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 show the above web page in their list of publications as an "On-line Published Abstract". We encourage students to follow up on their research with the aim of giving a presentation at a regular 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 and the Institute of Optics are jointly running two 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:

http://www.pas.rochester.edu/special/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.”

Frank Wolfs (Chair RSPS)
Department of Physics and Astronomy
University of Rochester

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	B&L 109	10:45 AM
Jeremy Hassett	B&L 407	3:00 PM
Kathryn Hollowood	B&L 208	10:00 AM
Alix Idrache	B&L 109	2:15 PM
Nicholas Jira	B&L 208	10:00 AM
Debra Johnson	B&L 109	2:30 PM
Kidane Kebede	B&L 208	10:00 AM
Margaret Kirkland	B&L 407	9:30 AM
David Knapick	B&L 106	9:45 AM
Kristopher Korzan	B&L 106	9:15 AM
Heather LaVallee	B&L 407	11:15 AM
Shane Linehan	B&L 106	11:00 AM
Luke Lyle	B&L 407	11:30 AM
Rachel Maizel	B&L 208	10:00 AM
Bradley Miles	B&L 109	9:30 AM
Joshua Mills	B&L 208	10:00 AM
Danielle Moruzzi	B&L 109	2:45 PM
Roberts Nelson	B&L 106	2:45 PM
Haejun Oh	B&L 208	10:00 AM
Kevin Osse	B&L 106	10:30 AM

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, Siena College

9:30 Design and Construction of an X-ray Diffractometer
Margaret Kirkland, Houghton College

9:45 Design and Construction of An Atomic Force Microscope
Jonathon Yuly, Houghton College

10:00 AM – 10:30 AM: SESSION II. POSTER SESSION (LOBBY AND B&L 208)

Progress Towards an LES Wall Model Including Unresolved Roughness
Kyle Craft and Andrew Redman, Houghton College

Doubling the 1.98GHz Pulse Rate of an Optical Comb Generator for Precision Time-base Calibration of Streak Cameras.
Rahman Ejaz, University of Rochester

Vortex and Breather Collisions in Josephson Junction Ladder
Usman Ghani, Colgate University

Characterization of Electron Showers in the MINERvA Test Beam Detector
Spencer Griswold and Amy Filkins, Clarkson University and SUNY Geneseo

Classifying Frog Calls Using Gaussian Mixture Model and Locality Sensitive Hashing
Kathryn Hollowood, Olatide Omojaro, Dalwinderjeet Kular, Eraldo Rebeiro Ph.D., Florida Institute of Technology

Electric Transport of Organic Polymer Thin Film Semiconductors
Nicholas Jira, Vincent Debiase, Ildar Sabirianov and Carolina C. Ilie, SUNY Oswego

Synchronization of Josephson Junction Neuron Circuits
Kidane Kebede and Kenneth Segall, Colgate University

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 Kim Michelle Lewis, Rensselaer Polytechnic Institute

Polarization Forces felt by Chiral Molecules
Joshua Mills and Enrique Galvez, Colgate University

Cosmic Ray Detection with Scintillation Detectors
Haejun Oh and Dr. Seongtae Park, University of Rochester and Center for Axion and Precise Physics (CAPP) at Institute for Basic Science (IBS) in Daejeon, Republic of Korea

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

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

Simulating the Penetrating Power of High-Energy Particles in HgCdTe Detector
Joshua Rosser, University of Rochester

Indirect Detection of Extrasolar Liquid Water
Anthony Terzolo and Melissa A. Morris, SUNY Cortland

Modeling Resonance Ionization
Jonathan Zeosky, Colgate University

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

SESSION CHAIR: PROF. CANDICE FAZAR, ROBERTS WESLEYAN COLLEGE

10:30 Efficiency Calibration of NaI Detectors for Measuring the $^{12}C(n, 2n)^{11}C$ Cross Section
Thomas Eckert, Houghton College

10:45 A Low Activity Mössbauer Source to Test General Relativity using the Transverse Doppler Effect
August Gula, Houghton College

11:00 Modifications to the Houghton College Cyclotron
Laurel Vincett, Houghton College

11:15 Searching for Neutron-Antineutron Annihilations at Daya Bay
Adam Dukehart, Siena College

11:30 Silicon Tracker for CMS Detector at CERN: R&D Phase II Upgrade
Jack Valinsky, Professor Regina Demina, Sergey Korjenevski, University of Rochester

10:30 AM – 11:30 AM: SESSION IIIB. ASTRONOMY AND ASTROPHYSICS (B&L 106)

SESSION CHAIR: ERIC MAMAJEK, UNIVERSITY OF ROCHESTER

10:30 Renewable Energy Storage: A Heavy Solution to a Heavy Problem
Kevin Osse, Siena College

10:45 Making Exoplanets Great Again
Cody Ciaschi and John Moustakas, Siena College

11:00 Advanced Optics Imaging
Shane Linehan, Siena College

11:15 Crustal Failure on Icy Moons and Satellites from a Strong Tidal Encounter
Alice C. Quillen, David Giannella, John G. Shaw, Cindy Ebinger, University of Rochester

10:30 AM – 12:00 PM: SESSION IIIC. CONDENSED MATTER PHYSICS (B&L 407)

