University of Rochester, April 18, 2026

Dear Participants:

Welcome to the 44th annual Rochester Symposium for Physics Students (RSPS). The RSPS was instituted to provide an opportunity for undergraduates to present an account of their own personal research at a meeting whose format was chosen to closely resemble those of professional scientific societies.

At these symposia, research projects are presented in talks or poster sessions by undergraduates representing many regional institutions. Topics include condensed-matter physics, atomic physics and optics, computational physics, astronomy, particle and nuclear physics, instrumentation and techniques, environmental physics, biological physics, medical physics, and educational physics. The abstracts of all the participants' papers are published annually in the RSPS proceedings and distributed to the participants. The information is also available online at: http://www.pas.rochester.edu/news-events/rsps/2026/index.html

Students who present these talks can list their RSPS presentation(s) on their resumes and show the above web page in their list of publications as an "Online Published Abstract". We encourage students to follow up on their research with the aim of giving a presentation at a regular American Physical Society (APS) meeting (which now also has a special session on undergraduate research), and eventually follow up with a publication in a regular journal, or in the APS Journal of Undergraduate Research.

At Rochester, the Department of Physics and Astronomy, Department of Chemistry, Department of Electrical and Computer Engineering and the Institute of Optics are jointly running four National Science Foundation (NSF) funded Research Experience for Undergraduates (REU) sites. We encourage you to apply to one of these summer programs. Examples of research projects, talks, publications and awards won by our REU participants can be found on our REU Web page: https://www.pas.rochester.edu/undergraduate/reu/index.html

Your audience will include both students and faculty members and will provide you with the opportunity to address a knowledgeable and appreciative assembly of fellow researchers. Scientific research is an extraordinary activity. We certainly hope that many of you will decide to pursue careers that involve you intimately in mankind's greatest intellectual adventure, to comprehend nature. To quote Albert Einstein, “The eternal mystery of the world is its comprehensibility.”

Kelly A. Douglass & Sheth Nyibule (Co-Chairs RSPS)
Department of Physics and Astronomy
University of Rochester

LIST OF PRESENTERS

Presenter	Time	Location
Andrew Bo	9:30am	B&L 109
Caroline Carvajal	10:30am	B&L Lobby
Shishir Chhetri	11:30am	B&L 106
Mark Crum	10:30am	B&L Lobby
Artem Denisenko	10:30am	B&L Lobby
Avery Di Iulio	9:30am	B&L 109
Aidan Dombrosky	10:30am	B&L Lobby
Gunnar Gasper	10:30am	B&L Lobby
Kylie Goldade	10:30am	B&L Lobby
David Gutierrez	10:30am	B&L Lobby
Mimi Harrison	10:30am	B&L Lobby
Collin Hitchcock	2:00pm	B&L 106
Randy Hong	10:30am	B&L Lobby
Ryan Jackson	10:30am	B&L Lobby
Cole Jerum	2:00pm	B&L 109
Liam Jones	10:30am	B&L Lobby
Justin Kenneally	9:30am	B&L 106
Jay Kneiss	9:30am	B&L 106
Asher Knight	2:00pm	B&L 109
Elizabeth Kuhlkin	11:30am	B&L 106
Julia Largett	9:30am	B&L 106
Dwayne Lewis	10:30am	B&L Lobby
Bill Luo	11:30am	B&L 109
Neha Matta	2:00pm	B&L 106
Eli Mayes	11:30am	B&L 109
Roshan Mehta	9:30am	B&L 106
Elias Melcher	9:30am	B&L 109
Oskar Moe	10:30am	B&L Lobby
Sophia Pavia	2:00pm	B&L 109
Samuel Plymale	10:30am	B&L Lobby
Shannon Rauch	10:30am	B&L Lobby
Jayden Roh	10:30am	B&L Lobby
Ryland Ross	11:30am	B&L 109
Chenfei Tang	11:30am	B&L 106
Samyak Tuladhar	2:00pm	B&L 106
Nate Tyler	9:30am	B&L 109
Dante Vara	10:30am	B&L Lobby

XLIV RSPS – ROCHESTER SYMPOSIUM FOR PHYSICS, ASTRONOMY AND OPTICS STUDENTS
SPS ZONE 2 REGIONAL MEETING

PROGRAM

8:00 AM – 8:30 AM: REGISTRATION / POSTER SETUP (B&L LOBBY)
8:00 AM – 8:30 AM: CONTINENTAL BREAKFAST (B&L 208)

8:30 AM: WELCOME: PROF. SHETH NYIBULE, UNIVERSITY OF ROCHESTER (B&L 109)

8:40 AM: KEYNOTE SPEAKER: REGINA BARBER, SHORT WAVE HOST (NPR'S SCIENCE PODCAST), "A PHYSICIST'S PATH TO NPR: LEARNING HOW TO SHARE SCIENCE BETTER."

9:30 AM – 10:30 AM: SESSION IA. CONDENSED MATTER & NUCLEAR AND PARTICLE PHYSICS (B&L 109)
SESSION CHAIR: PROF. MARK YULY, HOUGHTON UNIVERSITY

9:30 AM
Deuteron and Triton Induced Light Ion Reactions Produced via High-Power Short-Pulse Lasers
Andrew Bo
Houghton University
Advisor: Prof. Mark Yuly

9:45 AM
Synthesizing Nano-Shapes to Capture Forever Chemicals
Avery Di Iulio, Rachel Fister, Vijaysankar Kalappatil, Nicholas Bingham, Kristen Stojak Repa
SUNY Brockport
Advisor: Prof. Kristen Stojak Repa

10:00 AM
Density Functional Theory Calculations of Hydrogen Permeation through 2D Materials
Elias Melcher, Arjyama Bordoloi, Sobhit Singh, Zachary Robinson
University of Rochester
Advisors: Zachary Robinson and Sobhit Singh

10:15 AM
Design and Construction of a Scanning Tunneling Microscope for the Study of Thin Metal Films
Nate Tyler, Brandon Hoffman
Houghton University
Advisor: Prof. Brandon Hoffman

9:30 AM – 10:30 AM: SESSION IB. ASTRONOMY AND ASTROPHYSICS (B&L 106)
SESSION CHAIR: PROF. SHETH NYIBULE, UNIVERSITY OF ROCHESTER

