XXXIV

Annual

Rochester Symposium For Physics
(Astronomy & Optics) Students
SPS Zone 2 Regional Meeting held at SUNY Oswego

April 11, 2015

Department of Physics and Astronomy
University of Rochester
Rochester, NY 14627-0171

Cosponsored by:
National Office of the Society of Physics Students; Department of Physics and Astronomy, State University of New York at Oswego; Department of Physics and Astronomy, University of Rochester; National Science Foundation (REU Program); Department of Energy.

Rochester, April 11, 2015

Dear Participants:

Welcome to the 34th 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/2015/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	LOCATION	TIME
Grant Andrews	Room 170	9:15 AM
Alexander Arduini	Nucleus	10:00 AM
Jai Kwan Bae	Room 175	9:00 AM
Josh Bivens	Nucleus	10:00 AM
Jordan Blanchard	Room 170	11:00 AM
Andrew Bordash	Nucleus	10:00 AM
Joseph Brown	Room 170	10:45 AM
Daniel Burdette	Room 122	11:30 AM
James Buttner	Room 170	11:15 AM
Jordan Cady	Room 175	2:00 PM
Kathryn Coghlan	Room 170	2:30 PM
Sean Daigler	Room 175	2:15 PM
Martin Dann	Nucleus	10:00 AM
Vincent Debiase	Room 122	9:15 AM
Timothy Dougherty	Nucleus	10:00 AM
Thomas Dunn	Room 170	9:30 AM
Thomas Eckert	Nucleus	10:00 AM
Jeffrey Ellison	Nucleus	10:00 AM
Joseph Fairley	Room 170	2:00 PM
Grant Farrokh	Nucleus	10:00 AM
Cory Fish	Room 170	11:45 AM
Kyle Flemington	Room 175	2:30 PM
Robert Gaffney	Room 170	9:00 AM
Julian Girard	Room 170	11:30 AM
Charles Hamilton	Room 170	3:15 PM
Kasey Hogan	Room 122	10:45 AM
Chelsea Jean	Nucleus	10:00 AM
Nicholas Jira	Nucleus	10:00 AM
Trent Jones	Room 175	11:15 AM
Md Tanveer Karim	Room 122	11:00 AM
David Knapick	Room 122	9:45 AM
Ingrid Koch	Nucleus	10:00 AM
Heidi Kroening	Nucleus	10:00 AM
Amanda Landcastle	Room 170	2:45 PM
Paul Lashomb	Room 175	10:45 AM
Matt Legro	Room 170	3:00 PM
Dylan Mcintyre	Nucleus	10:00 AM
Emily Morrow	Room 175	11:00 AM
Sylvia Morrow	Room 175	2:45 PM

NAME	LOCATION	TIME
Annmarie Pryor	Room 170	2:15 PM
Brian Regan	Room 175	9:15 AM
Stephanie Robillard	Room 122	11:15 AM
Kenneth Roffo	Room 122	9:30 AM
Marie Romano	Nucleus	10:00 AM
Deep Shah	Nucleus	10:00 AM
Sherwin Shaju	Nucleus	10:00 AM
Ananya Sitaram	Room 175	9:30 AM
Emily Sobel	Nucleus	10:00 AM
Ivory Stokes	Nucleus	10:00 AM
Steven Torrisi	Room 175	9:45 AM
Fan Wu	Nucleus	10:00 AM
Shuchen Wu	Room 175	3:00 PM
Daniel Wysocki	Room 122	9:00 AM
Jun Yin	Room 175	11:30 AM
Xuanhan Zhao	Nucleus	10:00 AM

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

PROGRAM

8:00 AM – 8:30 AM: REGISTRATION AND POSTER SETUP (NUCLEUS)

8:30 AM: WELCOME (ROOM 122)

Prof. Frank Wolfs, University of Rochester
Dean Adrienne McCormick, SUNY Oswego
Prof. Dale Zych, SUNY Oswego

9.00 AM – 10:00 AM: SESSION IA. ASTRONOMY I (ROOM 122)

SESSION CHAIR: PROF. GEORGE HASSEL, SIENA COLLEGE

9:00 AM, Morphology of the Large Magellanic Cloud Using Classical Cepheids
Daniel Wysocki, Shashi Kanbur, Sukanta Deb, and Harinder P. Singh, SUNY Oswego, University of Delhi

9:15 AM, Conditional Entropy Methods for Period Detection in Variable Stars
Vincent DeBiase, Gabriel Lauffer Ramos, SUNY Oswego

