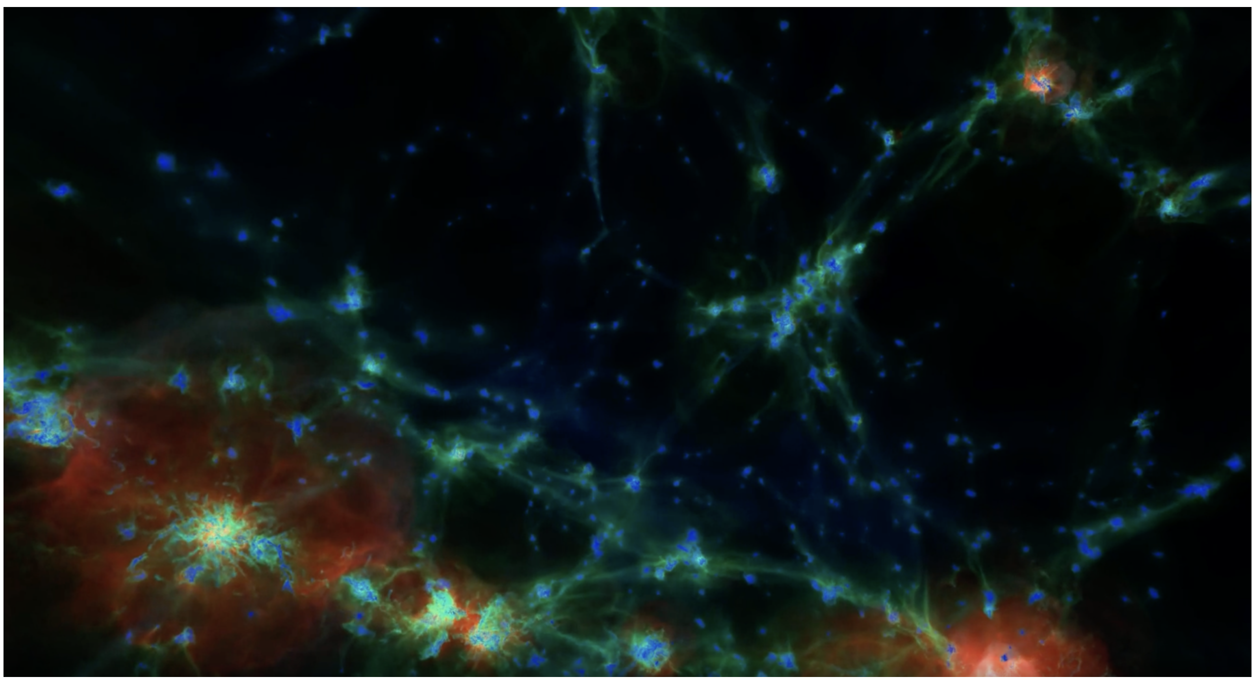
129^{th} Topical Symposium of the
New York State Section of the American Physical Society

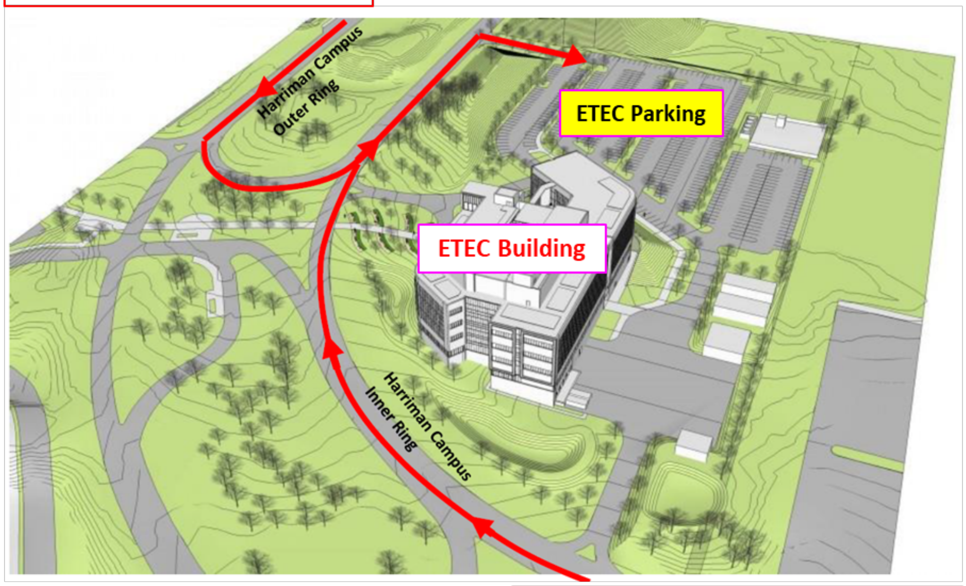
Structure of the Universe



ETEC Building
University at Albany – SUNY

April 6, 2024

From Washington Ave (North)