SESSION CHAIR: PROF. MOHAMMED TAHAR, SUNY BROCKPORT

10:30 Elastic Buckling of Pored Membranes
Sarah Carkner, Graziano Vernizzi, Siena College

10:45 From Viruses to Fullerenes: Monte Carlo Studies of Polyhedral Nano-structures
Joey Rowley, Graziano Vernizzi, Siena College

11:00 Effect of Deposition Rate on RMS Roughness of Indium Thin Films
Matthew Andrews and Zachary Robinson, SUNY Brockport

11:15 Design and assembly of inert gas annealing chamber for aluminum nitride films
Heather LaVallee and Zachary Robinson, SUNY Brockport and Virginia Anderson, Neeraj Nepal and Charles Eddy Jr., U.S. Naval Research Laboratory

11:30 Phase Transition in Vanadium Dioxide Nanostructures
Luke Lyle, University at Buffalo

11:45 The Optical Dynamics of Liquid Crystals. An investigation of the dynamics and characteristics of Nematic Liquid Crystals for use in the optical field
Nathan Fritz, Colgate University

12:00 PM – 1:00 PM: LUNCH (DANFORTH DINING HALL - BLDG 48 ON THE MAP AT THE END OF THE PROCEEDINGS

1:00 PM – 2:00 PM: PHYSICS JEOPARDY (B&L 109)

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, $\nu_\mu A \to \mu^- K^+ A$, is an inelastic and extremely rare electroweak interaction. In this interaction, a low four-momentum exchange with the nucleus brings a K^+ 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 K^+ and μ^-, 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 3σ 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).

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

Higgs boson production in bottom quark fusion or in association with bottom quarks is an important process for probing Beyond the Standard Model (BSM) scenarios at the CERN Large Hadron Collider (LHC). The theory predictions for these processes have to be under excellent theoretical control to be able to search for BSM couplings of the newly discovered Higgs boson. We first performed an analytic calculation of Next-to-Leading Order (NLO) corrections in Quantum Chromodynamics (QCD). We then compared our results with the ones of a state-of-the-art automated tool called GoSam and found agreement. After this validation step, we then used GoSam to calculate the electroweak NLO corrections. As a final step, we implemented these calculations in a Monte Carlo simulation program to obtain results for the production of a Higgs boson in the annihilation of a bottom and anti-bottom quark pair at the LHC.

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.

SESSION IC. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES

Implementing Field-Programmable Gate Array Technology with a Neutron/Gamma Ray Pulse Shape Discrimination Algorithm

Michael Englert, Siena College

Field-Programmable Gate arrays (FPGAs) are a fully customizable way to design integrated circuits. They represent an upgrade over a previous procedure called Application Specific Circuits (ASICs) in that they allow the user to make modifications to circuitry after manufacturing. Thus, FPGAs offer the advantages of minimized costs and increased performance to electrical and software engineers. We utilize the Zedboard, an FPGA development kit containing 85,000 programmable logic cells to process and optimize a neutron/gamma ray pulse shape discrimination algorithm using data obtained from NASA.

An In-Depth Analysis of Dust Particles With SEM

Jack Rogers, Siena College

Elemental analysis of dust was performed utilizing energy dispersive spectroscopy (EDS) on a scanning electron microscope (SEM) to elemental map samples from various locations. Samples were analyzed on carbon tape affixed to an aluminum stage, and were collected in numerous rooms and hallways from two main locations, the science academic building and main academic building, in order to quantify potential differences in the composition of dust as a function of location. Normalizing to the most highly concentrated element, after carbon and oxygen, it was found that for almost every location, the element being normalized to was calcium. However, applying a standard statistical t-test analysis showed very distinct and noticeable differences between each location; every room could be characterized by at least one element that peaked above the total average concentration of all rooms. This suggests that given the average elemental composition of each location, it would be possible to determine from which location an unknown sample was taken.

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 XRD and tests confirm no detectable increase in radiation levels above background (0.05mRem/hour). An interlock system will also be incorporated as an added safety measure.

Design and Construction of An Atomic Force Microscope
Jonathon Yuly, Houghton College

Progress towards the design and construction of a cost-effective Atomic Force Microscope (AFM) has been made at Houghton College. High voltage (1 kV) transistor amplifiers drive a tubular piezo-electric “leg” actuators in an effort to realize a “Johnny-walker” type mechanism. To image using tapping mode, another piezoelectric crystal will drive a scanning probe near its resonant frequency, while an optical deflection system measures cantilever oscillations using a Conex PSD-9 position sensing device. A spring/eddy-current dampening system will reduce building vibrations. The system will be controlled via a program written in LabVIEW.

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 previously developed wall model has been used primarily for jet engine aeroacoustics. However, jet simulations have not accurately captured thick initial shear layers found in some experimental data. This may partly be due to nozzle wall roughness used in the experiments to promote turbulent boundary layers. As a result, the wall model is extended to include the effects of unresolved wall roughness through appropriate alterations to the log-law. The methodology is tested for incompressible flat plate boundary layers with different surface roughness. Correct trends are noted for the impact of surface roughness on the velocity profile. However, velocity deficit profiles and the Reynolds stresses do not collapse as well as expected for higher roughness. Possible reasons for the discrepancies as well as future work are presented.

Doubling the 1.98GHz Pulse Rate of an Optical Comb Generator for Precision Time-base Calibration of Streak Cameras.