9:30 AM, Fourier Analysis of CSTAR RR Lyrae Variable Stars
Kenneth Roffo, Michael Leone, SUNY Oswego

9:45 AM, Firefly: Mission to Study Lightning and Terrestrial Gamma Ray Flashes
David Knapick, Siena College

9:00 AM – 9:45 AM: SESSION IB. EDUCATIONAL PHYSICS (ROOM 170)

SESSION CHAIR: PROF. MOHAMMED TAHAR, SUNY BROCKPORT

9:00 AM, Studying Collisions Using Tracker
Robert Gaffney, SUNY Brockport

9:15 AM, On the Relativistic Projectile Motion: Angle of Projection when Range and Vertical Height are Equal
Grant Andrews and Thomas Giffune, SUNY Potsdam

9:30 AM, Investigating the Spectral Composition of String Instruments
Thomas M. Dunn, Siena College

9:00 AM – 10:00 AM: SESSION IC. QUANTUM OPTICS (ROOM 175)

SESSION CHAIR: PROF. MICHAEL VINEYARD, UNION COLLEGE

9:00 AM, Fourier transform and Uncertainty Principle for a particle in an infinite square well
Jai Kwan Bae, University of Rochester

9:15 AM, Discriminatory Polarization Forces on Chiral Molecules
Brian Regan, Colgate University

9:30 AM, Analog Electronic Laser Stabilization to an Atomic Reference
Ananya Sitaram, Marek Haruza, Maitreyi Jayaseelan, Nicholas P. Bigelow, University of Rochester

9:45 AM, Light Pulse Control of Quantum Information in Bose-Einstein Condensates
Steven B. Torrisi, Justin T. Schultz, Azure Hansen, Joseph D. Murphree, Nicholas P. Bigelow, University of Rochester

10:00 AM – 10:45 AM: SESSION II. POSTER SESSION (NUCLEUS)

Investigations of New Laboratory Measurements of Oxygen Desorption in Astrochemical Models
Alexander Arduini, Deep Shah, Sherwin Shaju, George Hassel, Siena College

Spectral Analysis of French Horn and Trumpet Mouthpieces
Josh Bivens, SUNY Oswego

Temperature Dependence of the Saturation Magnetization in Ferromagnetic Metallic Glasses
Andrew Bordash and Jacob Mills, SUNY Oswego

Thin Film Solar Cells: Enhancing Efficiency using Various Nanoparticles
Martin Dann, Carolina C. Ilie, SUNY Oswego

Physics in video games: Using numerical methods to simulate Newtonian physics
Timothy Dougherty, SUNY Oswego

Coincidence Efficiency of Sodium Iodide Detectors for Positron Annihilation
Thomas Eckert, Laurel Vincett, and Mark Yuly, Houghton College, SUNY Geneseo, Laboratory for Laser Energetics

Study of P-N Junctions and Metal-to-Metal Interfaces
Jeffrey Ellison, SUNY Brockport

Design and Fabrication of a Small Single-Axis Acoustic Levitator
Grant Farrokh, Le Moyne College

Performing Fowler Sampling and Removing Cosmic Ray Hits to Reduce Noise Numerically from Long-Infrared Detector Images
Chelsea Jean, Craig McMurtry, Meghan Dorn, Judy Pipher, University of Rochester

Capillary Condensation Transitions and Meniscus: Parallel Planes, Nanotubes, and Wedges
Dylan J. McIntyre, Nicholas C. Jira, M. T. Romano, J. R. D'Rozario, M. Guedes-Duarte, T. Dougherty, and C.C. Ilie, SUNY Oswego

Evolution of the Composition of Dust in Protoplanetary Disks
Ingrid Koch, K.H. Kim, S.P. Fogerty, W.J. Forrest, Dan M. Watson, University of Rochester

Design and Construction of a Cost-effective Atomic Force Microscope
Heidi Kroening, Jonathon Yuly, and Brandon Hoffman, Houghton College

Capillary Condensation Transitions and Meniscus: Parallel Planes, Nanotubes, and Wedge
Dylan J. McIntyre, Nicholas C. Jira, M. T. Romano, J. R. D'Rozario, M. Guedes-Duarte, T. Dougherty, and C.C. Ilie, SUNY Oswego

The Brain as a Universe: Misconceptions and Limitation in Brain Theories
Marie Romano, SUNY Oswego