9:30 AM	**Tracing the Morphology-Density Relation with the DESI Bright Galaxy Survey** Julia Largett, Kelly Douglass and Segev BenZvi **University of Rochester** Advisor: Kelly Douglass, Segev BenZvi
9:45 AM	**Void vs Wall Galaxies: Comparing Galactic Evolution Through Bayesian Methods** Jay Kneiss **University of Rochester** Advisor: Prof. Segev BenZvi and Kelly Douglass
10:00 AM	**Impact-Induced Melting and Mixing for Planetary Collisions** Roshan Mehta, Miki Nakajima **University of Rochester** Advisors: Miki Nakajima
10:15 AM	**Using Statistical Moments of the 2pcf to Measure Primordial Non-Gaussianity** Justin Kenneally **University of Rochester** Advisor: Prof. Regina Demina

10:30AM – 11:25 AM: SESSION II. POSTER SESSION (B&L LOBBY)

Periodic Table of Multiquarks Using Thomas Fermi Statistical Model
Artem Denisenko and Zachary Ames
SUNY Niagara, Baylor University, Neural Innovations LLC, Everest Institute of Science and Technology

Two-Qubit, Small-Scale Quantum Computing as a Laboratory for Teaching: Demonstration & Workflow Design
Aidan Dombrosky, Amanda Flores, Tristan Christofferson
Vassar College

Simulating Nebular Emissions of Supermassive Dark Stars
Gunnar Gasper
Colgate University

Creating a Planetarium Show for the Cradle of Aviation Catholic Health Sky Theater
Kylie L. Goldade, Matthew J. Wright, Kerri E. Kiker, and Daniel Burke
Adelphi University

Developing User Manual Compiled from AI Summaries of Video Tutorials
Mark Crum, David Gutierrez, Shannon Rauch
United States Military Academy at West Point

Identifying Massive Quiescent Galaxy Candidates at $2.5<z<5$ with COSMOS-Web
Mimi Harrison and Jeyhan Kartaltepe
Rochester Institute of Technology

From Muscle Signals to Machines: sEMG-Based Deep Learning Control of Prosthetics
Randy Hong, Ileana Dumitriu, Daniel Graham and Peter Spacher
Hobart and William Smith Colleges

Ecoacoustic Monitoring Analysis of Construction Impacts on a College Campus Soundscape
Ryan Jackson, Ileana Dumitriu, John Halfman, and Peter Spacher
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Path Integral Monte Carlo for Open-Boundary Bosonic Lattices
Liam Jones, Hatem Barghathi, and Adrian Del Maestro
University of Buffalo

Exploring Light Absorption and Emission in Quantum Dot Solar Windows
Dwayne Lewis
Roberts Wesleyan University

Balloon Satellite: Sensor Payload and Data Analysis
Oskar Moe, Benjamin Sullivan, Aidan Lessard
United States Military Academy at West Point

Initial Test of the Ten-Inch Manipulator-Based Short Lived Isotope Counting System
Andrew Bo, Dante Vara, Samuel Plymale, Mark Yuly, Charles Freeman, George Marcus, Stephen J. Padalino, Chad J. Forrest, Arnold Schwemmlein, Ben Stanley, Christian Stoeckl, and Panos Gastis
Houghton College

Balloon Satellite: Mechanics, Design, and Launch Operations
Benjamin Sullivan, Jayden Roh, Caroline Carvajal, Aidan Lessard, Oskar Moe
United States Military Academy at West Point

Measurement of deuteron- and proton-induced lithium reaction cross sections for SLICS detector efficiency calibration
Dante Vara, Andrew Bo, Samuel Plymale, Mark Yuly, Michelle Woods, Silas Richardson, Chris Desiderio, Charles Freeman, George Marcus, Stephen J. Padalino, Chad J. Forrest, Arnold Schwemmlein, Ben Stanley
Houghton University

11:30 AM – 12:15 PM: SESSION IIIA. QUANTUM OPTICS / OTHER (B&L 109)
SESSION CHAIR: NITYA RAVI, UNIVERSITY OF ROCHESTER

11:30 AM **Nonlocal Geometric Phase**
Bill J Luo
Colgate University
Advisor: Prof Enrique J Galvez

11:45 AM **Programable Optical Circuits in Nanophotonic Media**
Eli Mayes
Colgate University
Advisor: Prof Enrique J Galvez

12:00 PM **Design and Implementation of a Modular Two-Dimensional Granular Silo for Photoelastic Force Chain Analysis**
Ryland Ross
Colgate University
Advisor: Prof. Lori McCabe

11:30 AM – 12:15 PM: SESSION IIIB. ASTRONOMY & ASTROPHYSICS (B&L 106)
SESSION CHAIR: PROF. KA-WAH WONG, SUNY BROCKPORT

11:30 AM **X-ray Observation of the Low-Luminosity Active Galactic Nucleus: PKS 0625-354**
Shishir Chhetri
SUNY Brockport
Advisor: Prof Ka-Wah Wong

11:45 AM **Probing the Atmosphere of the Benchmark Brown Dwarf HD 19467B with JWST/NIRSpec and VLT/SPHERE**
Chenfei Tang
University of Rochester
Advisor: Prof. Zhoujian "ZJ" Zhang

12:00 PM **X-ray Observation of the Gamma-Ray Emitting Radio Galaxy NGC 4261**
Elizabeth Kuhlkin, Ka-Wah Wong, Dacheng Lin, Jimmy Irwin, Rodrigo Nemmen, Erin Monie
SUNY Brockport
Advisor: Prof Ka-Wah Wong

12:15 PM – 1:45 PM: LUNCH & PHYSICS CAREER TALK/WORKSHOP
PROF. MATTHEW WRIGHT, ADELPHI UNIVERSITY "*BE A SHARK: CAREERS, NETWORKING*"
(RUSH RHEES LIBRARY – HAWKINS-CARLSON ROOM)

2:00 PM – 3:00 PM: SESSION IVA. INSTRUMENTATION / EXPERIMENTAL TECHNIQUES / OTHER (B&L 109)
SESSION CHAIR: PROF. KRISTEN REPA, SUNY BROCKPORT

