Rochester, April 2, 2016

Dear Participants:

Welcome to the 35th 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 on line at

http://www.pas.rochester.edu/news-events/rsps/2016/index.html

Students who present these talks can list their RSPS presentation(s) on their resumes and

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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.”

Frank Wolfs (Chair RSPS)

LIST OF SPEAKERS

NAME	ROOM	TIME
Matthew Andrews	B&L 407	11:00 AM
Elijah Beaudin	B&L 106	9:30 AM
Rik Brown	B&L 407	2:00 PM
Sarah Carkner	B&L 407	10:30 AM
Lisong Chen	B&L 109	9:45 AM
Cody Ciaschi	B&L 106	10:45 AM
Kyle Craft	B&L 109	9:00 AM
Oliver Di Nallo	B&L 109	2:00 PM
Adam Dukehart	B&L 109	11:15 AM
Thomas Eckert	B&L 109	10:30 AM
Rashman Ejaz	B&L 208	10:00 AM
Michael Englert	B&L 407	9:00 AM
Nathan Fritz	B&L 407	11:45 AM
Usman Ghani	B&L 208	10:00 AM
David Giannella	B&L 106	11:15 AM
Tyler Godat	B&L 106	2:30 PM
Spencer Griswold	B&L 208	10:00 AM
August Gula		

NAME	ROOM	TIME
Andrew Redman	B&L 208	10:00 AM
Jack Rogers	B&L 407	9:15 AM
Marie T. Romano	B&L 208	10:00 AM
Joey Rowley	B&L 407	10:45 AM
Ryan Rubenzahl	B&L 106	9:00 AM
Benjamin Saltzman	B&L 407	3:15 PM
Brendan Sheehan	B&L 407	2:45 PM
Matthew Tenorio	B&L 407	2:15 PM
Rashman Ejaz	B&L 208	10:00 AM
Jack Valinsky	B&L 109	11:30 AM
Laurel Vincett	B&L 109	11:00 AM
Ziyue Wang	B&L 109	9:15 AM
Stephanie Warnken	B&L 106	2:00 PM
Miranda Wharram	B&L 106	2:15 PM
Jonathon Yuly	B&L 407	9:45 AM
Jonathan Zeosky	B&L 208	10:00 AM

XXXV – ROCHESTER SYMPOSUM FOR PHYSICS (ASTRONOMY AND OPTICS) STUDENTS
SPS ZONE 2 REGIONAL MEETING

PROGRAM

8:15 AM – 8:45 AM: REGISTRATION AND POSTER SETUP (B&L LOBBY)

8:45 AM: WELCOME: PROF. FRANK WOLFS, UNIVERSITY OF ROCHESTER (B&L 109)

9.00 AM – 10:00 AM: SESSION IA. NUCLEAR AND PARTICLE PHYSICS (B&L 109)

SESSION CHAIR: JOSEPH EBERLY, UNIVERSITY OF ROCHESTER

9:00 Remote Operation of a Farnsworth-Hirsch Fusor
Kyle Craft, Houghton College

9:15 Observation of Coherent Production of K^+ in Neutrino Interactions on Carbon Nuclei
Ziyue Wang and Chris M. Marshall, University of Rochester

9:30 The Hadron Resonance Gas Model at Various Heavy-Ion Collision Energies
Bradley Miles, Colgate University

9:45 Study of Next-to-Leading Order QCD and Electroweak Corrections to Higgs Boson Production in the Bottom Quark Fusion Process
Lisong Chen, University at Buffalo

9:00 AM – 10:00 AM: SESSION IB. ASTRONOMY AND ASTROPHYSICS (B&L 106)

SESSION CHAIR: PROF. ANTHONY CLARK, UNITED STATES MILITARY ACADEMY

9:00 Simulating Outrigger Tanks around the HAWC Gamma Ray Observatory
Ryan Rubenzahl and Segev BenZvi, University of Rochester

9:15 What it Takes to Make an Observatory Operational
Abigail Daniel and Kristopher Korzan, United States Military Academy

9:30 Using the Galaxy Correlation Function to Constrain the Nature of Dark Matter
Elijah Beaudin, Dr. John Moustakas and Dr. Matthew Bellis, Siena College

9:45 Mission Analysis of the NSF CubeSat Firefly
David Knapick, Siena College

9:00 AM – 10:00 AM: SESSION IC. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES (B&L 407)

SESSION CHAIR: PROF. GRAZIANO VERNIZZI, SIENA COLLEGE

9:00 Implementing Field-Programmable Gate Array Technology with a Neutron/Gamma Ray Pulse Shape Discrimination Algorithm
Michael Englert, Siena College