Rahman Ejaz, University of Rochester

A time-delayed optical path length multiplexing technique is used to double the effective pulse rate of a 1.98GHz Vertical Cavity Surface Emitting Laser (VCSEL) optical comb generator. The 1mW average power, 665nm, 60ps picket width 1.98GHz output is delivered through a 100/140µm n.a 0.29 GRIN Fiber. Propagating through the multimode fiber randomizes polarization. The fiber output is collimated and split into two paths using a polarizing beamsplitter cube. A relative time delay of 253.0±0.5 ps is introduced between the p-polarized and s-polarized beam paths, followed by recombination using a second polarizing beamsplitter cube. The recombined collimated paths are focused (imaged) into the output fiber. OSLO was used to model, analyze and optimize the optical system. Analysis indicates energy throughputs >90%; a non-polarization splitting and recombining technique throughput is <50%. Mechanical mounts were designed to hold, align and adjust the optical elements with minimal instrumental complexity. The two 1.98GHz paths are interleaved creating a 3.96GHz comb with <1ps of inter-pulse phase mismatch

Vortex and Breather Collisions in Josephson Junction Ladder
Usman Ghani, Colgate University

Vortices and breathers can exist in the ladder array coupling arrangement of Josephson Junctions. The results of collisions between vortices and breathers have been simulated in previous work however, they have never been observed. The Josephson Junction ladder was used to observe these collisions and the results were found to match the simulations.

Characterization of Electron Showers in the MINERvA Test Beam Detector
Spencer Griswold and Amy Filkins, Clarkson University and SUNY Geneseo

The MINERvA detector is designed to take precision measurements of neutrino-nucleus scattering using the NuMI beam at the Fermi National Accelerator Laboratory in Batavia, IL. It is composed of a scintillator-based inner tracking region surrounded by electromagnetic and hadronic sampling calorimetry. A scaled-down version of the MINERvA detector was operated in a hadron test beam at the Fermilab Test Beam Facility to measure calorimetric response to protons, pions, muons and electrons with 2-8 GeV/c momentum. The scope of this project was to characterize the transverse profile and energy distributions of electron showers in these 'Test Beam' data. A muon plane-by-plane calibration was used to ensure data quality. These measurements will be used to tune the MINERvA detector simulations and evaluate systematic uncertainties in measurements taken by the main detector. This project was supported in part by NSF award PHY-1156339.

Classifying Frog Calls Using Gaussian Mixture Model and Locality Sensitive Hashing
Kathryn Hollowood, Olatide Omojaro, Dalwinderjeet Kular, Eraldo Rebeiro Ph.D., Florida Institute of Technology

The state of the environment is a state of concern. Pressures such as littering, pollution, and climate change deteriorate the natural habitats. To help repair this, we need some way to track these habitat damages. We need a bio-indicator. Frogs make excellent bio-indicators due to their permeable skin. This skin allows them to absorb water and Oxygen. However, when they live in polluted areas they absorb toxins as well. As pollution rates rise, their populations suffer decline. Citizen scientists have been monitoring frog calls for years as a way to track their populations. This process requires a sizable time commitment, training, and expensive equipment. This research focuses on using machine learning methods to analyze a visual representation of the frequency distribution and key features of the sound of the frog calls. The two machine learning methods that were compared were Gaussian Mixture Models and Locality Sensitive Hashing. Tests performed on a dataset of frog calls of 15 different species produced promising classification results for the Gaussian Mixture Model approach.

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 Kim Michelle Lewis, Rensselaer Polytechnic Institute

The goal of this study is to develop a method to sort and homogenize human mesenchymal stem cell (hMSC) phenotypes based on their electrophysiological properties. Polyaniline: Poly(L-lactic) Acid (PANI:PLLA) thin films were fabricated as a biocompatible and electroconductive substrate to seed the hMSCs and effectively obtain a current-voltage (I-V) curve of each individual cell utilizing a current sensing atomic force microscope (CSAFM). This paper presents a comparison between the resistance and adhesion to glass microscope slides of PANi:PLLA thin films fabricated from

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

We investigate a proposed force felt by chiral molecules, F = b□H. The direction of this force is related to the chirality of a molecule, and would allow for chiral separation, which is of interest primarily to the pharmaceutical industry in testing individual enantiomer effects. The magnitude for this force is thought to be significantly weaker than present detection methods can observe. A magnification technique is proposed and tested in order to increase the precision of our detection apparatus. However, this magnification technique still needs to be implemented into the full apparatus to observe the proposed force.

Cosmic Ray Detection with Scintillation Detectors

Haejun Oh and Dr. Seongtae Park, University of Rochester and Center for Axion and Precise Physics (CAPP) at Institute for Basic Science (IBS) in Daejeon, Republic of Korea

Our curiosity towards the characteristics of cosmic rays lead us to believe that there must be a relationship between certain conditions and the rate of cosmic rays penetrating our environment. Cosmic rays are very small and travel at near the speed of light. What if we could measure that rate per minute? Surly, it must depend on the direction at which the cosmic rays approach our surface. After asking these questions, we seek to find the relationship between the coincidence rate of the muons and the separation of the two scintillation detectors. We can guarantee that the two signals occurring at the same time and coinciding is detected to be a cosmic ray. In order to find the flux of cosmic rays in many various angles, we have oriented the detectors horizontally and vertically. The measurements were compared to the precisely approximated prediction from the codes I made. We were able to conclude that the measurements did agree with the predictions we made.