Modeling of Carbon Chain Anion Species of The Low-mass Protostellar Region L1527
Deep Shah, Georgs Hassel, Sherwin Shaj, & Alexander Arduini, CURCA

Simulation of Deuterated Species of the Low-mass Protostellar Region L1527
Sherwin Shaju, George Hassel, Alexander Arduini, Deep Shah, Siena College

Quantifying Forces on Strongly Absorbing Materials Rotating in Optical Traps
Ryan Kropas and Emily Sobel, SUNY New Paltz

Modes and Q Factors of the Top Plate of Guitars
Ivory Stokes, University of Rochester

Dust Mineralogy Survey for T-Tauri Stars in Taurus-Auriga and Ophiuchus Region
Fan Wu, William Forrest, Shane Fogerty, University of Rochester

SEM-EDX Analysis of Aerosol Samples
Xuanhan Zhao, Union College

10:45 AM – 11:45 AM: SESSION IIIA. ASTRONOMY II (ROOM 122)

SESSION CHAIR: PROF. ERIC MONIER, SUNY BROCKPORT

10:45 AM, Quasar Emission Line Variability From Hubble Space Telescope Archive Data
Kasey Hogan, SUNY Brockport

11:00 AM, Characterizing the variability of 4-10 Myr old T-Tauri stars in the Orion OB1 Association
Md Tanveer Karim, University of Rochester

11:15 AM, C IV Absorbers in the Sloan Digital Sky Survey
Stephanie Robillard, SUNY Brockport

11:30 AM, Characterizing the Outflow Energetics of the 'Cloverleaf' Quasar Using Broad Absorption Lines
Daniel P. Burdette, SUNY Brockport

10:45 AM – 12:00 PM: SESSION IIIB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES I (ROOM 170)

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

10:45 AM, Neutron Transport Analysis of Small Module Reactors to Support U.S. Army Energy Requirements at Forward Deployed Locations
CDT Joseph L. Brown and CDT Zachary D. Lewis, United States Military Academy

11:00 AM, Establishing a Laser Induced Breakdown Spectroscopy System for Post-Detonation Nuclear Forensics Applications
CDT Jordan A. Blanchard, CDT Eddie T. Ortega, and CDT Taylor M. Richard, United States Military Academy

11:15 AM, Noise Analysis in Terahertz Spectroscopy
James Buttner, Colgate University

11:30 AM, High-Throughput Electric Field Induced Second Harmonic Generation in Highly-Monodisperse Microdroplets
Julian Girard, ENS Cachan, University of Michigan

11:45 AM, Portable, Directional Neutron Detector
CDT Cory Fish, CDT Brad Bachand, MAJ Tony Clark, MAJ Will Koch, United States Military Academy at West Point

10:45 AM – 11:45 AM: SESSION IIIC. NUCLEAR AND PARTICLE PHYSICS (ROOM 175)

SESSION CHAIR: PROF. MARK JULY, HOUGHTON COLLEGE

10:45 AM, Measuring Parity Violation in Cobalt-60 Decay
Paul Lashomb and Mark Yuly, Houghton College

11:00 AM, A table top demonstration of general relativity using the Mössbauer effect
Emily Morrow, August Gula, and Mark Yuly, Houghton College

11:15 AM, Materials Testing Using Non-Radiating Techniques
CDT Trent Jones, United States Military Academy

11:30 AM, Recovering from Saturation
Jun Yin, University of Rochester

12:00 PM – 1:00 PM: SESSION IV. LUNCH (MARANO CAMPUS CENTER)

1:00 PM – 2:00 PM: SESSION V. “*VARIABLE STARS AND THE EXTRA-GALACTIC DISTANCE SCALE*”, PROF. SHASHI KANBUR, SUNY OSWEGO (ROOM 175)

2:00 PM – 3:30 PM: SESSION VIA. CONDENSED MATTER AND BIOLOGICAL PHYSICS (ROOM 170)

SESSION CHAIR: PROF. MATTHEW BELLIS, SIENA COLLEGE

2:00 PM, 3D Printed Prosthetics
Joseph Fairley, Siena College & InMoov

2:15 PM, Projected Thoughts: Liquid-Crystal-Display (LCD) to Cathode Ray Tube (CRT) to Projected Matrix
Annmarie Pryor and Theresa Vaughan, Siena College and Wadsworth Center

2:30 PM, Analysis of Annealed Indium Films
Kathryn Coghlan, SUNY Brockport

2:45 PM, Growth and Oxidation of Indium Thin Films
Amanda Landcastle, SUNY Brockport

