A leading explanation for the low mass of our system is Jupiter's Grand Tack. In this theory, our rocky planets are the result of a second era of planet formation sparked by the migration of Jupiter through the inner solar system. During this migration, existing planets and planetesimals were swept together and were eventually ground down into a band of debris suitable for new planet formation. To understand the Grand Tack, and figure out how this mechanism could clear a system's mass, we simulate young solar systems and study the outcomes of interactions between orbiting bodies. From these simulations, we quantify the interactions between perturbed planetesimals and track the system's mass distribution to constrain the solar system conditions needed to set the stage for a second round of planet formation.

25. Electromagnetic Counterparts of Advanced LIGO Binary Black Hole Merger Events

Cierra Coughlin[1], Alex Urban[2]
1. Columbia University, 2. California Institute of Technology

The Advanced LIGO (Laser Interferometer Gravitational Wave Observatory) detectors have successfully detected gravitational wave signals from four binary black hole (BBH) mergers, GW150914, LVT151012, GW151226, and GW170104. These discoveries have prompted follow-up campaigns to search for any electromagnetic (EM) counterparts to the gravitational wave transients, which have yielded no strong candidates, except for the detection of a weak gamma ray transient 0.4 seconds after GW150914 in the sky localization of this gravitational wave event. Our motivation for this project is therefore to study various models of binary black hole mergers to predict whether or not any EM emission should be expected, and if so, what kind, how much, and when. While we currently do not believe that BBH mergers produce EM counterparts, the results of this study will help assess the prospects of these campaigns given our current observing limitations and will ultimately be an important step forward for future work in multimessenger astronomy.

26. Competing Ideas in Quantum Measurement: The Search for a Perfect "Theory of Everything"

Melissa Schmitz[1], Christopher Bass[1]

1. Le Moyne College

Since the quantum revolution in the early 20th century, finding the "perfect" theory to completely describe the universe at the subatomic scale drove some of the greatest minds in modern physics. We study quantum non-locality theory using de Broglie-Bohm Pilot Wave Theory as a model hidden variable theory and Bell's Theorem as a model quantum measurement inequality to understand the fundamental theoretical challenges posed by quantum entanglement and contextuality. Controversial claims of a supposed "disproof of Bell's Theorem" using Clifford algebra-valued local hidden variables is investigated through mathematical and computational methods. We compare results to the expected predictions of Bell's Theorem and the Copenhagen interpretation of quantum mechanics.

27. ProtoDUNE beam simulation and reconstruction, beam data handling

Lige (Caroline) Zhang[1], Joshua Klein[2]

1. Drexel University, 2. University of Pennsylvania

The Deep Underground Neutrino Experiment is a future long baseline neutrino oscillation experiment that is designed to study neutrino mass hierarchy and parity violation. ProtoDUNE-SP is a single phase DUNE far detector prototype which is currently under construction at CERN. Electron and hadron beams with a range of momentums with be provided by the CERN H4 beamline. The ProtoDUNE liquid argon detector simulation utilizes LArSoft while the G4 beam simulation is a separate component outside of the detector simulation. I will present my recent work on the ProtoDUNE beam interface, beam/TPC merging and matching, and beam information handling.

28. ADVACT Detector Analysis

Michelle Baird[1], Suzanne Staggs[1], Kevin Crowley[1], Joshua Lathem[1]

1. Princeton University

The ADVACT array of detectors will be used to get a more accurate picture of the Cosmic Background Radiation than we currently have. I studied the time constants of the TES detectors that used a test- sinusoidal input instead of the standard square-wave input. Many different methods were used in order to find accurate values of the time constants from the sinusoidal waves. We were able to find estimates for tau from curve fits, but the results I found appeared to be heavily effected by noise, and should have been impossible to obtain. I later began comparing resonsivity with dI/dP to get better estimates for tau.

29. Investigating the Mechanical Response to Stress in Coronary Arteries

Aisling Power[1], Caitlin Nicholson[1], Becky Sanft[1]

1. University of North Carolina at Asheville

While the biomechanics of vascular smooth muscle (VSM) are very little understood, VSM tone seems to play an important role in arterial regulation. Such regulation is especially important in maintaining appropriate blood pressure under non-normotensive disease states such as hypertension and age-related intimal plaque deposition. This research investigates the mechanical response of individual layers of the arterial wall tissue to different levels of stress due to internal blood pressure and the contractile activity produced by the VSM. COMSOL Multiphysics was used to build a physically accurate, three-layered, axial symmetric cross section of a coronary artery, in order to better understand arterial tissue biomechanics. The composite tissue materials were defined using experimental data from studies done on human coronary arteries. The model provides a better understanding of arterial stress dynamics in relation to muscle contraction, intimal thickening, blood pressure, and material properties.

30. Neural Dynamics of Food and Hunger in C. elegans

Milena Chakraverti-Wuerthwein[1], Andrew Leifer[1]
1. Princeton University

Foraging behavior in Caenorhabditis elegans varies depending on the feeding conditions that the worm experienced immediately prior to foraging. Previous literature describes a difference in foraging behavior that arises from worms feeding on different sized E. coli patches. This project focuses on confirming published results through applying similar experimental methods and developing methods of preparation for deeper investigation into the neural dynamics. Behavior spans a large range of timescales, from instantaneous movements to decision-making, sleep, and associative learning. Short timescale behaviors, such as basic locomotion, are widely understood to be encoded in certain sequences of neuron firing, but little is known about longer timescales. Foraging behaviors in C. elegans present a way of exploring the neural dynamics of longer timescale behavior in a simple organism with a fully mapped out brain. With a characterized behavioral difference, we can then use novel new imaging methods that track and record the neural activity of every neuron in the worm brain to begin to unlock the mystery of longer timescale behaviors.