From Western Ave (US-20, South)

Driving Directions

The ETEC building is in the Harriman State Office Complex, which is adjacent to the University at Albany campus. The address of the ETEC building is ETEC, 1220 Washington Avenue, Albany, NY 12226. It is important that you include "ETEC" in your search if you are using a mapping program; otherwise, the search may send you to the state police barracks.

From the UAlbany Campus:

There is no direct street access to the ETEC building from the UAlbany campus. You must first drive to either Washington Avenue or Western Avenue (US-20) and go east towards downtown Albany. Just after passing the UAlbany campus, there will be an entrance to the Harriman State Office Complex (State Office Buildings).

- If entering Campus Access Road from Washington Avenue, you will see the ETEC building on your left. You will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building. The parking lot is on the north side of the building.
- If entering Campus Access Road from Western Avenue, you will also need to take a U-turn so that you are driving towards the ETEC building, not away from it. Again, the parking lot is on the north side of the ETEC building.

From the North:

Take the Northway (I-87) south to Exit 1E. Merge onto I-90 east (toward Albany/Boston). Then take Exit 3 (State Office Buildings), which will put you on Campus Access Road. Once you see the ETEC building on your left, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

Driving Directions (cont.)

From the South:

Take the Thruway (I-87) north to Exit 24. Merge onto I-90 east (toward Albany/Boston). Then take Exit 3 (State Office Buildings), which will put you on Campus Access Road. Once you see the ETEC building on your left, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

From the West:

Take the Thruway (I-90) east to Exit 24. Merge onto I-90 east (toward Albany/Boston). Then take Exit 3 (State Office Buildings), which will put you on Campus Access Road. Once you see the ETEC building on your left, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

From the East:

Take I-90 west to Exit 3 (State Office Buildings), which will put you on Campus Access Road. Once you see the ETEC building on your left, you will take a U-turn to access the side of Campus Access Road that passes in front of the ETEC building.

Venue

The symposium will be held on Saturday, April 6, 2024. All events will be on the first floor of the ETEC building. The registration/badge pickup, coffee breaks, lunch, poster session, and banquet will be in the ETEC foyer. All talks will be in the ETEC 149A/151A lecture hall. No food or drinks are allowed in the lecture hall. There are rest rooms to the right of the lecture hall.

For members of the Executive Committee of the New York State Section of the American Physical Society, there will be an executive committee meeting on Friday evening from 6:30 PM to 7:30 PM in the ETEC 107 conference room.

Wi-Fi Access

There is free Wi-Fi access in the ETEC building. The Wi-Fi network is "UAlbany Guest". No password is needed. The Wi-Fi network "eduroam" is also available for those who have an eduroam account through your university.

Structure of the Universe

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University at Albany – SUNY

nyssaps.org

Schedule of Events

Friday, April 5, 2024

6:30 PM – 7:30 PM	Executive Committee Meeting (ETEC 107)

Saturday, April 6, 2024

8:30 AM – 9:00 AM	Reception/Badge Pickup (ETEC Foyer)
9:00 AM – 9:15 AM	Welcoming Remarks (ETEC 149A/151A)
9:15 AM – 9:45 AM	*Under the Shadow of the Moon: Eclipses (Then and Now), and Why They Are Still Worth Dropping Everything For* Mindy Townsend Department of Physics and Astronomy, Siena College
9:45 AM – 10:15 AM	*Isotopic Systems in Iron Meteorites: Keys to the Early Solar System* Heather Watson Physics and Astronomy Department, Union College
10:15 AM – 10:30 AM	Break
10:30 AM – 11:00 AM	*Supernovae in the Precision Astronomy Epoch* Shing Chi Leung Mathematics and Physics Department, SUNY Polytechnic Institute
11:00 AM – 11:30 AM	*Dynamical Mass Estimates for Supercluster-Scale Filaments* Mary Crone Odekon Physics Department, Skidmore College
11:30 AM – 12:30 PM	Lunch (ETEC Foyer)
12:30 PM – 1:00 PM	*WIMPs and Axions and Extra Dimensions, Oh My!* Matthew Szydagis Department of Physics, University at Albany
1:00 PM – 1:30 PM	*Detecting Dark Matter: LZ and the Snowball Chamber* Cecilia Levy Department of Physics, University at Albany