3:00 PM, Synchronization of Josephson Junction Neurons
Matt LeGro, Colgate University

3:15 PM, Microhardness and Atomic Disorder of the *Balanus Amphitrite* Exoskeleton
Charles Hamilton, Colgate University

2:00 PM – 3:15 PM: SESSION VIB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES II (ROOM 175)

SESSION CHAIR: PROF. BRANDON HOFFMAN, HOUGHTON COLLEGE

2:00 PM, The Design and Construction of an X-ray Diffractometer for the Study of Thin Metal Films
Jordan Cady and Brandon Hoffman, Houghton College

2:15 PM, Design and Construction of a Laser Interferometer to Study Thin Metal Films
Sean Daigler and Brandon Hoffman, Houghton College

2:30 PM, The Construction of a Deposition Chamber for the in-situ Study of Thin Metal Films
Kyle Flemington and Brandon Hoffman, Houghton College

2:45 PM, A Study of Weak Magnetic Focusing
Sylvia Morrow and Mark Yuly, Houghton College

3:00 PM, Measurement of the Primary D-T and D-D Ion Temperature Using Neutron Time of Flight Spectra in Inertial Confinement Fusion Experiments
Shuchen Wu, University of Rochester

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SESSION IA. ASTRONOMY I

Morphology of the Large Magellanic Cloud Using Classical Cepheids

Daniel Wysocki, Shashi Kanbur, Sukanta Deb, and Harinder P. Singh, SUNY Oswego, University of Delhi
Advisor: Shashi Kanbur

We study the three-dimensional structure of the Large Magellanic Cloud, using observations of classical Cepheid variable stars. Optical band observations were taken from the OGLE-III survey and near-infrared observations from the CPAPIR survey. Both planar and ellipsoidal models are fit to the galaxy in order to obtain inclination and position angles.

Conditional Entropy Methods for Period Detection in Variable Stars

Vincent DeBiase, Gabriel Lauffer Ramos, SUNY Oswego
Advisor: Shashi Kanbur

Variable Stars are important objects in Astrophysics because they can potentially provide constraints on the theories of stellar evolution and stellar pulsation and be used in wider Astrophysics problems such as the age and distance scales. The most important observable is their period - yet this is sometimes difficult to measure. Here we report on a new method to calculate the period of a variable star based on conditional entropy. We describe the method and apply it to recalculate the periods of Cepheids and RR Lyraes in the OGLE III variable star database and compare with existing results. We end with a discussion of possible discrepancies.

Fourier Analysis of CSTAR RR Lyrae Variable Stars

Kenneth Roffo, Michael Leone, SUNY Oswego
Advisor: Dr. Shashi M. Kanbur

Fourier Analysis was executed on CSTAR data from the 2008 and 2010 observation seasons in Antarctica. Metallicities for several Non-Blazkho RR Lyrae stars will be presented and discussed.

Firefly: Mission to Study Lightning and Terrestrial Gamma Ray Flashes

David Knapick, Siena College
Advisor: Dr. Allan Weatherwax

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 focus on the Firefly mission design as well as the scientific data obtained from Firefly.

SESSION IB. EDUCATIONAL PHYSICS

Studying Collisions Using Tracker

Robert Gaffney, SUNY Brockport
Advisor: Dr. Mohammed Tahar

After video-recording several 1D (carts on air track) and 2D (pucks on air table) collisions, Tracker is used to obtain positions vs. time, which are subsequently analyzed to show momentum conservation. In 1D, both elastic and inelastic collisions are analyzed with clear results of momentum conservation. In 2D, both the objects positions and orientations can be tracked to separate the linear motion and the rotation of the objects. The videos can be used for demonstration in class at most levels and the use of Tracker enhances internalization of the concepts involved in collision(s) and teaches analysis skills at intermediate/ high levels. Analysis is further extended to the center-mass reference frame of the two objects especially for 2D collisions and angular momentum conservation.