2:00 PM **Development of a Single-Shot Spectrometer for Two-Color Plasma THz Sources**
Cole Jerum, Jeremy Pigeon
University of Rochester
Advisor: Prof. Jeremy Pigeon

2:15 PM **A New Evaporator for the Lithium Deposition Chamber at Houghton University**
Asher Knight
Houghton University
Advisor: Prof. Mark Yuly

2:30 PM **DIY Sonar Scanner**
Sophia Pavia
Siena University
Advisor: Prof. Matthew Bellis

2:00 PM – 3:00 PM: SESSION IVB. BIOLOGICAL PHYSICS / EDUCATIONAL PHYSICS / ASTROPHYSICS / OTHER (B&L 106)
SESSION CHAIR: PROF. GEORGE HASSEL, SIENA UNIVERSITY

2:00 PM **Fluid Flow Measurement in Extracorporeal Membrane Oxygenation**
Neha Matta
Siena University
Advisor: Prof. Matthew Bellis

2:15 PM **Computing the CMB Angular Power Spectrum from First Principles**
Collin Hitchcock
Siena University
Advisor: Prof Matthew Bellis

2:30 PM **Visualizing Action: An Interactive Exploration of Classical and Quantum Mechanics**
Samyak Tuladhar
Siena University
Advisor: Prof. John P. Cummings

SYMPOSIUM ABSTRACTS:
SESSION IA. CONDENSED MATTER & NUCLEAR AND PARTICLE PHYSICS

Deuteron and Triton Induced Light Ion Reactions Produced via High-Power Short-Pulse Lasers

Andrew Bo, **Houghton University,** Advisor: Prof. Mark Yuly

Light ion and neutron nuclear reactions can be induced via Inertial Confinement Fusion (ICF) and Target Normal Sheath Acceleration (TNSA) using high-power, short-pulse lasers like the OMEGA-60 and OMEGA-EP lasers at the Laboratory for Laser Energetics. In order to measure these reactions, the Short-Lived Isotope Counting System (SLICS) was developed. SLICS can be inserted into the OMEGA-60 and OMEGA-EP target chambers using a Ten Inch Manipulator (TIM). As an initial test of the SLICS detector, TNSA deuterons struck a natural lithium target to induce ^{7}Li(d,p)^{8}Li reactions. SLICS then counted the beta decays from the ^{8}Li product nuclei to calculate the ^{8}Li yield, to which predicted yields, calculated using previously measured ^{7}Li(d,p)^{8}Li cross-sections, were compared. The TIM based SLICS is now a standard diagnostic for experiments on OMEGA-60 and OMEGA-EP.

Synthesizing Nano-Shapes to Capture Forever Chemicals

Avery Di Iulio, Rachel Fister, Vijaysankar Kalappatil, Nicholas Bingham, Kristen Stojak Repa, **SUNY Brockport,** Advisor: Prof. Kristen Stojak Repa

Per- and poly-fluoroalkyl substances known as PFAS or "forever chemicals" are a group of fluorinated chemicals used in manufacturing due to their non-stick and fire-resistant properties. Consequently, their high chemical resistance results in accumulation throughout the environment, including the human body. Iron oxide nanoparticles are an ideal candidate for magnetic extraction of PFAS from water due to their biocompatibility and magnetic properties. To attract and hold PFAS molecules, iron oxide nanoparticles were coated in an ultra-porous fluorinated silica composite. The presence of a magnetic field causes the nanocomposites, with captured PFAS, to aggregate together, leaving clean water behind. To optimize the extraction process, several shapes and sizes of nanoparticles were produced including spheres, cubes, cuboctahedra, rods, and "octopods" (cubes with concave inward sides), with plans to test their efficacy in PFAS capture. Particles were characterized via transmission and scanning electron microscopy, x-ray diffraction, energy dispersive x-ray spectroscopy, x-ray photoelectron spectroscopy, and magnetometry.

Density Functional Theory Calculations of Hydrogen Permeation through 2D Materials

Elias Melcher, Arjyama Bordoloi, Sobhit Singh, Zachary Robinson,
University of Rochester, Advisors: Zachary Robinson and Sobhit Singh

Efficient separation of hydrogen isotopes has become an important problem in fusion energy. Over the past few years, it has been shown that graphene can act as an isotope separator. Its selectivity for the permeation of different isotopes is largely due to quantum effects. It has also been shown that defects play an important role in this. In this project, I have performed preliminary density functional calculations of hydrogen permeation through a graphene membrane using VASP. The hydrogen permeation barrier that a pristine graphene lattice imposes is 2.9 eV. The role of defects, particularly Stone-Wales and grain boundaries, is currently under investigation. We will share our latest results.

This material is based upon work supported by the Department of Energy [National Nuclear Security Administration] University of Rochester “National Inertial Confinement Fusion Program” under Award Number(s) DE-NA0004144.

Design and Construction of a Scanning Tunneling Microscope for the Study of Thin Metal Films

Nate Tyler, Brandon Hoffman, **Houghton University,** Advisor: Prof. Brandon Hoffman

Houghton University is building a Scanning Tunneling Microscope (STM) to analyze the surface of thin metal films in air at an atomic resolution. A dual-stage vibration isolation system is used to reduce noise. Stepper motors move the scanning head toward the sample surface, after which a piezo buzzer scans a tip across the surface while adjusting the height to maintain a constant current. The position of the tip is therefore an image of the surface. All the electronics are controlled by a Teensy 4.1 microcontroller. The hardware, electronics, and software have been successfully tested independently of one another, but not yet as a complete system.

SESSION IB. ASTRONOMY AND ASTROPHYSICS

Tracing the Morphology-Density Relation with the DESI Bright Galaxy Survey

Julia Largett, Kelly Douglass and Segev BenZvi
University of Rochester

The morphology-density relation, the observed correlation between a galaxy's structure and the density of its environment, is a key diagnostic of galaxy evolution. We trace its development with the Dark Energy Spectroscopic Instrument (DESI) Bright Galaxy Survey (BGS), which contains >10 million galaxies across 14,000 deg^2 at $z < 0.6$. To characterize environment, we reconstruct the underlying large-scale density field using PyCosmoMMF, a NEXUS+-based algorithm that assigns each point in space to one of the four cosmic-web components: clusters, filaments, walls, or voids.