1:30 PM – 2:00 PM	*A Close Look at the Galactic Ecosystem with the Hubble Space Telescope* Yong Zheng Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute
2:00 PM – 2:15 PM	Break
2:15 PM – 2:45 PM	*Gravitational Wave Scattering* Robert Penna Mathematics and Physics Department, SUNY Polytechnic Institute
2:45 PM – 3:15 PM	*Improved Models and AI Methods for Exoplanet Characterization* Kevin Knuth Department of Physics, University at Albany
3:15 PM – 5:00 PM	Poster Session (ETEC Foyer)
5:00 PM – 6:00 PM	Banquet (ETEC Foyer)
6:00 PM – 6:45 PM	Keynote Presentation: *The Milky Way Galaxy is in Disequilibrium* Heidi Jo Newberg Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute
6:45 PM – 7:00 PM	Award Presentations

Oral Presentations

9:15 AM – 9:45 AM

Under the Shadow of the Moon: Eclipses (Then and Now), and Why They Are Still Worth Dropping Everything For

Mindy Townsend

Department of Physics and Astronomy, Siena College

On Monday, April 8, the entire North American continent will experience a solar eclipse. Those lucky few who can make it to the path of totality will see something that is widely considered to be the most stunning and affecting astronomical phenomena humans can hope to see: a total solar eclipse. Solar eclipses have been the inspiration for legends and traditions, and have even been sources of major scientific advancement. Even today, when the mechanism of eclipses have been determined, these majestic events still inspire awe and wonder what else is out there.

9:45 AM – 10:15 AM

Isotopic Systems in Iron Meteorites: Keys to the Early Solar System

Heather Watson

Physics and Astronomy Department, Union College

Much of our knowledge of the processes occurring during the early Solar System comes from samples of meteorites, representing different stages of planet formation and differentiation. In this talk I will discuss some of the ways that we quantify and constrain the timing of early solar system and planetary processes. In particular I will discuss how our understanding of solid state diffusion in meteorite materials such as metals and sulfides constrains our interpretation of radio-isotopic age measurements, and I will present recent experimental results that add to this knowledge.

Oral Presentations

10:30 AM – 11:00 AM

Supernovae in the Precision Astronomy Epoch

Shing Chi Leung

Mathematics and Physics Department, SUNY Polytechnic Institute

Supernovae are fascinating objects in the universe because of their roles in galactic chemical enrichment, cosmological measurement and their association with high-energy physics including nuclear and particle physics. The launch of high precision telescopes and extensive stellar and supernova surveys have largely improved our quantitative understanding of supernovae, so that we can build realistic supernova models based on the high-quality data. In this talk I will briefly review the importance of supernovae in astrophysics and their explosion mechanisms. I will talk about the opportunities in this decade. At last I will show how recent data bring us new insight in stellar and supernova astrophysics from our recent projects.

11:00 AM – 11:30 AM

Dynamical Mass Estimates for Supercluster-Scale Filaments

Mary Crone Odekon

Physics Department, Skidmore College

As the initial density perturbations of the early universe grow, they form large-scale structures such as sheets, filaments, and clusters. Observations of these structures provide tests of cosmological models over different spatial scales and in different dynamical environments. For example, nearly a century ago it was recognized that galaxies in clusters are moving so quickly that – if our theories of gravity are correct – there must be "dark matter" in additional to visible matter in order to hold them together. Since then, our knowledge of larger-scale structures has vastly improved. In this talk, I will describe two methods for estimating the mass in supercluster-scale filaments using new observational data.

Oral Presentations

12:30 PM – 1:00 PM

WIMPs and Axions and Extra Dimensions, Oh My!

Matthew Szydagis

Department of Physics, University at Albany

The mystery of dark matter is one of the greatest puzzles in modern science. What is 85% of the matter, or 25% of the mass/energy, of the universe made up of? No human knows for certain. Despite mountains of evidence from astrophysics/cosmology, direct laboratory detection eludes physicists. A leading candidate to explain dark matter is the WIMP (Weakly Interacting Massive Particle), a thermal relic left over after the Big Bang. I will explain how Supersymmetry and Kaluza-Klein models produce natural WIMP candidates, but also cover axions, and possibilities that do not work, such as modifying gravity to explain away observations.