9:15 An In-Depth Analysis of Dust Particles With SEM
Jack Rogers,

Simulating the Penetrating Power of High-Energy Particles in HgCdTe Detector

Joshua Rosser, University of Rochester

Indirect Detection of Extrasolar Liquid Water

10:30 AM – 11:45 AM: SESSION IIIA. NUCLEAR AND PARTICLE PHYSICS (B&L 109)

SESSION CHAIR: PROF. CANDICE FAZAR, ROBERTS WESLEYAN COLLEGE

10:3

2:00 PM – 3:00 PM: SESSION IVA. NUCLEAR AND PARTICLE PHYSICS/OTHER (B&L 109)

SESSION CHAIR: PROF. MARK JULY, HOUGHTON COLLEGE

2:00 Track construction from nuclear recoils in detector gas
Samuel Jung, Oliver Di Nallo and Rebecca Jeffery, United States Military Academy

2:15 Finding the Differential Scattering Cross Section of High Energy Neutrons
CDT Alix Idrache, United States Military Academy

2:30 Motorized Control of Radio Telescope
Debra Johnson, Siena College

2:45 Constraining uncertainties in Climate Change: measuring the reflective and absorptive properties of water vapor
Danielle Moruzz, Siena College

2:00 PM – 3:00 PM: SESSION IVB. BIOLOGICAL PHYSICS, EDUCATIONAL PHYSICS AND QUANTUM OPTICS (B&L 106)

SESSION CHAIR: PROF. BRANDON HOFFMAN, HOUGHTON COLLEGE

2:00 Balanus Amphitrite Atomic Disorder in Differing Environments
Stephanie Warnken and Dr. Rebecca Metzler, Colgate University

2:15 Conservation of Momentum
Miranda Wharram, SUNY Brockport

2:30 Quantum communication with Alice and Bob
Tyler Godat, University of Rochester

2:45 Harmonic Vibrational Frequencies: Approximate Global Scaling Factors for the TPSS, M06, M08, and M11 functional families using common basis sets
CDT Roberts G. Nelson, United States Military Academy

2:00 PM – 3:15 PM: SESSION IVC. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES (B&L 407)

SESSION CHAIR: PROF. MARK ROSENBERRY, SIENA COLLEGE

2:00 Water Level Control of a Two Tank System
Rik Brown, Siena College

2:15 MightyOhm Geiger Counter Sensitivity
Matthew Tenorio, Siena College

2:30 Worrying About Finding a Date with a Best-Fit Line
Brendan Sheehan, Colgate University

2:45 Aberration Corrected Electron Optics for Next Generation Streak Tube Design
Jeremy Hassett, University of Rochester

3:00 Design of an apochromatic diffraction-limited collection lens system for the VISAR/SOP diagnostic
Benjamin Saltzman, University of Rochester

SESSION IA. NUCLEAR AND PARTICLE PHYSICS

Remote Operation of a Farnsworth-Hirsch Fusor

Kyle Craft, Houghton College

The Farnsworth-Hirsch fusor at Houghton College is being modified to allow remote operation. The Farnsworth-Hirsch fusor is a type of inertial electrostatic confinement fusion device that can produce neutrons from deuterium-deuterium fusion reactions as well as x-rays from high-energy electrons. The original Sorensen high voltage power supply has been replaced with a Bertan 815-30N that is able to be controlled remotely through the use of an external analog set voltage. To control and monitor the pressure inside of the chamber, a Apex AX-MC-50SCCM-D mass flow controller and a CCM501 cold-cathode ion gauge are used. LabVIEW code running on a remote computer controls the devices over an ethernet-to-serial interface. Details of the implementation will be discussed, as well as preliminary results from the remote operation of the fusor.

Observation of Coherent Production of K^{+} in Neutrino Interactions on Carbon Nuclei

Ziyue Wang and Chris M. Marshall, University of Rochester

Neutrino-induced charged-current coherent kaon production, $\nu\ A \rightarrow\ ^{-}K\ A$, is an inelastic and extremely rare electroweak interaction. In this interaction, a low four-momentum exchange with the nucleus brings a $^{+}$ on shell and leaves the nucleus intact in its ground state. This interaction is significantly more rare than its counterpart, neutrino charged-current coherent pion production because of Cabibbo suppression and kinematic suppression due to the larger kaon mass. We search for such events in the scintillator tracker of MINERvA by observing the final state $^{+}$ and $^{-}$, no other detector activity, and using the kinematics of the final state particles to reconstruct the small momentum transfer to the nucleus, which is a model-independent characteristic of the process. We find evidence for the process at 3! significance.