For morphology classification, we use a machine-learning classifier previously developed for the Siena Galaxy Atlas (SGA). The SGA is a catalog of bright, nearby galaxies constructed from the DESI Legacy Surveys. We adapt a pre-trained self-supervised algorithm, ssl-legacysurvey, that clusters galaxy images by color and morphology in a high-dimensional latent space and creates low-dimensional groupings of galaxies based on appearance. We then assign morphological types using a k-nearest-neighbor algorithm applied to the low-dimensional representation.

By combining these classifications with our density-field reconstruction, we quantify how morphology varies with the environment across a large volume of the low-redshift Universe. Although the morphology-density relation is well-established at $z < 0.6$, this work provides the foundation and methodology needed to extend the study to higher redshifts with future surveys.

Void vs Wall Galaxies: Comparing Galactic Evolution Through Bayesian Methods

Jay Kneiss, **University of Rochester**, Advisor: Prof. Segev BenZvi and Kelly Douglass

In this talk I will detail the use of two sample non parametric Bayes-Factor tests as described in Holmes et al. 2015 paper to compare the evolution of void and wall galaxies. The analysis makes use of the large data sets from year 3 of the Dark Energy Spectroscopic Instrument (DESI) survey and void-wall classifications from the Void Analysis Software Toolkit's (VAST) VoidFinder algorithm to create bins of galaxies based on magnitude and redshift. Different properties of the void and wall galaxies in the bin are then compared using the non parametric Bayes-Factor used as a determination of how different the void and wall populations are at that magnitude and redshift range. This quantity is then compared across different redshifts to determine if void and wall galaxies are becoming more or less different across redshift and, by proxy, time. Properties tested include stellar mass, color index, star formation rate, and metallicity.

Early results for low redshift (z < .24) and absolute magnitude between -14 and -20 indicate differences between galaxy environments in all properties besides metallicity, with color index showing the clearest evolution of difference. Possible interpretations and future directions are discussed.

Impact-Induced Melting and Mixing for Planetary Collisions

Roshan Mehta, Miki Nakajima, **University of Rochester**,
Advisor: Miki Nakajima

As a planet forms, it experiences several collisions during the accretion stage. These impacts can induce notable melting in the target mantle and entrainment of the impactor's core in the target body's mantle, altering the planet's composition and thereby its subsequent evolution. Here, we extend the work of Nakajima et al. (2021), which developed scaling laws for the melt-mass, internal energy gain, and spatial heating during planetary impacts.

We perform smoothed-particle-hydrodynamics (SPH) simulations of collisions with impactor-to-total mass ratios of γ = 0.001, 0.003, 0.01, 0.03, 0.1, 0.3 at angles of θ = 0°, 30°, 45°, 60°, and 90°. Once the target body reaches a steady state, we quantify the impact-induced melting and how much of the impactor's core is entrained in the mantle. We find that for γ = 0.001 and γ = 0.003, the previous scaling laws of Nakajima et al. (2021) can underestimate the amount of melting that occurs. We also find that the entrainment of the impactor's core in the target mantle is most prominent for θ = 60° and a small impactor mass, and decreases sharply for nearly all other cases, differing from previous investigations (e.g., Marchi et al. (2018)).

Using Statistical Moments of the 2pcf to Measure Primordial Non-Gaussianity

Justin Kenneally, **University of Rochester**, Advisor: Prof. Regina Demina

The theory of cosmic inflation suggests that the universe, in its very early stages, underwent a period of rapid expansion. It is unclear what mechanisms drove this expansion, as such there are many different theories about how this expansion occurred. These theories make different predictions about the present day overdensity distribution of the universe, with the simplest prediction positing that the two-point correlation function (2pcf) of the overdensity takes the form of a Gaussian distribution. Deviations of the 2pcf from the Gaussian distribution is called Primordial non-Gaussianity, and is quantified by a parameter fNL. Measuring fNL with higher accuracy will thus grant us deeper insight as to what caused cosmic inflation. In hopes of making our measurements of fNL more precise, I am creating a statistical model which measures fNL by utilizing the first three moments of the 2pcf. This presentation will discuss the motivation, methodology, and current progress of this work.

SESSION II. POSTER SESSION

Periodic Table of Multiquarks Using Thomas Fermi Statistical Model

Artem Denisenko and Zachary Ames
SUNY Niagara, Baylor University, Neural Innovations LLC, Everest Institute of Science and Technology

The study analyzes all combinations of tetra- and penta- quarks using a semiclassical model of modern physics. The indications of existence of the particles are obtained by calculating ground state energies of the systems by implementing Thomas Fermi density functions, assuming that the temperature is zero and the cloud is spherically symmetric. The long-term goal of the study is to create a first-of-its-kind periodic table of multiquark particles.

Two-Qubit, Small-Scale Quantum Computing as a Laboratory for Teaching: Demonstration & Workflow Design

Aidan Dombrosky, Amanda Flores, Tristan Christofferson
Vassar College

In this work, we describe the integration of a two-qubit quantum computer, based on nuclear magnetic resonance, into a research and teaching environment at the undergraduate level. Using a sequence of progressively complex experiments, we illustrate how hands-on access to a small-scale quantum computer can clarify core concepts of quantum mechanics and computing, such as superposition, entanglement, and tomography. We discuss the practical challenges encountered by students, including calibration and discrepancies between simulated and experimental outcomes. These obstacles prove to be valuable teaching opportunities to introduce the realities of uncertainty in quantum devices. We believe that this quantum laboratory bench can effectively bridge the gap between abstract quantum coursework and experimental quantum information science training.

Simulating Nebular Emissions of Supermassive Dark Stars

Gunnar Gasper
Colgate University

The James Webb Space Telescope has observed many compact, luminous objects in the young universe, much too massive and bright too early to fit current galactic models. One solution are Supermassive Dark Stars, stars made of hydrogen and helium that are fueled by dark matter self-annihilation. Such objects could grow to millions of solar masses and billions of solar luminosities, matching observations. Dark Stars can be simulated using tools to predict specific unique absorption and emission lines, as well as fit nebulae around them to account for their spectroscopic effects.