1:00 PM – 1:30 PM

Detecting Dark Matter: LZ and the Snowball Chamber

Cecilia Levy

Department of Physics, University at Albany

The hunt for dark matter, the mystery particle(s?) that makes up 25% of the mass of the universe, has been going for decades, so far unsuccessfully. Experiments are now much bigger and much more sensitive, and there is hope for a discovery. In this talk, I will go over the history of dark matter detection techniques, and will then focus on LUX-ZEPLIN (LZ), the most sensitive dark matter detector active today, and on the Snowball Chamber, a new prototype of dark matter detector, based on supercooled water, which could be used in complementarity with current experiments.

1:30 PM – 2:00 PM

A Close Look at the Galactic Ecosystem with the Hubble Space Telescope

Yong Zheng

Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute

Galaxies are not lonely islands floating in the Universe. They host large gaseous reservoirs of baryons, aka gaseous halos, which exist far beyond the galaxies' visible extent. The galaxies and their gaseous halos together form the galactic ecosystems, in which inflows from the gaseous halos replenish star-forming fuel in galaxies, whereas outflows from galaxies erupt like volcanoes and deliver a large amount of baryons into the halos. In this talk, I will describe the distribution and kinematic flows of baryons in the galactic ecosystems the using high-resolution spectroscopy of the Hubble Space Telescope.

Oral Presentations

2:15 PM – 2:45 PM

Gravitational Wave Scattering

Robert Penna

Mathematics and Physics Department, SUNY Polytechnic Institute

Gravitational waves are the gravitational analogue of electromagnetic waves. But this is not a perfect analogy! Electromagnetic waves pass right through each other, while gravitational waves scatter and interact with each other. I will describe a simplified model where gravitational scattering is exactly solvable. Then, I will describe a huge symmetry of this model called the Geroch group, which explains why it is exactly solvable.

2:45 PM – 3:15 PM

Improved Models and AI Methods for Exoplanet Characterization

Kevin H. Knuth

Department of Physics, University at Albany

The fields of astronomy and astrophysics are engaged in an unprecedented era of discovery as recent missions have revealed thousands of planets (exoplanets) orbiting other stars. In addition to exoplanet detection, efforts are underway to characterize them, meaning that for the first time in history we are discovering what the population of planets in the universe, is really like!

To infer the nature of these planets, we rely on machine learning or artificial intelligence (AI) programs, which given a set of hypothesized characteristics of a planet, predict the data that should be observed by our instruments. Comparison of predicted data and observed data provides the basis by which the hypothesized planetary characteristics can be tested. Continued success requires our models to precisely predict the observations, which means that they must considering subtle observable details. These details include physical characteristics, such as the precise shape of the planet, which can range from spherical to ellipsoidal to piriform, and can include rings and/or moons, as well as orbital perturbations by accompanying planets, which could be as dramatic as the three-body problem. These details also include illumination of the planet by the host star, especially in the case of closely-orbiting planets for which the light rays emanating from the star are not parallel; infrared thermal emissions; and atmospheric refraction and scattering of light.

In addition to using AI to analyze telescope data, we are developing an AI system which, given up to 30 stellar and planetary parameter values, will predict the expected atmospheric transmission spectrum of the planet. This will make it possible to infer the most probable planetary parameters given a set of observed planetary spectra recorded from telescopes like the James Webb Space Telescope while simultaneously assessing the exoplanet's potential habitability.

Keynote Presentation

6:00 PM – 6:45 PM

The Milky Way Galaxy is in Disequilibrium

Heidi Jo Newberg

Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute

In the last two decades, whole-sky surveys have made it possible to get detailed information about the Milky Way galaxy. Gone are the cartoon-like descriptions of two static, double exponential profile disks of younger stars encased in a smooth, power law halo of older stars that I was introduced to in college. We now know that the older halo stars were made in other, smaller galaxies that were ripped apart by the Milky Way's gravity as they were swallowed up in a merger event. These smaller galaxies also cause wave-like disturbances in the Milky Way's disk stars, explaining moving groups, coherent motions, density ripples, and the Z-Vz phase space spiral. These disk disturbances could affect the growth of spiral structure, which is the most apparent feature of a spiral galaxy like the Milky Way. The disequilibrium of the Milky Way is important for understanding the amount and distribution of its component dark matter, which makes up ~85% of its mass. How much of the dark matter is in dwarf galaxies, how much is in dark subhalos, and the general shape of the Milky Way's dark matter halo are all up for discovery as we piece apart the dynamical interactions within our galaxy.