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 performances of different architectures. Here, common issues in neuro-fuzzy modeling are explored and novel approaches to system modeling are analyzed.

Simulating the Penetrating Power of High-Energy Particles in HgCdTe Detectors
Joshua Rosser, University of Rochester

Detector arrays flown on space telescopes, such as the proposed NEOCam mission, must be able to withstand cosmic ray hits in space. The two largest flux components are form protons and alpha particles (Simpson, 1983). I simulated the energies below which each particle stops in the HgCdTe infrared cutoff material, and found that protons with energies below 5.1 MeV are stopped in the detector, and alpha particles with the same energy stop ¼ of the distance into the material that the protons stop. These are the most potentially damaging particles, as higher energy particles tend to pass through the detector and impart less energy. Some shielding will be present. I found that for 3 mm shielding, these low-energy damaging particles will be stopped by the shielding. It was ultimately found that protons with energies less than 24 MeV and alpha particles with energies less than 95.75 MeV will be stopped.

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 from the asteroid belt, providing evidence for liquid water in the early Solar System. Most phyllosilicates show a distinct emission in the mid-infared portion of the electromagnetic spectrum, and can be detected in extrasolar disks. We have analyzed the spectra of several candidate extrasolar planetary systems, and have found the signature of phyllosilicates in the extrasolar disks RX J1111.7-7620, 1RXS J161410.6-230542, 1RXS J132207.2-693812, RX J1612.6-1859, and HII 2881. The detection of phyllosilicates in these disks would indicate the presence of liquid water and indicate a similarity to our own Solar System. We present a comparison of our model spectral energy distribution (SED) of the protoplanetary disk RX J1111.7-7620 to observations obtained by the Spitzer Space Telescope.

Modeling Resonance Ionization

Jonathan Zeosky, Colgate University

The goal of my research is to create a realistic and useful simulation of Rb and Sr atoms in an electric field. This model is being created to optimize resonance ionization rates in a time of flight mass spectrometer to be used for on surface dating of extra planetary bodies. At the current time we have a complete model of a three-state atom, we now seek to find conditions that will optimize the performance of our device.

SESSION IIIA. NUCLEAR AND PARTICLE PHYSICS

Efficiency Calibration of NaI Detectors for Measuring the $^{12}C(n, 2n)^{11}C$ Cross Section

Thomas Eckert, Houghton College

One possible inertial confinement fusion diagnostic involves tertiary neutron activation via the $^{12}C(n, 2n)^{11}C$ reaction. A recent experiment to measure this reaction cross section involved coincidence counting the annihilation gamma rays produced by the positron decay of ^{11}C using a pair of NaI detectors. This requires an accurate value for the full-peak coincidence efficiency of the NaI detector system. The GEANT 4 toolkit was used to develop a Monte-Carlo simulation of the detector system that was used to calculate the required efficiencies. For validation, simulation predictions have been compared with the results of two experiments. In the first, full-peak coincidence positron annihilation efficiencies were measured for ^{22}Na decay positrons that annihilate in a small plastic scintillator. In the second, a NIST-calibrated ^{68}Ge source was used. A comparison of calculated with measured efficiencies, as well as $^{12}C(n, 2n)^{11}C$ cross sections, will be presented.

A Low Activity Mössbauer Source to Test General Relativity using the Transverse Doppler Effect

August Gula, Houghton College

An experimental test of general relativity can be made using the transverse Doppler effect. The novel design of this experiment entails the development of low activity Mössbauer sources. Small amounts (less than 1 μCi) of ^{57}Co are electroplated onto thin steel foils (0.0254 mm) and heated to 1000°C in a vacuum. The use of these weak sources should be possible with coincidence techniques to reduce the background rate. A rotating disk absorber will be used for longitudinal Doppler effect tests prior to developing the transverse Doppler effect apparatus. Current progress and future plans will be presented.

Modifications to the Houghton College Cyclotron

Laurel Vincett, Houghton College

Over the last decade, a small 6-inch cyclotron has been constructed at Houghton College, capable of accelerating protons to a theoretical maximum of 400 keV. A new vacuum chamber has been constructed using welded aluminum flanges to fix continuing problems with leaks. Previous studies indicate that ions in the cyclotron are falling out of phase and being lost because of the slowly changing magnetic field needed for weak focusing. One solution to this problem is fixed-field alternating gradient focusing using a radial-sector magnet. A x-y scanner has been implemented to map the magnetic field, first of our current flat pole tips and in the future to map the field from the radial-sector pole tips.

Searching for Neutron-Antineutron Annihilations at Daya Bay

Adam Dukehart, Siena College

Some theoretical models predict the oscillation of a neutron to an antineutron; a process that violates baryon number. We use the low noise detectors at the Daya Bay Neutrino Experiment to search for the antineutron produced in this process by detecting its annihilation. We used simulated data to determine the detector response, and final estimates of the frequency of the oscillations are determined by comparing simulated and experimental data.