Creating a Planetarium Show for the Cradle of Aviation Catholic Health Sky Theater

Kylie L. Goldade, Matthew J. Wright, Kerri E. Kiker, and Daniel Burke
Adelphi University

Stories Behind the Stars is an original planetarium program developed for the Cradle of Aviation's Catholic Health Sky Theater, designed to integrate astronomical education with cultural storytelling. The program begins with an introduction to the celestial sphere, star naming conventions, and the role of the International Astronomical Union (IAU). The second segment features a randomized selection of one of the 88 IAU-recognized constellations, allowing for the narration of its historical and cultural significance. This randomized structure ensures unique experiences for returning audiences and highlights lesser-known constellations. Content development draws from academic astronomy coursework, scholarly research, IAU materials, and diverse cultural sources. The program is implemented using Digistar 7, a hybrid Lua–Python environment, presenting both technical and pedagogical challenges. By blending scientific accuracy with narrative engagement, this project aims to enhance public understanding of astronomy through immersive, repeatable experiences.

Developing User Manual Compiled from AI Summaries of Video Tutorials

Mark Crum, David Gutierrez, Shannon Rauch
United States Military Academy at West Point

Many programs and devices in astronomy require hours of user-manual videos to be utilized properly. The West Point Observatory is attempting to use artificial intelligence (AI) to summarize the instructional videos for their equipment to create a concise how-to guide for operating the imagery analysis software. In this study, Gemini, ChatGPT, and Copilot were all tested to compare the quality of each AI's ability to break down and interpret the videos. The testing was measured by the success of following the steps that the AI's produced. Then, at the conclusion we summarized the results from each model and wrote our own user-manual utilizing the best parts of each model that can be used by future cadets.

Identifying Massive Quiescent Galaxy Candidates at 2.5<z<5 with COSMOS-Web

Mimi Harrison and Jeyhan Kartaltepe
Rochester Institute of Technology

Massive galaxies exhibit a bimodal distribution in the Universe, consisting of active star-forming and quiescent populations persisting through high redshifts. Theoretical models of galaxy evolution and hierarchical structure formation cannot explain how galaxies in the cosmologically young Universe could become quenched of star formation in significant numbers so quickly. With access to revolutionary observational equipment and sample sizes larger than previously possible, we present and verify a sample of 250 high-redshift quiescent galaxy candidates selected from the COSMOS-Web catalogs using rest-frame color-color diagrams to identify and distinguish these galaxies from active star-forming ones. Spectral energy distribution models, using flux measurements from the COSMOS-Web survey, test whether these candidates fit a typical quiescent galaxy's SED profile. Data from JWST's NIRCam instrument reveal the morphologies of these high-redshift quiescent candidates. Finally, archival spectroscopic data confirm quiescence and the efficacy of color-color techniques at higher redshifts. The volume of data and the extensive area covered by COSMOS-Web provide a window into the formation and evolution of some of the earliest massive galaxies of the Universe.

From Muscle Signals to Machines: sEMG-Based Deep Learning Control of Prosthetics

Randy Hong, Ileana Dumitriu, Daniel Graham and Peter Spacher
Hobart and William Smith Colleges

Surface electromyography (sEMG) is a widely utilized biomedical technique that employs non-invasive skin surface sensors to record neural signals controlling skeletal muscles. Through signal processing via deep learning models, sEMG signals can be translated into precise robotic manipulation for various applications. This project explores the recreation of humanistic movement within robotic systems using a 3D-printed prosthetic hand capable of motor function via servo motors. sEMG sensors placed on arm's skin of a human subject recorded neural signals sent to the arm's muscles. The recorded neural signals from sEMG sensors are input into an Arduino. The Arduino uses deep learning models to output joint-angle predictions of the user's hand. Subsequently, these joint-angle predictions will be mirrored by the prosthetic through rotation of each prosthetic fingers' respective servo motors. This could open a way for a potential application of human-machine interfaces integrated with drone technology to intuitively control robotic systems. The primary challenge that exists is processing neural signals to accurately reflect the user's movement and intention. Three deep learning models' ability to decipher movement were used: gesture classification that recognizes predefined hand gestures; pose regression that predicts joint-angle coordinates; and pose tracking that predicts motion within each joint. Each method was assessed through their ability to accurately and timely replicate an individual's hand gestures using the 3D-printed prosthetic hand highlighting their strengths and weaknesses. By identifying performance trade-offs across sensing and learning approaches, this study contributes to the engineering of adaptive, sensor-integrated human–machine interfaces for advanced robotic systems.

Ecoacoustic Monitoring Analysis of Construction Impacts on a College Campus Soundscape

Ryan Jackson, Ileana Dumitriu, John Halfman, and Peter Spacher
Hobart and William Smith Colleges

Ecoacoustic monitoring uses environmental sound as a non-invasive sensor to assess ecological structure, human activity, and environmental disturbance across space and time. By analyzing patterns in acoustic energy, frequency content, and variability, ecoacoustics provides a scalable framework for environmental mapping and monitoring. In semi-urban settings such as college campuses, construction activity presents a natural opportunity to examine how short-term anthropogenic disturbances alter local soundscapes.

This study investigated how the soundscape of a college campus changed during the construction of a new science building using principles from acoustic ecology and geospatial analysis. Ambient sound was recorded at multiple locations across the Hobart and William Smith Colleges campus using a stereo microphone (Lewitt LCT 040 Match) and a field recorder (Zoom F3). Each recording site was georeferenced into Geographic Information System (GIS), allowing acoustic measurements to be analyzed in a spatial context. Fourier spectral analysis and ecoacoustic indices were applied to quantify changes in acoustic complexity associated with anthropogenic noise.

GIS enables the stacking of multiple layers such as land use, vegetation, topography, and human infrastructure, providing essential spatial context for acoustic data. The sound data were analyzed to model spatial dependence, evaluate spatial autocorrelation, and assess how construction-related noise propagated across the campus. This interdisciplinary framework demonstrates how coupling ecoacoustics with GIS enhances the interpretation of environmental sound data, allowing soundscapes to be treated as spatially distributed signals rather than isolated measurements. The results highlight the potential of ecoacoustics-GIS integration as a scalable tool for environmental monitoring.