Poster Presentations

P1 (UG) **Investigating Granular Magnetic Storage Behavior by Measuring Hysteresis of Nickel Iron Blends**

Makenzie Eccleston and Dr. Ken Podolak

Physics Department, SUNY Plattsburgh

We seek to investigate various magnetic storage materials that could provide a cost-efficient method of storage through analyzing magnetic hysteresis effects. To measure magnetic hysteresis, a homemade vibrating sample magnetometer (VSM) was designed and utilized with an electromagnet and vibrating drum. We mixed samples of micron-sized iron and nickel with the total mass being constant and tested them using the VSM.

We seek to find smaller areas under hysteresis loops that result in less work to change the magnetic moment of the sample. This would indicate a lower energy consumption material.

P2 (HS) **Laser-Induced Polarization for the Electron-Ion Collider**

Emily Snyder, Katherine Ranjbar, and Alice Snyder

Port Jefferson High School,
350 Old Post Road, Port Jefferson, NY 11777

The use of an intense ultrashort laser pulse to induce electron polarization has been proposed in existing literature. Utilizing the Python programming language, the local constant crossed-field approximation (LCFA) was replicated with the aim of determining values for transverse polarization given a nonzero initial polarization. It has been shown that over multiple laser shots, lower values of the quantum efficiency parameter are associated with higher transverse polarization output, yet require a greater number of shots to attain maximal polarization. Moreover, the quantum efficiency parameter has been redefined as a function of intensity for Ti:sapphire laser necessary to induce polarization in the Electron-Ion Collider.

P3 (GR) **Control of Laser Filamentation by Single-shot Measurements of Plasma Densities in Filaments**

Devi Sapkota, Nicole A. Batista, Jack W. Agnes, Yuxuan Zhang, and Bonggu Shim

Department of Physics, Applied Physics and Astronomy, Binghamton University, State University of New York, Binghamton, New York 13902

Laser filamentation is high-intensity self-guidance of a high-power laser pulse due to the dynamic balance between optical Kerr effect and plasma defocusing [1]. It has numerous applications such as lightning control, rain and snow making, remote sensing, air lasing, and new light sources. Visualization of the Kerr effect and plasma can provide an important control knob for the generation and propagation of laser filamentation. In this work, we control laser filamentation by combining two laser pulses and investigate to see the effect of the two-pulse addition by directly measuring and visualizing plasma densities in filamentation using a single-shot method called multi-object plane imaging (MOPI) [2].

1. Couairon, Arnaud, and André Mysyrowicz. "Femtosecond filamentation in transparent media." Physics reports 441.2-4 (2007): 47-189
2. Li, Zhengyan, et al. “Single-shot visualization of evolving, light-speed structures by multiobject-plane phase-contrast imaging.” Optics Letters 38.23 (2013): 5157-5160.

Poster Presentations

P4 (UG) **Weather and Climate Impacts on Lake Champlain**

Earth Sonrod

Department of Physics and Astronomy, Ithaca College

In a lake system, pollution and organisms are impacted by water conditions, such as temperature, oxygen content, and nutrient levels. These conditions vary in a lake. Since the light is absorbed and scattered by water molecules, the deeper the water, the less light from above the surface will reach the bottom. As a result, the temperature distribution is stratified: the top layer is warmer and less dense than the deeper layer. A body of water is therefore layered into three sections containing differing amounts of pollutants and organisms. Physical stresses such as temperature changes and wind affect the water layering. Predicting the impact of these physical stresses on the water stratification is an important component of understanding nutrient and ecological dynamics within lakes. This research analyzed two years of acoustic Doppler current profiler (ADCP) observations from Lake Champlain and employed Principal Component Analysis (PCA) to obtain the most dominant patterns of variability of the north-south current flow. Sample cross-correlation function (CCF) analysis was applied to capture linear or lag linear relationships between principal components and the north-south component wind with the hope of creating a predictive model capable of forecasting changing currents. Using results from the CCF analysis, a linear model was created. We continue to evaluate our model as a predictor of Lake Champlain currents.

P5 (UG) **Observing Supernova 2023ixf**

Stoker Stoker, Dylan Sczerba, and Dr. Amy Bartholomew

Physics and Astronomy Department, State University of New York at New Paltz

On May 19th, 2023, a star 21 million lightyears away in the M101 galaxy went supernova, dying in a brilliant burst of light. We used the resources of SUNY New Paltz's Smolen Observatory to image this supernova, named SN 2023ixf, in four different photometric filters as often as we could over the course of six months. We then analyzed the 100+ images we took to produce light curves for SN 2023ixf that show how its brightness changed over time in the B, V, R, and I photometric filters. Using our light curves, we were able to confirm what type of supernova SN 2023ixf is, as well as learn about particular features of supernovae.