The Hadron Resonance Gas Model at Various Heavy-Ion Collision Energies

Bradley Miles, Colgate University

The Hadron Resonance Gas model can be applied to the thermal system formed in a heavy-ion collision. Previous work with this model made various simplifying assumptions about the collision and post-collision cooldown -- we aim to relax these assumptions. In past research, the baryon density was set equal to zero (as in very high collision energies), our work allows for a nonzero baryon density. This allows us to investigate the thermodynamics of heavy ion collisions at a variety of beam energies. Our main results are the calculation of various thermodynamic quantities including both finite baryon density and chemical freeze-out (non-equilibrium evolution of the system).

SESSION IB. ASTRONOMY AND ASTROPHYSICS

Simulating Outrigger Tanks around the HAWC Gamma Ray Observatory

Ryan Rubenzahl and Segev BenZvi, University of Rochester

We simulated sixteen different configurations for possible outrigger tank candidates to be used in an expansion of the HAWC Gamma Ray Observatory. We used the HAWC collaboration's simulation software AERIE, which uses a combination of Geant4, CORSIKA, and collaboration-developed C++ and Python to accurately simulate air-shower particles derived from a gamma ray impacting the atmosphere so that we could inject these air-shower particles into each of the different outrigger configurations. The different configurations included varying tank sizes, two internal linings with differing reflectivities, and opposing PMT orientations. We simulated incoming muons and gammas over a range of energies entering the tanks at varying radial separations from the center of the tank. We found the tanks with upward-facing PMTs to collect more overall light, but for the amount of light to decrease with radial separation. Tanks with downward-facing PMTs were found to acquire a more uniform response, with the amount of light either staying constant or increasing with increasing radial separation.

What it Takes to Make an Observatory Operational

Abigail Daniel and Kristopher Korzan, United States Military Academy

In 2016 the West Point Science Building underwent a major renovation that allowed for the creation of an Astronomical Observatory well-equipped for research-grade observation and astrophotography. Our presentation will detail the current progress we have taken in making the Observatory functional, as well as the steps required to develop high-quality astrophotography images.

Using the Galaxy Correlation Function to Constrain the Nature of Dark Matter

Elijah Beaudin, Dr. John Moustakas and Dr. Matthew Bellis, Siena College

Distance measurements between galaxies, and their resulting correlations, reveal much about the large-scale structure of the universe and the gravitational effects of dark matter. Using data from the Sloan Digital Sky Survey and the utilization of high performance computing, we sought to study the gravitational effects of dark matter, the evolution of the relative densities of baryonic matter, dark matter, and dark energy, and how these affect the observed separations between galaxies. We have developed a suite of tools in Python, which takes advantage of standardized astrophysics libraries, to select the relevant SDSS data and calculate the one-dimensional and two-dimensional two-point correlation functions.

Mission Analysis of the NSF CubeSat Firefly
David Knapick, Siena College

The NSF Firefly CubeSat is a 3U mission designed to perform cutting-edge science, as a secondary payload. Firefly is the first dedicated mission launched to study Terrestrial Gamma ray Flashes (TGFs), their link to lightning, and their effect in producing energetic electrons that may become stably trapped in the inner radiation belt. Firefly combines a gamma ray / electron scintillation detector, VLF radio receiver, and optical photometers to perform simultaneous measurements of lightning and TGFs from a single platform. Firefly will push the boundaries of TGF detection and build on the successes of past missions such as RHESSI, CGRO, AGILE, and Fermi by pursuing focused TGF science. Firefly demonstrates the capability of small missions such as CubeSat to do important, focused science, with abundant student involvement, and with a minimal budget and available resources. This presentation will highlight the science objectives of the mission and analyze how orbital perturbations effect the lifetime of Firefly. In particular, studying how solar activity can cause temperature fluctuations in the atmosphere, which will cause atmospheric density to change. This change in atmospheric density can greatly alter the lifetime of Firefly and future CubeSat missions.