On the Relativistic Projectile Motion: Angle of Projection when Range and Vertical Height are Equal

Grant Andrews and Thomas Giffune, SUNY Potsdam
Advisor: Biman Das

Relativistic projectile motions in many ways are different from ordinary projectile motions. We have investigated analytically and numerically different aspects of the motion of an object projected at relativistic speeds at an arbitrary angle and location. We have numerically determined the path of charged particles, such as protons and electrons, in a constant vertical force field, moving at relativistic speeds at different projection angles. We focused our attention on determining the projection angle for which the projectile's range is equal to its maximum height. This angle is known to be approximately 76° for non-relativistic projectiles. From the expressions of range and maximum height for a relativistic projectile we attempted to determine the angle of projection for which range and maximum height are equal to compare with its non-relativistic value. The resulting equation is complex for a relativistic motion and could not be solved analytically for the angle of projection. We found the angle for protons and electrons in a constant downward electric field graphically and numerically from the knowledge of the vertically downward electric force and the initial relativistic momentum. The angle for which the range and maximum heights are equal, unlike for an ordinary projectile, is found to be a function of the speed. The value of the angle increases from 76° for non-relativistic speeds and approaches 80.3° as the speed of the projectile approaches the speed of light. The result was found to be independent of the force, charge and mass of the projectiles, as expected. We used Microsoft Excel and MATLAB to solve graphically and numerically and for the plots. The details of the work will be presented.

Investigating the Spectral Composition of String Instruments

Thomas M. Dunn, Siena College
Advisor: Allan T. Weatherwax, Ph.D.; Joseph Kujawski

The difference in sound quality between various stringed instruments is a well-known phenomenon. An instrument's "voice" is the product of the sympathetic harmonics present in the sound produced by the resonant body when any particular fundamental note is played on the strings. Several factors affect these resonant harmonics, including adjustments to the bridge, sound post and tailpiece. We have studied the effect of the tailpiece on the frequency content of the sound produced by an instrument, and found that changes to the tailpiece resulting in a change in the afterlength of the string results in a different ratio and balance of frequencies in the harmonic tones from low (down to ~40 Hz) all the way to the high frequencies (~30 kHz). Particularly, when a tailpiece is changed from a standard model to a novel "Frirsz" model, the overall frequency composition becomes more balanced, and frequencies contributing to a phenomenon known as a "Wolf Tone" and resulting in an undesirable warbling at certain notes, are reduced.

SESSION IC. QUANTUM OPTICS (ROOM 175)

Fourier transform and Uncertainty Principle for a particle in an infinite square well

Jai Kwan Bae, University of Rochester
Advisor: Joseph H. Eberly

A Fourier transformation is a mathematical theorem that states any integrable periodic function can be written as a sum of simple sinusoidal functions. This implies the Fourier theorem can be used to analyze an arbitrary integrable wave function of a quantum particle, and it lets us manipulate the wave function of the particle in various ways. I will use it to explore various features of the momentum-coordinate uncertainty principle as it applies to a particle confined to a small region inside an infinite square well potential.

Discriminatory Polarization Forces on Chiral Molecules
Brian Regan, Colgate University
Advisor: Professor Kiko Galvez

We present a study of the possibility of a chiral dependent force arising from the interaction of Poincare-beam polarization patterns with chiral molecules. Optical trapping of nanoscale particles has already proven the ability of optical forces to manipulate and control objects via electric field gradients. When similar forces are used to manipulate chiral molecules, the interaction between the optical field and molecule is affected by the magnetic moment of the molecule. This interaction is usually ignored due to its relative small magnitude in relation to electric moment interactions, but is significant here due to its dependence on the chirality of the molecule.
We investigate a force that is dependent on properties of the molecules as well as gradients of the electric energy and helicity of the laser beam used. The helicity portion of the force points in opposite directions for opposite enantiomers, so F is discriminatory. We investigate the new and exciting properties of magnetic moment interactions using this beam.

Analog Electronic Laser Stabilization to an Atomic Reference
Ananya Sitaram, Marek Haruza, Maitreyi Jayaseelan, Nicholas P. Bigelow, University of Rochester
Advisor: Professor Nicholas P. Bigelow

In the production of ultracold atoms by laser cooling, it is necessary to precisely control the frequency of the lasers. This is necessary so that the light can optically pump the atoms repeatedly from a ground state to an excited state. To do this, the laser should be tuned to the resonant frequency of the specific atomic transition. To lock the laser to that frequency, a feedback loop circuit in conjunction with the saturated absorption spectrum of the atoms can be used. We have performed saturated absorption spectroscopy of Cesium atoms and revealed the hyperfine structures and atomic transitions using a piezo-actuated diffraction grating to control a laser diode and vapor cell of Cesium atoms. A variation on a proportional-integral-derivative (PID) circuit has been implemented to produce the feedback to lock the laser.