P6 (UG) **Determining Trap Stiffness of Optical Tweezers**

Jacob Beadle and Vincent Santini

Physics and Astronomy Department, State University of New York at New Paltz

A presentation of the student research done under Dr. Catherine Herne at SUNY New Paltz. Optical tweezers are useful tools which can be used in multiple applications including microbiology, material science, and medicine. Optical tweezers work by focusing intensity at a small beam waist. The photons transfer their momenta into the trapped object. The force of the beams hold on the object acts like Hooke's law force. In this project, a calibration method is used to calculate the force of the trap by it's stiffness and the displacement of an object within the trap. The presentation explains how this is done using optical tools and software and goes in depth into an optical tweezer setup and some of its uses.

Poster Presentations

P7 (HS) **Are Galaxy Tendrils Consistent with the Standard Model of Cosmology?**

Jocelyn Elphick

Saratoga Springs High School

Testing the standard model of cosmology plays a critical role in astrophysics. In previous research, the Millennium Simulation, a cosmic mathematical model, has been compared to real- life observations to determine if it is an accurate representation of the universe. Here, galaxies and groups of galaxies from the Millennium Simulation were used to examine if tendrils, which are large-scale structures that are made up of galaxies, can be found within the simulation, as they have been previously found in observed data sets. Additionally, filaments, also large-scale structures, were searched for as they have also been found in previous studies. The sample of galaxies and groups from the Millennium Simulation included 10,107 galaxies and 1,311 groups. To determine if tendrils could be calculated, the nearest neighbor density (the number of galaxies near another galaxy) was found within the data set for every galaxy and group, as calculated based on the third-nearest neighbor to a galaxy. Then, using the same minimum spanning tree algorithm; that has been applied in real-life observational studies, tendrils along with filaments were searched for in the Millennium Simulation. The algorithm found seven filaments and 65 tendrils, which is similar to reported real-life data. By searching for filaments and tendrils not only did this study validate the accuracy of the Millennium Simulation, but it also provides insight into the dynamics of gravity and dark matter on a large scale.

P8 (UG) **Can We Distinguish Between Cosmic String Cusps and Colliding Blackholes?**

Claire O'Connor and Dr. Eric Myers

Physics and Astronomy Department, State University of New York at New Paltz

Since their discovery, gravitational waves have been deemed to be produced by compact binary coalescences (CBCs). Two bodies orbit each other and slowly lose energy in the form of gravitational waves. Eventually, these bodies merge, thus releasing massive amounts of energy. This research investigates the possibility of another source for the resulting gravitational waves, cosmic string cusps. Cosmic strings are a type of topological defect that are thought to have formed in the early universe as long, dense strings of matter. They interact via intercommutation, which can result in discontinuities known as cosmic string cusps. These cusps travel down the cosmic string, releasing energy in the form of gravitational waves. As of yet, they have not been detected.

Data was sourced from the Gravitational Wave Open Science Center (GWOSC) and was analyzed by way of optimal matched filtering. Through this process, noise and technical limitations were accounted for prior to checking the correlation between recorded events and simulated signals. These simulated signals were checked against both CBC events (detected signals) and cosmic string cusp injections (simulated signals). Signals were compared based on their produced signal-to-noise ratio (SNR). Higher SNR values were associated with a closer match to the provided event or injection. When tested on a combined total of approximately 100 events and injections, cosmic string cusps were shown to be a closer match.

Poster Presentations

P9 (GR)

Unraveling the Dynamics of an Exoplanet in the Goldilocks Zone of α Centauri A & B

Dwiti Krushna Das[1], Ashutosh Pattnaik[2], Soumik Bhattacharyya[3], Ramanlal Dasmandal[4], Samim Akhtar[5], and Subrata Sarangi[6]

[1]*College of Nanotechnology, Science & Engineering, University at Albany, Albany, NY, USA*
[2]*Astronomical Observatory of the Jagiellonian University, Krakow, Poland*
[3]*National Institute of Science Education and Research, Bhubaneswar, Odisha, India*
[4]*Samanta Chandrasekhara Amateur Astronomy Association, Bhubaneswar, Odisha, India*
[5]*Tech Mahindra, Noida, UP, India*
[6]*Centurion University of Technology and Management, Bhubaneswar, Odisha, India*

The search for exoplanets within the Alpha Centauri A (α Cen A) and α Cen B systems has garnered significant attention, with both observational and simulation approaches underway. Prior research suggests that potential Earth-like exoplanets within the habitable zones of the binary system would possess masses approximately below 50 Earth masses for α Cen A and below 10 Earth masses for α Cen B.