Path Integral Monte Carlo for Open-Boundary Bosonic Lattices

Liam Jones, Hatem Barghathi, and Adrian Del Maestro
University of Buffalo

The superfluid phase of the 1D Bose-Hubbard (BH) model at zero temperature can be described in the continuum by Luttinger liquid (LL) theory with bozonized phase and density fluctuations. For open boundary conditions (OBC), LL models predict Friedel oscillations in the ground state boson density due to breaking of translational symmetry. Motivated by such predictions, in this research we implement OBC in a zero-temperature path integral Monte Carlo (PIMC) algorithm for the BH model to study ground state observables. We benchmark energy and density estimators with OBC against exact diagonalization (ED) calculations and observe the expected error scaling with increasing projection length. Additionally, we introduce a one-body correlation matrix estimator implemented via non-canonical PIMC measurements. We then demonstrate Friedel oscillations in a 48-site system at quarter filling and perform nonlinear fitting to a reduced functional form for comparison with LL theory predictions. The algorithm employed here is extensible to general dimensions for square lattices as well as to honeycomb, kagome, and other 2D lattice types, inviting discussion of future implementations.

Exploring Light Absorption and Emission in Quantum Dot Solar Windows

Dwayne Lewis
Roberts Wesleyan University

Quantum dots are nanoscale semiconductor particles with tunable optical properties, making them promising materials for solar energy applications. In this project, I investigate how self-absorption and Stokes shift affect photon transport in quantum dot solar windows. Using computational simulations, I modeled photon absorption, emission, and transport in quantum dot arrays with varying sizes and densities. The simulations track how photons are reabsorbed or escape the material, allowing analysis of efficiency under different configurations. Preliminary results indicate that higher quantum dot density increases self-absorption, reducing photon escape efficiency, while larger Stokes shifts improve photon extraction. These findings provide insight into the design of more efficient quantum dot-based solar windows , which could improve solar energy capture in buildings and contribute to renewable energy solutions. This work is ongoing, with plans to explore additional configurations and validate simulation results against experimental data. By simulating photon transport in these materials, this project demonstrates a computational approach to understanding and optimizing quantum dot solar energy systems.

Balloon Satellite: Sensor Payload and Data Analysis

Oskar Moe, Benjamin Sullivan, Aidan Lessard
United States Military Academy at West Point

In a joint mission between the United States Military Academy, Vassar College, and SUNY New Paltz, five USMA cadets worked alongside faculty, officers, and students from partner institutions to launch a high-altitude balloon carrying a multi-institution scientific payload. The payload included sensors designed and prepared by student researchers from all three colleges. This presentation focuses on the instruments flown aboard the balloon, including environmental sensors, navigation and tracking hardware, and student-designed data-collection modules. We outline the preparatory steps taken prior to launch, such as programming microcontrollers, powering and integrating payload components, and conducting ground tests to ensure reliable operation at altitude. We present the data obtained during ascent, float, and recovery, and highlight key observations and lessons learned from the mission. Balloon satellite launches offer a unique combination of scientific research, engineering practice, and mission execution, making them a valuable hands-on experience that strengthens cadets' technical communication skills, expands their understanding of space-related operations, and supports their development as future officers in an increasingly space-enabled Army.

Initial Test of the Ten-Inch Manipulator-Based Short Lived Isotope Counting System

Andrew Bo, Dante Vara, Samuel Plymale, Mark Yuly, Charles Freeman, George Marcus, Stephen J. Padalino, Chad J. Forrest, Arnold Schwemmlein, Ben Stanley, Christian Stoeckl, and Panos Gastis.
Houghton College

The Short-Lived Isotope Counting System (SLICS) is designed to measure cross sections for astrophysically relevant light-ion reactions and energies. The dE-E phoswich detector telescope, which identifies beta particles from decaying 20 ms to 20 s half-life reaction product nuclei, has been redesigned to fit in a Ten-Inch Manipulator (TIM) for insertion in the OMEGA-60 and OMEGA-EP target chambers at the Laboratory for Laser Energetics. In the first test of the new design, ^{8}Li decays were detected after the ^{7}Li(d,p)^{8}Li reaction was triggered by a pulse of OMEGA-EP target normal sheath acceleration (TSNA) deuterons. This poster presents a description of the new design and preliminary test results.

Balloon Satellite: Mechanics, Design, and Launch Operations
Benjamin Sullivan, Jayden Roh, Caroline Carvajal, Aidan Lessard, Oskar Moe
United States Military Academy at West Point

Five cadets from the United States Military Academy, together with students and faculty from Vassar College and SUNY New Paltz, collaborated on the design and launch of a high-altitude balloon satellite. Balloon satellite missions have a long history at USMA, beginning in 2010 and totaling thirteen launches prior to a brief pause in 2023. This year, the program was restarted as a joint inter-institutional effort. Our team designed the payload enclosure, parachute system, radar reflector, and tracking components, and incorporated payload modules contributed by all three colleges. We describe the practical steps involved in planning a successful launch, including FAA regulations, site selection to avoid ocean landings, calculation of the required lift, and determining the appropriate helium volume to achieve the desired ascent rate and maximum altitude. We also discuss insulation strategies for protecting electronics in the stratosphere and procedures for testing and validating the GPS tracker and onboard systems. This project provided valuable experience in scientific system design, mission planning, and multidisciplinary coordination -- skills essential both for future research work and for the professional development of cadets preparing for technical roles in the Army.