Silicon Tracker for CMS Detector at CERN: R&D Phase II Upgrade

Jack Valinsky, Professor Regina Demina, Sergey Korjenevski, University of Rochester

We conducted preliminary quality assurance tests on Novati test structures for an upgrade to the silicon tracker subsystem of the Compact Muon Solenoid (CMS) detector on the Large Hadron Collider (LHC). Tests included: IV and CV measurements (0 V to 500 V in 5 V increments) on test diodes looking at depletion and breakdown voltages, interstrip resistance and capacitance measurements (5 random strips out of 60), and IV tests on calorimeter hexagons (0 V to 700 V in 5 V increments). All measurements were conducted in the university's Semiconductor Testing Lab, a class 10,000 clean room. Initial findings indicate that Novati is a viable supplier for the upgrade.

SESSION IIIB. ASTRONOMY AND ASTROPHYSICS

Renewable Energy Storage: A Heavy Solution to a Heavy Problem

Kevin Osse, Siena College

One of the most significant issues plaguing the growth of renewable energy is that of reliability. The Sun doesn't shine and the wind doesn't blow at our command.Furthermore, unlike energy from fossil fuels, the source of energy generated these ways cannot be stored for a later date. This project explores a potential answer (as well as its practicality) to these nagging issues: gravitational potential energy. This idea, at its most basic, is that of using any excess electricity generated by greener sources immediately to lift an object of considerable mass from a region of base potential to a higher elevation. This allows us to convert the electrical energy into potential energy that can be stored until it is needed, at which point the object would descend. Using gears and a rack and pinion, this descent can drive a generator and thus generate energy when the original energy source is no longer producing. Using national energy consumption data, this project analyzed the benefit (both fiscal and environmental) this system could provide for consumers of different demands, from single residential homes to small cities. By comparing this analysis to the impact and availability of current battery technology and solar energy efficiency, we determine whether this type of project is worth pursuing as a viable option in terms of proceeding towards adopting cleaner energy.

Making Exoplanets Great Again

Cody Ciaschi and John Moustakas, Siena College

Since 1995, over 2000 planets outside our solar system (so-called exoplanets) have been discovered. Most have these have been found by the Kepler satellite by measuring the decrease in flux when the exoplanet eclipses its parent star – known as the transit method. This light curve allows us to infer the radius, orbital period, and semi-major axis of the planet. We use a Markov Chain Monte Carlo algorithm to constrain these physical characteristics given the observed light curves from Kepler. We compare our results to published measurements, and discuss the prospects for analyzing the full Kepler database.

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 is capable of. In my experiments, I tested the CCD both with and without the AO8 attachment and compared the images. I took images from close range using various light sources to imitate the light emitted from a star. I found that the quality of the images were better using the AO8 but only to a very small extent due to the images being taken from such a close range.

Crustal Failure on Icy Moons and Satellites from a Strong Tidal Encounter

Alice C. Quillen, David Giannella, John G. Shaw, Cindy Ebinger, University of Rochester

We employed N-body simulations to explore the possibility of crustal failures on icy bodies as a result of strong tidal encounters. By recording the strain experienced by a spherical mass-spring model during a parabolic encounter with a similar mass perturber, we predict where cracks will form. This strain is capable of causing significant, long fractures across a simulated body and may be responsible for the formation of observed features on a number of moons in our Solar System, such as Dione or Tethys.

SESSION IIIC. CONDENSED MATTER PHYSICS

Elastic Buckling of Pored Membranes

Sarah Carkner, Graziano Vernizzi, Siena College

A main open question in nanoscience is the understanding of how pores affect the shape and overall geometry of small membranes. It is well known that defects (disclinations) on a membrane can exhibit a buckling transition with increasing membrane radius. In particular, a five-fold disclination can buckle into conical shapes while seven-fold disclinations can produce a saddle shape to the buckled membrane. It is currently unknown whether the presence of a disclination inside a nanopore affects the buckling transition. In this research project, we study systematically the buckling transition of a disk containing a five-fold or seven-fold disclination at its center, where a pore is also present. We consider the effect on the buckling transition when varying the pore size vs. the membrane size. We perform a series of numerical minimizations of the elastic free-energy of discrete triangulated elastic meshes, and discuss the implications of our results on the behavior of large membranes in the
continuous limit.

From Viruses to Fullerenes: Monte Carlo Studies of Polyhedral Nano-structures

Joey Rowley, Graziano Vernizzi, Siena College

An open question in soft condensed-matter physics is how regular polyhedral structures can arise spontaneously at the nano-meter scale. Canonical examples are the icosahedral shell of spherical viruses, or the quasi-icosahedral symmetry of several large fullerene molecules. We perform Monte Carlo studies of the equilibrium thermodynamics of those structures, with the aim to determine their thermal phase diagram. The novelty of our approach is the application of Random Matrix Theory to describe all possible arrangements of viral capsomers around a spherical shell, and of isomers of fullerenes.

Effect of Deposition Rate on RMS Roughness of Indium Thin Films

Matthew Andrews and Zachary Robinson, SUNY Brockport

Metal thin films are essential for a wide range of modern products, from household mirrors to hard drives. Precise control over the properties of thin films is important because small changes in the structure of a film can have a large impact on its performance in a particular application. The RMS roughness of a thin film affects many of its properties, including its conductivity and superconductivity. In this study, a series of indium thin films are deposited by thermal evaporation on silicon dioxide substrates while systematically varying the deposition rate. The Volmer-Weber growth mode exhibited by the indium film allows for the roughness to be controlled via the deposition rate. The roughness is measured using atomic force microscopy. Higher deposition rates are found to result in a decrease in the RMS roughness of the films.