In this study, we present the results of orbital dynamics with an orbit integration program utilizing the Leap-Frog algorithm within the open-source SciLab environment. Our simulations involve a 3-body system consisting of α Cen A, α Cen B, and an exoplanet (α Cen Aa) orbiting the former star. Maintaining planet-star mass ratios (M_p/M_A) in the range of approximately 10^{-4} to 10^{-5} aligns with previous findings. The gravitational interactions induce characteristic wobbles in the orbits of both stars, a phenomenon we discuss herein. Furthermore, we are actively pursuing methodologies to enable the experimental detection of such subtle wobbles in star orbits employing Earth-based telescopes.

This research contributes to our understanding of exoplanetary dynamics within binary star systems and holds implications for future observational endeavors aimed at identifying habitable exoplanets. Through numerical simulations and eventual experimental validation, we aim to refine our comprehension of the complex interplay between exoplanets and their host stars, particularly within systems like Alpha Centauri A-B. Our findings underscore the importance of interdisciplinary efforts in advancing exoplanetary science and ongoing efforts to identify habitable worlds beyond our solar system.

P10 (UG)

Surface and Defect Characterization of Coatings for Use in Gravitational-Wave Detectors

Emma Derrick[1], Kace Colby[1], Prottoy Samir[1], Freddy Coronel[1], Hank Zhang[1], Alexandra Fraser[1], Slawek Gras[2], and Antonios Kontos[1]

[1]*Physics Program, Bard College*
[2]*MIT KAVLI Institute*

High temperature annealing is an effective way to decrease mechanical losses on amorphous mirror coatings. However, annealing causes crystallization, which degrades optical quality. TiO_2 doped GeO_2 coatings have been shown to exhibit all the desired optical properties for a mirror coating, but annealing has been shown to create bubbles, which render the coating unusable. In this work, we explored a coating layer structure that had the potential to prevent the formation of bubbles. Using a scattering set-up designed in our lab and microscopy, imaging after annealing has shown that our new structure did not prevent bubble formation after 600°C.

Poster Presentations

P11 (GR) **Surface Analysis of Ru and Ir Thin Films after Device Fabrication Processing Techniques**

Randall Wheeler[1], Shivan Antar[1], Anthony Valenti[1], Carl A. Ventrice, Jr.[1], Matthew Strohmayer[2], Joleyn Brewer[2], Christopher Nassar[2], and Christopher Keimel[2]

[1]*Department of Nanoscale Science and Engineering, University at Albany*
[2]*Menlo Micro, Inc.*

Microelectromechanical systems (MEMS) are micron scale devices with moving parts. In particular, MEMS devices can be used for radio frequency (RF) switches. Ruthenium is often used as the electrical contact material of these MEMS-based RF switches because of its resistance to oxidation at elevated temperatures. In addition, the most stable stoichiometry of ruthenium oxide is RuO_2, which is an electrically conductive oxide. As the power density of MEMS devices is increased, the rate of metal oxide formation on the surface of the metallic Ru contacts is expected to increase, which may adversely affect the performance of the device. Since iridium resists oxidation at high temperatures and also has an electrically conductive native oxide, it may be an alternative contact material for higher temperature applications. Measurements have been made to determine the stoichiometry and thickness of the surface oxide on Ru and Ir films after typical semiconductor fabrication processing techniques such as reactive ion etch (RIE), plasma ashing processes, and annealing in air. The metal thin films are deposited on SiO_2/Si(100) substrates, and the primary analysis techniques used for this study are angle-resolved XPS and AFM.

P12 (UG) **Scattered Light Simulations for 3rd-Gen Gravitational Wave Detectors**

Kace Colby, Emma Derrick, Prottoy Samir, and Antonios Kontos

Physics Program, Bard College

Simulations of light in laser interferometers play a critical role in designing gravitational-wave detectors as these calculations help inform decisions for various parameters. These parameters can include the cavity geometry and the optical properties of the mirrors, chosen with the aim of maximizing the sensitivity of the detector. In this work we present simulations of how scattered light induces noise in Cosmic Explorer, a planned, 3rd Generation GW detector. Specifically, we estimate the noise due to scattered light from seismically excited moving beam-tube baffles. We include the frequency-upshifted noise caused by phase wrapping that occurs when stray lighted is scattered from the baffles and inner walls of the beam tube. This frequency upshift happens when stray light is modulated by motion from the beam tube walls and baffles with amplitude comparable to or greater than the wavelength of the stray light. This stray light can recombine with the main beam, meaning that knowing the correct frequency and amplitude of the recombined light is important when calculating the potential noise in a detector's signal.