Design and Construction of an X-ray Diffractometer

Margaret Kirkland, Houghton College

An X-ray diffractometer (XRD) is being built at Houghton College for the purpose of analyzing thin metal films. X-rays are produced via electron bombardment of the source target using a HiTeck 40 kV, 25 mA variable power supply. Lin Engineering 101411 stepper motors are mounted with a 96:1 gear ratio to produce sample and detector position precisions of 0.019 degrees per full step. A LabVIEW program has been written to control data collection and stepper motors. Lead and steel shielding surrounds the

SESSION II. POSTER SESSION

Progress Towards an LES Wall Model Including Unresolved Roughness

Kyle Craft and Andrew Redman, Houghton College

Wall models used in large eddy simulations (LES) are often based on theories for hydraulically smooth walls. While this is reasonable for many applications, there are also many where the impact of surface roughness is important. A

Electric Transport of Organic Polymer Thin Film Semiconductors

Nicholas Jira, Vincent Debiase, Ildar Sabirianov and Carolina C. Ilie, SUNY Oswego

We discuss herein the nanocomposite organic thin film diodes for the use of plasmonic solar cells. This experimental work follows the theoretical calculations done for plasmonic solar cells using the MNPBEM toolbox for MatLab. These calculations include dispersion curves and amount of light scattering cross sections for different metallic nanoparticles. This study gives us clear ideas on what to expect from different metals, allowing us to make the best choice on what to use to obtain the best results. One specific technique for light trapping in thin films solar cells utilizes metal nanoparticles on the surface of the semiconductor. The characteristics of the metal, semiconductor interface allows for light to be guided in between them causing it to be scattered, allowing for more chances of absorption. The samples were fabricated using organic thin films made from polymers and metallic nanoparticles, more specifically Poly(1-vinylpyrrolidone-co-2-dimethylaminoethyl methacrylate) copolymer and silver or gold nanoparticles. The two fabrication methods applied include spin coating and Langmuir-Blodgett technique. The transport properties are obtained by analyzing the I-V curves and bad gap calculations.

Synchronization of Josephson Junction Neuron Circuits

Kidane Kebede and Kenneth Segall, Colgate University

We study the collective dynamics of neural networks using the non-linear properties of coupled Josephson Junction circuits that model biologically realistic neurons. Previous studies have observed a phase-flip bifurcation in the synchronization of coupled JJ neurons on a superconducting chip fabricated with the help of Hypres, Inc. We present similar experimental behavior observed on a new, characteristically different chip containing JJ neurons. We perform numerical simulations of synchronization behavior as a function of varying coupling parameters in order to confirm observed phase-flip bifurcation computationally.

Design and Characterization of Single and Double Layer Polyaniline: Poly(L-lactic) Acid Thin Films for Human Mesenchymal Stem Cell (hMSC) Classification Applications

Rachel Maizel, Emily Laurilliard and

varying layering techniques. Results show there was no significant difference in the resistances of films fabricated from different layering techniques. All films adhered to the glass under dry conditions; however, none of the films withstood adhesion to the glass when introduced to phosphate-buffered saline (PBS)

Polarization Forces felt by Chiral Molecules

Joshua Mills and Enrique Galvez, Colgate University

A Test of the Validity of Inviscid Wall-Modeled LES
Andrew Redman and Kyle Craft, Houghton College

Computational expense is one of the main deterrents to more widespread use of large eddy simulations (LES). As such, it is important to reduce computational costs whenever possible. In this vein, it may be reasonable to assume that high Reynolds number flows with turbulent boundary layers are inviscid when using a wall model. This assumption relies on the grid being too coarse to resolve either the viscous length scales in the outer flow or those near walls. We are not aware of other studies that have suggested or examined the validity of this approach. The inviscid wall-modeled LES assumption is tested here for supersonic flow over a flat plate on three different grids. Inviscid and viscous results are compared to those of another wall-modeled LES as well as experimental data–the results appear promising. Furthermore, the inviscid assumption reduces simulation costs by about 25% and 39% for supersonic and subsonic flows, respectively, with the current LES application. Recommendations are presented as are future areas of research.

Trends in Neuro-Fuzzy Networks: Frequent Issues & Novel Approaches
Marie T. Romano, SUNY Oswego

Fuzzy neural networks integrate the advantages of artificial neural networks and fuzzy logic. Neural networks are utilized for pattern recognition and fuzzy logic allows for the reasoning of uncertain and imprecise information. Implementing this hybrid system poses common issues to researchers, such as difficulty in deciding fuzzy partition locations, slow convergence when data is large and difficulty in evaluating comparative

Indirect Detection of Extrasolar Liquid Water

Anthony Terzolo and Melissa A. Morris, SUNY Cortland

Phyllosilicates are hydrous minerals that are created by the interaction of rock and liquid water. Phyllosilicates are found in abundance in certain types of meteorites originating