Design and assembly of inert gas annealing chamber for aluminum nitride films
Heather LaVallee and Zachary Robinson, SUNY Brockport and Virginia Anderson, Neeraj Nepal and Charles Eddy Jr., U.S. Naval Research Laboratory

Aluminum nitride (AlN) has interesting properties that make it a leading candidate for future microelectronic applications. For instance, AlN has a band gap of 6.2 eV, making it an ideal material for generation of ultraviolet light. Atomic layer epitaxy is one technique that has been used to deposit aluminum nitride in the form of a thin film. This relatively low-temperature (< 500 °C) growth technique does not result in state-of-the-art crystallinity of the material. Therefore, to increase the crystallinity, systematic anneals were performed in a quartz tube furnace at temperatures ranging from 550 °C to 900 °C. Following each anneal, atomic force microscopy was used to observe changes to the sample's morphology. In this presentation, the design and assembly of a tube furnace, as well as early experimental results, will be discussed.

Phase Transition in Vanadium Dioxide Nanostructures
Luke Lyle, University at Buffalo

Strongly correlated materials exhibit a wide variety of extraordinary optical and electronic properties that can serve as a panacea for industrial applications. We present electronic transport measurements of vanadium dioxide nanostructures, a strongly correlated transition metal oxide system, with a unique thermally driven insulator-metal phase transition ~ 340 K. This transition can also be driven by electrical and optical means thereby making this a very useful material for switching applications. The research aims to address issues such as percolation of nanoscale metallic domains at temperatures near the phase transition. The nucleation and propagation of domains across the transition are studied through a high-resolution optical microscope for both electrical and thermal stimulations. This work is supported by NSF DMR 0847324.

The Optical Dynamics of Liquid Crystals. An investigation of the dynamics and characteristics of Nematic Liquid Crystals for use in the optical field
Nathan Fritz, Colgate University

The Liquid Crystal phase of matter is one in which inter molecular interactions within a certain range of temperatures or concentrations of crystals give rise to moderately short-range order of the medium. These materials are also susceptible to applied electric or magnetic fields, which effectively orient the molecules across a larger area. Through manipulation by an applied electric field and mechanically produced boundary conditions on the sample cells, rod-like nematic liquid crystals (5CB) are investigated to gain a preliminary understanding of another important characteristic of liquid crystals: birefringence. Both the production of sample cells and a method of their measurement were investigated. This research offers an introduction to the basics of liquid crystal dynamics for the undergraduate laboratory as a stepping stone for future work in understanding and eventually controlling the formation of disclinations and dislocations within the medium for various applications in the optical field.

SESSION IVA. NUCLEAR AND PARTICLE PHYSICS/OTHER

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

Using data collected from a mobile time-projection chamber nuclear detector, directional track construction from data gathered from the nuclear recoil of particles moving through the detector gas can be accomplished through software and mathematical analysis. This presentation will present current work on this project.

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

The project in question is a directional fast neutron detector. The detector's chamber contains Helium-4 and a scintillator, CF_4. The chamber's pressure is maintained at atmospheric pressure. There is an incremental voltage difference generated from the top to the bottom of the chamber using copper rings and resistors. The latter generates a uniform electric field. When a neutron enters the chambers and scatters off an alpha particle, the resulting ionization leaves a track because of the scintillator. A CCD camera captures the tracks and the data provides information about the location of the neutron source. This discussion will focus on the use of quantum mechanics and the method of partial waves to find the differential scattering cross section. Additionally, it will cover the spin-orbit coupling that occurs during the interaction and the contribution of the degeneracy of the angular momentum quantum number. Lastly, the discussion covers the phase relationship between the incident and scattered waves of particles.

Motorized Control of Radio Telescope
Debra Johnson, Siena College

The Department of Physics and Astronomy has been working to re-construct VIPER, a 2-meter radio telescope, on campus at Siena over the past few years, and we have successfully assembled the mirror cradle, fork, altitude drive, and a 21-cm detector. This year I have undertaken the task to create a system that will read the altitude angle to create a soft stop for the motors of the telescope. I worked with Matlab, and Simulink throughout the year to design a small-scale system that will control the motors. The information gained will be of use for the control of the telescope motor. I also worked on developing operating instructions for VIPER.

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

Danielle Moruzz, Siena College

The global climate is affected by both the amount and type of clouds in the atmosphere. Different types of clouds will contribute to either the cooling or warming of the Earth by reflecting sunlight or trapping infrared radiation rising from the ground. This depends on the size and density of the water droplets in the clouds, both of which are affected by levels of aerosols in the atmosphere. However, the effect of these aerosols is an open question. I have built a proof-of-principle test stand to measure the effects of water vapor (clouds) on visible and infrared light. I am also able to monitor the atmospheric temperature and pressure inside the chamber. With the use of a laser and photodiode we will be able to study how much light is reflected and transmitted by the cloud. We use both visible and infrared lasers to probe the wavelength dependence of the transmission and absorptive properties of these clouds.

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 ($L = r \times p$), particularly when the objects are not just point objects, but possess a physical size and shape. We use an air table and record collisions between disks that can have 2D linear motion and rotation about their center-mass, which carries additional. Both the linear motion and rotation will be extracted from the videos using Tracker to obtain position v. time graphs. The product of this project is material for lesson(s) in High school or Introductory Physics.