Poster Presentations

P13 (GR)

Does the Mass of the Large Magellanic Cloud Inferred from Tidal Streams Depend on the Simulation Technique?

Hiroka T. Warren and Heidi Jo Newberg

Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute

A recent study estimates an unusually large mass for the Large Magellanic Cloud (LMC) from its strong effect on the path the Orphan-Chenab Stream (OCS), a stream of stars in the Milky Way halo that formed from the tidal disruption of a dwarf galaxy. This study finding an LMC mass of 1.38×10^{11} $M_\odot$ used the modified Lagrange Cloud Stripping (mLCS) technique, also known as the particle-spray modeling, in order to generate the model OCS to compare with the measured positions of stream stars. Here, we show that there are significant differences in the spatial locations of stars generated from the more rigorous N-body simulations compared to the faster but more approximate particle-spray modeling of the OCS. We ran N-body simulations with MilkyWay@home code, which is publicly available on GitHub. The particle-spray modeling was generated by the galpy package, streamspray. The differences the position of the stream arise from differences in the stripping radius of the dwarf galaxy stars. While the N-body simulation shows a wide range of particle stripping radius from the center of the dwarf galaxy, the particle-spray modeling releases particles at the same radius in each time step. This inaccuracy in stream location could affect the measurement of LMC mass. In our future work we will quantify the difference in mass estimates between the two simulation techniques.

P14 (GR)

Ga_2O_3 - Next Generation Ultra-Wide Band Gap Semiconductors for Power Electronics

Shruti De[1,2], Sahyadri Anil Patil[1], Adam M Janover[2], Mengbing Huang[2]

[1]*Department of Physics, University at Albany*
[2]*Department of Nanoscale Science and Engineering, University at Albany*

The potential technological development based on gallium oxide (Ga_2O_3) has emerged enormously since the last decade, owing to the attractive material characteristics of gallium oxide (Ga_2O_3), namely, high critical field strength, widely tunable conductivity, mobility, and cost-effective material growth. A major targeted application based on Ga_2O_3 semiconductors is the new-generation power electronics that is expected to operate in more demanding situations (e.g., greater voltages/currents/temperatures) as driven by the technological trend for clean energy. This work discusses why Ga_2O_3 materials are attracting world-wide research attention in such applications. With examples of preliminary data, we show the implementation of different characterization techniques such as XPS (X-ray Photoelectron Spectroscopy) and XRD (X Ray Diffraction) for understanding the material properties of Ga_2O_3 samples. A key effort in research is to understand the role of structural defects toward the defect engineering for enhanced device performance. In the end, there will be a short exploration about DLTS (Deep Level Transient Spectroscopy) technique for characterizations of energy position, concentration and carrier capture cross section of electronic defects in semiconductors.

Poster Presentations

P15 (GR) **Predicting Exoplanet Habitability** ***(A Multifactorial Approach using AI)***

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In recent decades, the evolution of space technology, fueled by advancements in computing such as Artificial Intelligence (AI) and Machine Learning (ML), has profoundly transformed our capacity to explore and study space. The efforts of SpaceX and Blue Origin to commercialize space exploration represent a pivotal paradigm shift, promising to democratize access to space and revolutionize our relationship with the universe. Despite the seemingly boundless expanse of space, it holds vast data reservoirs, now more accessible than ever thanks to cutting-edge space observatories like the James Webb Space Telescope. Observatories like the James Webb and Hubble telescopes have made distant space and exoplanets easily accessible and gather extensive data about the same. Artificial Intelligence helps us clean and analyze this vast amount of data. It can help us generate a prediction model based on the collected data to understand the basic requirements of habitability on a planet now or in the future. To do so, Bayesian data analysis will play a crucial role in predicting the spectral features of extrasolar planets by forecasting spectral bin heights with multi-planetary parameters. Each bin is a function of all these parameters, and spline curves with defined knots can be employed to model spectral bin heights. This iterative process will enhance our understanding of Bayesian techniques and align with the broader goal of characterizing extrasolar planets through innovative data analysis. Ultimately, this endeavor will contribute to a better understanding of Exoplanet habitability in the past, present, or future.