Measurement of deuteron- and proton-induced lithium reaction cross sections for SLICS detector efficiency calibration
Dante Vara, Andrew Bo, Samuel Plymale, Mark Yuly, Michelle Woods, Silas Richardson, Chris Desiderio, Charles Freeman, George Marcus, Stephen J. Padalino, Chad J. Forrest, Arnold Schwemmlein, Ben Stanley
Houghton University

The Short-Lived Isotope Counting System (SLICS) was developed identify and count beta decays of product nuclei produced by light-ion reactions generated with high-power short-pulse lasers using inertial confinement fusion (ICF) or target normal sheath acceleration (TNSA). An experiment was performed in 2024 to measure the efficiency of this detector by creating a known amount of ^{8}Li at a point in front of the detector, then counting the resulting number of detected beta decays. Unfortunately, previous measurements of the ^{7}Li(d, p)^{8}Li, ^{7}Li(p, α)^{4}He, and ^{6}Li(d, α)^{4}He cross sections needed to predict the amount of 8Li vary widely. To address this problem, an experiment was carried out using the SUNY Geneseo

Pelletron in which 1.1 MeV, 1.3 MeV and 1.5 MeV protons and deuterons were incident on a self-supporting 116 nm thick gold foil coated with thin layer of natural lithium. The elastic scattering from the gold, ^{6}Li and ^{7}Li yielded the beam current, and 6Li and 7Li thickness, respectively. Measurement of charged particle energy spectra at angles of 40°, 60°, 90°, 120°, 140°, 160°, and 166° allowed the relevant cross sections to be determined.

SESSION IIIA. QUANTUM OPTICS

Nonlocal Geometric Phase

Bill J Luo, **Colgate University**, Advisor: Prof Enrique J Galvez

Geometric phase is a phase that is dependent solely on the geometry of a path taken by a system. Quantum entanglement is a phenomenon where entangled particles within a quantum system have correlated measurements. We sought to combine these ideas by verifying that cyclic polarization transformations on entangled photons where each photon takes a different path is equivalent to the same polarization transformations on one photon. Our results showed that applying polarization transformations on either entangled photon is equivalent to applying polarization transformations on one photon. From this work, we concluded that as long as the order of the polarization transformations is preserved, we can freely move polarization-transforming optical elements between entangled photons.

Programable Optical Circuits in Nanophotonic Media

Eli Mayes, **Colgate University**, Advisor: Prof Enrique J Galvez

Optical circuits are used for many tasks including quantum and classical communications. Optical circuits are typically capable of accomplishing a limited number of tasks due to rigidity in their creation. This project addresses this shortcoming by creating an optical system to create a programmable optical circuit using adaptive optics and a scattering media. Similar work is being done with multi-mode fibers, but there has not been much research into the use of nanophotonic media. In this paper, we will be attempting to verify the first half of the optical setup for the programmable optical circuit. Although we have not successfully verified the first half of the optical circuit, we have been able to verify the alignment of the system, the generation of our bases, and have been able to observe partial focusing during the data collection for the physics informed neural network. This project is the first part of a larger investigation which hopes to be a proof of concept for an n x m programmable optical circuit utilizing spatial separated input modes.

Design and Implementation of a Modular Two-Dimensional Granular Silo for Photoelastic Force Chain Analysis

Ryland Ross, **Colgate University**, Advisor: Prof. Lori McCabe

This research advances experimental studies of granular materials through the design and construction of a modular two-dimensional silo system optimized for photoelastic analysis. Building on prior work that established a reliable fabrication method for uniform polyurethane photoelastic particles and validated a darkfield circular polariscope configuration, this project focuses on developing an experimental platform capable of systematically investigating granular flow behavior. The apparatus consists of a 2 ft tall by 1 ft wide quasi-two-dimensional silo designed to accommodate interchangeable internal geometries, including adjustable outlet widths, funnel angles, and modular inserts positioned along the flow path. This flexibility enables controlled studies of phenomena such as force chain transmission, arch formation, and clogging in granular media. The system is integrated with a calibrated optical polariscope and imaging setup to capture stress-induced birefringence patterns during particle flow. By providing a configurable environment for controlled granular experiments, this platform enables quantitative investigation of how boundary conditions and internal structures influence stress propagation and flow stability. The resulting dataset and apparatus establish a foundation for future studies of granular dynamics and clogging mitigation strategies.

SESSION IIIB. ASTRONOMY & ASTROPHYSICS

X-ray Observation of the Low-Luminosity Active Galactic Nucleus: PKS 0625-354

Shishir Chhetri, **SUNY Brockport**, Advisor: Prof Ka-Wah Wong

Among many of the TeV-emitting extragalactic sources, only a few of them belong to radio galaxies with misaligned jets, a type of low-luminosity active galactic nuclei. , The origin of the TeV emission, as well as that of the X-ray emission of these TeV radio galaxies, is still not well understood. In this work, we study one of the TeV radio galaxies, PKS 0625–354, observed with the NuSTAR X-ray Observatory. Hard X-ray emission above 10 keV is detected from the source for the first time. The emission in the 15–20keV band is clearly detected with a significance of about 6σ, while weaker emission (2.5σ) is seen in the 20–25 keV band and no significant emission is detected at higher energies. Image analysis was performed to examine the spatial structure of the source in both soft (3–7 keV) and hard (15–20 keV) bands. This suggest that the hard X-ray is likely coming from region near supermassive black hole instead of background sources. The origin of the hard X-ray emission and its implication for the TeV emission will be discussed.

Probing the Atmosphere of the Benchmark Brown Dwarf HD 19467B with JWST/NIRSpec and VLT/SPHERE

Chenfei Tang, **University of Rochester**, Advisor: Prof. Zhoujian "ZJ" Zhang

HD 19467 B is a benchmark brown dwarf companion whose spectra exhibit molecular absorption features from H_2O, CH_4, CO, and CO_2, making it an excellent target for atmospheric characterization. We have analyzed its 1--5um near-infrared spectra using data from JWST/NIRSpec and VLT/SPHERE observations, and determined its physical and chemical properties using atmospheric retrievals, which compare observed spectra with theoretical models through a Bayesian data-driven framework. We have performed detailed retrieval analysis that explores a range of modeling assumptions, including different temperature-pressure parameterizations, prior choices, cloudy versus cloud-free scenarios, and equilibrium versus disequilibrium chemistry. From these retrievals, we constrained key properties including chemical composition, surface gravity, radius, atmospheric thermal structure, and cloud properties. These results place HD 19467 B in the broader context of recent studies of substellar atmospheres and underscore the importance of model selection in the interpretation of brown dwarf spectra.