Quantum Communication with Alice and Bob
Tyler Godat, University of Rochester

We use a MATLAB code to calculate the communication modes of a free-space-link with a Fresnel number of three. From the calculated communication modes, we use our code to generate a mutually-unbiased set of modes called angular modes. We simulate the propagation of both sets of modes through the optical communication link and investigate their efficiency, bias, and cross-talk. A set of so-called robust modes is then created by reducing the transmission efficiency of the lower order communication modes to that of the highest, an approximate value of 0.63. From our analysis, the transmission efficiency and therefore mutual information of the robust system is calculated to be lower than that of the original. However, the original system exhibits a high degree of bias in the receiver, whereas the robust system does not. Future work would like to investigate the quantum security of both systems.

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

We are attempting to calculate approximate global multiplicative scaling factors for the Density Functional Theory (DFT) calculation of harmonic vibrational frequencies using both meta-GGA and meta-Hybrid functionals from the TPSS, M06, M08 and M11 families. Standard Dunning Correlation Consistent, Pople split valence, Sadlej, and Sapparro polarized triple-ζ basis sets are employed. A total of 96 harmonic frequencies are being calculated for 30 gas phase organic and non-organic molecules typically found in detonated solid propellant residue. Our proposed approximate multiplicative scaling factors are determined using a least squares approach comparing the computed harmonic frequencies to experimental counterparts well established in the scientific literature. A comparison of our work to previously published, well established, global scaling factors will be made to test the reliability of our methods and molecular test set. The status of this project will be presented at the meeting.

SESSION IVC. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES

Water Level Control of a Two-Tank System

Rik Brown, Siena College

This talk will be covering the demonstration of PID water level control of a two tank system. This two-tank system will model the level control of a simplified small run-of-the-river hydro project. Using Matlab and Simulink, we build a block diagram with built-in function blocks embedded in the program to create a simulation of the entire system. We interface with the actual physical system through an arduino that communicates between the control system and the Simulink program to run our water release valve effectively controlling our desired water level to a given setpoint of our choosing. One can see that with PID control, level response time is controlled much more smoothly as we approach our set level, resembling a well-adjusted overdamped system as opposed to an underdamped system that we see without PID control.

MightyOhm Geiger Counter Sensitivity

Matthew Tenorio, Siena College

For my research I have been testing the MightyOhm Geiger Counter kit. This is a $99.95 kit that requires the buyer to assemble it themselves. It is designed to be an available tool for students studying nuclear physics. I will be comparing the MightyOhm Geiger Counter to a typical Geiger Counter that is ten times the price, and is assumed to have greater sensitivity to detect radiation. The results from my data confirm this assumption. The results will be analyzed. In addition to this, I focused on seeing if the MightyOhm Geiger Counter kit is sensitive enough to use for the purposes of a Modern Physics class, these results will be analyzed as well.

Worrying About Finding a Date with a Best-Fit Line

Brendan Sheehan, Colgate University

A novel kind of resonance ionization mass spectrometry has yielded large uncertainties in the collected data. Because the mass spectrometer is designed to find an age of a rock sample through the isochron technique, correctly fitting a line to the data is critical to calculating the correct age of the sample. An uncertainty in the x-direction, an uncertainty in the y-direction, and a third uncertainty that appears in both directions make finding a line of best fit nontrivial, and a solution for finding an optimized line is not agreed upon in the literature. A bivariate fit that considers the covariance in the uncertainties must therefore be used to find the line of best fit and therefore the best-constrained age of the rock sample. Here, we provide a detailed proof of a method for finding a bivariate best fit to a set of data in the cases with zero covariance and with nonzero covariance, and posit that an improved method of optimization of the calculated line to the best line has been found.

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.

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

The Laboratory for Laser Energetics OMEGA system is a short-pulse, high-power 60 beam laser system used for direct drive inertial confinement experiments. A collection optic for the SOP was designed with a four-element f/3.3 apochromat to have diffraction-limited performance over the 590-850 nm range and an 800 μm field of view. Most of the optical power of the system is provided by a low-cost front element that acts as a blast shield. Spherical and chromatic aberrations are corrected in a three-element component that is protected from high-energy interactions at the target chamber center by the blast shield. A systematic method of determining the best three glass types for the apochromat out of the 126 available glasses in the Schott catalog was created. Spherical aberration minimization was used to determine the initial curvatures of the lenses in the apochromat, which were then optimized using the lens design program OSLO.