Advanced Optics Imaging

Shane Linehan, Siena College

There is only so much that can be observed with the naked eye, which is why the telescope is such a fundamental asset for astronomers. Among the various tools at an astronomer's disposal is the CCD, or charged coupled device. It's an integrated circuit that works by collecting and storing light in the form of pixels and converting those pixels into electrical charges. Using the CCD coupled with the AO8, an adaptive optics unit that allows an SBIG camera to attain the best image resolution that a telescope isTJ ET Q q 0.24 0 0 0

SESSION IIIC. CONDENSED MATTER PHYSICS

Design and assembly of inert gas annealing chamber for aluminum nitride films

Heather LaVallee and Zachary Robinson, SUNY Brockport and Virginia Anderson,

SESSION IVA. NUCLEAR AND PARTICLE PHYSICS/OTHER

Track construction from nuclear recoils in detector gas

Constraining uncertainties in Climate Change: measuring the reflective and absorptive properties of water vapor

Danielle Moruzz, Siena College

SESSION IVB. BIOLOGICAL PHYSICS, EDUCATIONAL PHYSICS AND QUANTUM OPTICS

Balanus Amphitrite Atomic Disorder in Differing Environments

Stephanie Warnken and Dr. Rebecca Metzler, Colgate University

Ocean acidification due to increasing carbon dioxide in the environment results in the decrease in pH of the water and can negatively affect marine species. Climate change also alters the salinity of the oceans because the water cycle. More precipitation will decrease salinity and freezing waters or increased evaporation will lead to higher salinities. The changes in ocean chemistry lead to negative changes in the mechanical properties of the shells. The process in which changes in seawater chemistry affect the process of biomineralization and the local disorder in the crystals is not well understood. Balanus amphitrite samples grown in varying levels of salinity were studied. By using Fourier Transform Infrared Spectroscopy, we were able to analyze the amount of disorder in the biomineral structure of the samples using grinding curve peak height ratios. The amount of disorder increased as salinity decreased. Gaining a better understanding of the effect of environment on atomic disorder will aid in the study of climate change, and how marine organisms are impacted.

Conservation of Momentum

Miranda Wharram, SUNY Brockport

Conservation of momentum (linear and angular) is an important and difficult concept for beginners. We use a combination of videos (to record events) and a free software platform (Tracker) to generate visual and analytical material to help show/demonstrate conservation of momentum (P) in one and two dimensions. In 1D we use air tracks (3m) and record two cart collisions and using Tracker we generate position versus time plots for both carts and analyze those graphs to obtains the carts momentums (P = mv). The momentum of an object being a vector quantity we extend the procedure(s) to 2D. However, in 2D, there is an added conceptual step of angular momentum (L = r x p), particularly when the objects are not just point objects, but possess a physical size and shape. We use an air table and record col -0.3 (e-0.5 Q) 0.2 (rt0.2 (i) 0.6 u6i) 0.6 u6in -0.3.D8thamv321.8

Aberration Corrected Electron Optics for Next Generation Streak Tube Design

Jeremy Hassett, University of Rochester

Research on the next generation streak tube will be presented where the electron optics are capable of controlling all third order aberrations and providing sub-10 μm resolution in two dimensions. The current design borrows ideas from quadrupole-octupole type spherical aberration correctors used in electron microscopes. A combination of quadrupole lenses provides the proper astigmatic beam shapes within the integrated octupole fields, and images the electrons emitted from the photocathode. The octupole fields are used to control the three main third order aberrations induced in the system: spherical aberration, fourfold astigmatism, and star aberration. This design is intended to bridge the gap between the ~30 μm resolution of the best streak cameras and the 0.1 nm resolution of many electron microscopes. This resolution improvement will inspire many experimental measurements that are currently unachievable with streak cameras.

LIST OF PARTICIPANTS

Name		**Institution**
Kurt Aikens	Faculty	Houghton College
Jonathan Ballard	Undergraduate Student	Houghton College
Elijah Beaudin	Undergraduate Student	Siena College
Rik Brown	Undergraduate Student	Siena College
Sarah Carkner	Undergraduate Student	Siena College
Lisong Chen	Undergraduate Student	University of Buffalo
Cody Ciaschi	Undergraduate Student	Siena College
Anthony Clark	Faculty	United States Military Academy
Micah Coats	Undergraduate Student	Houghton College
Kyle Craft	Undergraduate Student	Houghton College
Abigail Daniel	Undergraduate Student	United States Military Academy
Vincent DeBiase	Undergraduate Student	SUNY Oswego
Amanda Depoian	Undergraduate Student	Siena College
Oliver Di Nallo	Undergraduate Student	

Kristopher Korzan	Undergraduate Student	United States Military Academy
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WHERE IS LUNCH?

BUILDING 48, DANFORTH DINING HALL.