X-ray Observation of the Gamma-Ray Emitting Radio Galaxy NGC 4261

Elizabeth Kuhlkin, Ka-Wah Wong, Dacheng Lin, Jimmy Irwin, Rodrigo Nemmen, Erin Monie, **SUNY Brockport**, Advisor: Prof Ka-Wah Wong

Gamma-ray emitting radio galaxies are very rare, and their gamma-ray emission mechanisms remain unclear. We investigate the gamma-ray emitting radio galaxy NGC 4261 hosting a low-luminosity active galactic nucleus (LLAGN) using X-ray data from the NuSTAR and Chandra observatories. Previous studies suggest that X-ray emission originates from the jets. However, the possibility of radiatively inefficient accretion flows (RIAF) significantly contributing to the X-rays cannot be ruled out. Hard X-ray emission $\gtrsim$ 10 keV had never previously been detected, making it challenging to distinguish between models. We report the first detection of hard X-ray emission and present our study of the origin of the X-ray emission. Our results also place constraints on the synchrotron self-Compton (SSC) model, which is believed to be the high energy emission mechanism in gamma-ray emitting radio galaxies.

SESSION IVA. INSTRUMENTATION / EXPERIMENTAL TECHNIQUES / OTHER

Development of a Single-Shot Spectrometer for Two-Color Plasma THz Sources

Cole Jerum, Jeremy Pigeon, **University of Rochester**, Advisor: Prof. Jeremy Pigeon

Photoionization by the fundamental (ω) and second harmonic (2ω) components of a laser pulse can drive a net plasma current, leading to the generation of broadband terahertz (THz) radiation. With this method, different frequencies of the generated THz radiation constructively interfere at distinct angles. We present the design of a single-shot THz spectrometer that exploits this angular dispersion of two-color THz generation through the use of fast elliptical mirrors – mapping this angular content onto a detector array. An ammonia vapor cell serves as a spectral fiducial for verification and calibration. This presentation discusses the optical design and expected performance of the spectrometer.

A New Evaporator for the Lithium Deposition Chamber at Houghton University

Asher Knight, **Houghton University**, Advisor: Prof. Mark Yuly

Light ion nuclear reaction experiments using ultra-fast high-power lasers performed at the Lab for Laser Energetics (LLE) use thin lithium films to measure nuclear cross sections using Inertial Confinement Fusion (ICF) or Target Normal Sheath Acceleration (TNSA). To make these films, a new lithium evaporator system has been developed at Houghton University. The new evaporator is easier to install, separates the two evaporator boats in order to evaporate one material at time for multilayer targets, uses a linear feedthrough to position the substrates, and incorporates a deposition rate monitor to control the layer thickness. Because lithium reacts with air, the new design allows the creation of a protective layer to coat the lithium film, and the deposition chamber is inside of an argon glove box. This presentation will describe the motivation, design, and advantages of the new system.

SESSION IVB. BIOLOGICAL PHYSICS / EDUCATIONAL PHYSICS / OTHER

DIY Sonar Scanner

Sophia Pavia, **Siena University**, Advisor: Prof. Matthew Bellis

This project explores the physics of ultrasonic waves and phased array beamforming through the construction of a low-cost sonar-based imaging system. The system uses an array of eight ultrasonic transducers operating at approximately 40 kHz, which emit sound pulses with carefully controlled time delays. By introducing small timing differences between each transducer, the waves interfere constructively and destructively, allowing the direction of the beam to be steered electronically without any moving parts. A single receiver detects the reflected signals, and the strength of these echoes is analyzed as a function of angle to build a basic spatial map of the surrounding environment. So far, my work has focused on assembling the circuitry using surface-mount components, learning micro-soldering techniques, and beginning to implement the control algorithms needed for phase shifting. Moving forward, I plan to improve the resolution and depth of the system to create more detailed images. Overall, this project builds a strong foundation for understanding technologies like medical ultrasound, which use similar physics principles for imaging inside the human body.

Fluid Flow Measurement in Extracorporeal Membrane Oxygenation

Neha Matta, **Siena University**, Advisor: Prof. Matthew Bellis

This project explores the design of Extracorporeal Membrane Oxygenation (ECMO). ECMO is a life support machine that supports the heart and lungs by pumping the blood out of the body, through an oxygenator, and back into the body. One major component of ECMO is the minimally intrusive flow measurement, which I chose to study primarily. To do this, I am building a system that measures the flow rate of water using a wheel flow meter, arduino, a photosensor, and an iphone flashlight.

Computing the CMB Angular Power Spectrum from First Principles

Collin Hitchcock, **Siena University**, Advisor: Prof Matthew Bellis

The Cosmic Microwave Background (CMB) angular power spectrum conveys the physics of Baryon Acoustic Oscillation (BAO). These are the imprint of sound waves from the early universe, and understanding where it's features come from requires building it from the ground up. I present a forward computation of the CMB angular power spectrum from its first principles that uses real Planck SMICA data by implementing the spherical harmonic decomposition from scratch. The associated Legendre polynomials were calculated by stable l-recurrence with normalized coefficients that prevent numerical overflows occurring at high values of ℓ. The results were validated against SciPy's spherical harmonic function and HEALPix's anafast function, with the computation being accelerated by Numba JIT compilation. Progressively increasing ℓ max mirrors the historical improvement in angular resolution from COBE through WMAP to Planck and directly demonstrates what physical scales become resolvable at each stage. This provides physical intuition for the connection between the power spectrum and the underlying BAO structure.

Visualizing Action: An Interactive Exploration of Classical and Quantum Mechanics

Samyak Tuladhar, **Siena University**, Advisor: Prof. John P. Cummings

Action is one of the most fundamental aspects of physics, yet it remains a barely-explored topic in undergraduate curricula. While classical mechanics and quantum mechanics texts invoke the principle of least action and Feynman's path integral formulation, students graduate with limited conceptual understanding and minimal hands-on experience. This project presents an interactive visualization application that enables students and physics enthusiasts to directly explore how action determines classical and quantum behavior. Using visualizations to clarify the concepts of action and how it changes in different potentials. This project has two aspects: the first mode introduces action and shows how kinematics and mechanics follow from the principle of the least action. The second mode introduces action in a quantum framework, emphasizing Feynman's "sum-of-all-paths" method and its relationship to the classical path. Through this project, we hope to have intuitive and clear explanations and visualization about actions that can help the student not only understand action, but see it in classical and quantum mechanical contexts, and help them understand one of the most fundamental concepts in physics.

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