LIST OF PARTICIPANTS

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Jared Frey	Undergraduate Student	Houghton College
Michael Ganger	Undergraduate Student	Houghton College
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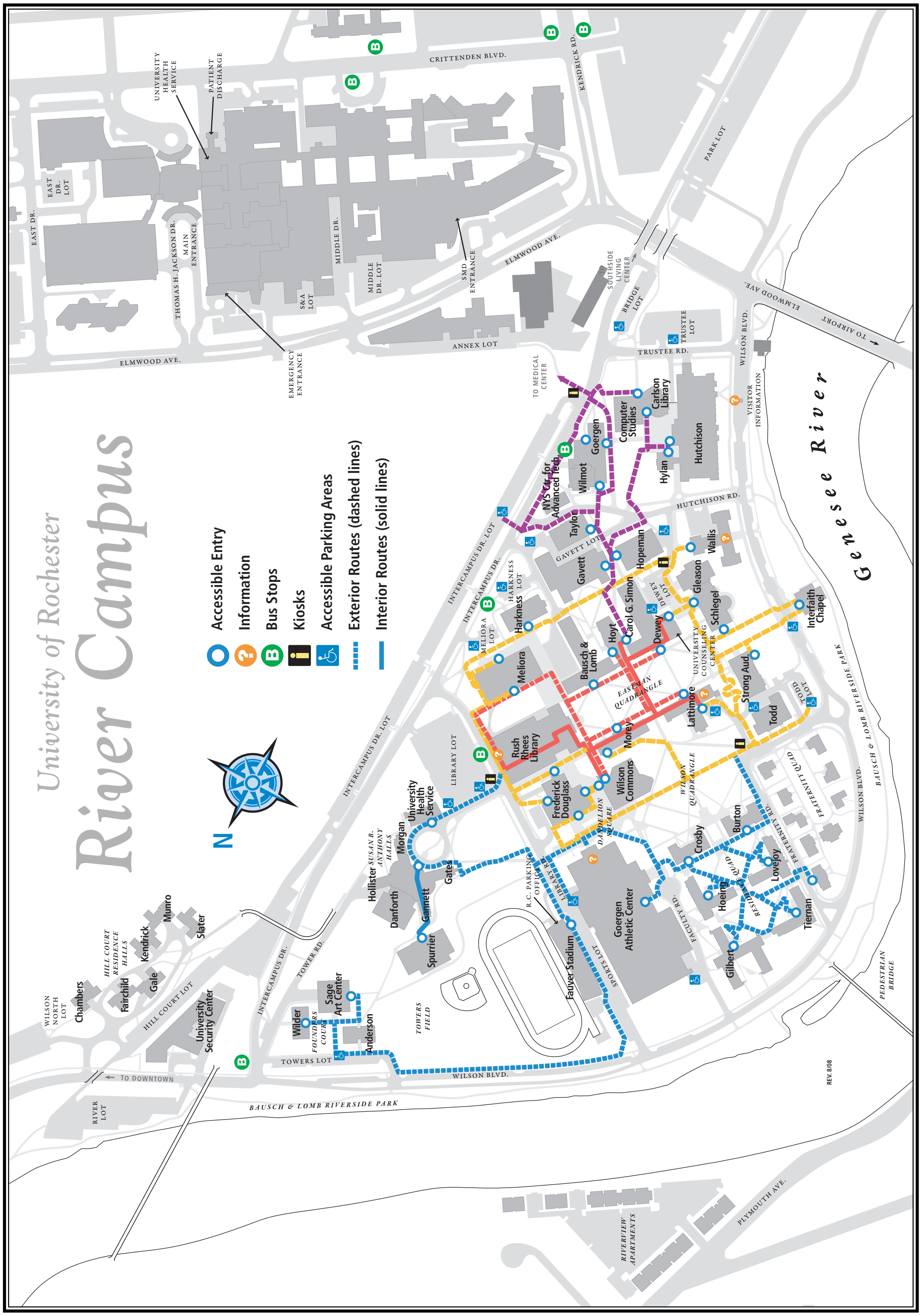
WHERE IS LUNCH?

BUILDING 48, DANFORTH DINING HALL.


University of Rochester
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Accessible Entry
Information
Bus Stops
Kiosks
Accessible Parking Areas
Exterior Routes (dashed lines)
Interior Routes (solid lines)
N
Genesee River
ELMWOOD AVE.
CRITTENDEN BLVD.
KENDRICK RD.
INTERCAMPUS DR.
WILSON BLVD.
HUTCHISON RD.
TRUSTEE RD.
BAUSCH & LOMB RIVERSIDE PARK
PLYMOUTH AVE.
TO AIRPORT
TO DOWNTOWN
TO MEDICAL CENTER
EMERGENCY ENTRANCE
SMD ENTRANCE
MAIN ENTRANCE
ANNEX LOT
PARK LOT
BRIDGE LOT
TRUSTEE LOT
VISITOR INFORMATION
Carlson Library
Computer Studies
Goergen
Hylan
Hutchison
Wilmot
NYS Ctr. for Advanced Tech.
Taylor
Gavett
Hopeman
Wallis
Gleason
Schlegel
Interfaith Chapel
Carol G. Simon
Dewey
Hoyt
Bausch & Lomb
Harkness
Meliora
EASTMAN QUADRANGLE
Lattimore
Strong Aud.
Todd
Rush Rhees Library
Morey
Wilson Commons
Frederick Douglass
DANDELION SQUARE
WILSON QUADRANGLE
University Health Service
Morgan
Hollister
Danforth
Gates
Gannett
Spurrier
Goergen Athletic Center
Fauver Stadium
TOWERS FIELD
Crosby
Burton
Lovejoy
Hoeing
Tiernan
Gilbert
FRATERNITY QUAD
Sage Art Center
Wilder
Anderson
FOUNDERS COURT
TOWERS LOT
Chambers
Fairchild
Gale
Kendrick
Munro
Slater
HILL COURT RESIDENCE HALLS
University Security Center
RIVER LOT
RIVERVIEW APARTMENTS
PEDESTRIAN BRIDGE
REV. 8/08