Light Pulse Control of Quantum Information in Bose-Einstein Condensates
Steven B. Torrisi, Justin T. Schultz, Azure Hansen, Joseph D. Murphree, Nicholas P. Bigelow, University of Rochester
Advisor: Nicholas P. Bigelow

Bose-Einstein Condensates are an exotic state of matter in which millions of atoms near absolute zero temperature act as a quantum object, exhibiting simultaneous wave and particle behavior. Quantum information extends the notion of data storage and retrieval to the discrete quantum states of quantum mechanical objects, allowing for new capabilities in data storage and processing. Precisely timed, tunable, and controllable laser light pulses are critical to interacting with Bose-Einstein Condensates (BECs). We are developing a control system for generating such laser pulses that will be used to harness BECs as a medium for quantum information. These pulses allow us to control the quantum spin states of a BEC to store data. This system is under investigation from a theoretical and experimental perspective. We present progress made on developing the electronic control of the laser and on modeling the state transitions. This system will permit a fine degree of optical control over a BEC's quantum properties, which may lead to advances in quantum information processing in a BEC.

SESSION II. POSTER SESSION

Investigations of New Laboratory Measurements of Oxygen Desorption in Astrochemical Models

Alexander Arduini, Deep Shah, Sherwin Shaju, George Hassel, Siena College
Advisor: Dr. George Hassel

We are investigating the effects of newly measured surface binding energy values of O-bearing species on the formation of solid and gas-phase H_2O in two different computational models representing a dense cloud and initial cloud formation. Chemical models of dense clouds often utilize the “pseudo-time-dependent” approximation, in which the physical conditions are held fixed and uniform as the chemistry occurs. The cloud formation model is intended to investigate the initial synthesis of molecular species as gas cools and condenses behind a shock in the diffuse interstellar medium. This follows more complex models of the evolution of physical conditions. Using different binding energies in our dense cloud models and cloud formation models did not yield any significant changes in the amount of ice layers produced, or in the abundance of surface and gas H_2O, except for in the 200 K warm-up model, in which there was a noticeable difference observed. Also, in our 10K model and constant temperature models, we are studying the effects that different levels of diffusion energy have on the desorption of O-bearing species.

Spectral Analysis of French Horn and Trumpet Mouthpieces

Josh Bivens, SUNY Oswego
Advisor: Dale Zych

Measurement methods have been developed for measuring the acoustic input impedance of horns using voltage controlled oscillator and lock-in amplifier techniques. Resonance curve data for French horn and trumpet mouthpieces have been fitted successfully to the analog network of a Helmholtz resonator driven by one of its internal walls (Ref.1). These methods are being developed in order to study a wide variety of effects such as hand-in- bell and mutes associated with horns. Results for the horn and trumpet mouth pieces will be shown along with preliminary results for two trumpets of different quality.

1. Fletcher, N and Rossing, T. "The Physics of Musical Instruments," 2nd ed. Springer-Verlag, New York. p. 230 (1998).

Temperature Dependence of the Saturation Magnetization in Ferromagnetic Metallic Glasses

Andrew Bordash and Jacob Mills, SUNY Oswego
Advisor: Dale Zych

The magnetization of two-transition amorphous metal-metalloid systems (Fe40Ni40P14P6 and Fe40Ni38Mo4B18) have been studied between temperatures 78K and 340K in magnetic fields up to 1.27 Tesla using a newly constructed vibrating sample magnetometer. The purpose of these measurements is to develop methods for studying other ferromagnetic non-crystalline systems. As expected, a dominant T^3/2 term was observed in the saturation magnetization due to the excitation of long-wavelength spin waves or magnons. When taking into account the different Curie temperatures for the two samples, the T^3/2 term contributions are close; however, terms varying as T^5/2 are different. The vibrating sample magnetometer will be described along with its calibration using paramagnetic palladium.

Thin Film Solar Cells: Enhancing Efficiency using Various Nanoparticles

Martin Dann, Carolina C. Ilie, SUNY Oswego
Advisor: Carolina C. Ilie

We present herein the work started at SUNY Oswego as a part of a SUNY SCAC grant. The SUNY SCAC Committee has awarded Dr. Carolina Ilie and Martin Dann a grant to carry out extensive studies on thin film solar cells. The focus of the study is to develop miniaturized solar cells using rare earth free metals, yet have at least the same efficiency as the industry standard. The Langmuir Blodgett method of thin film deposition will be used to create a nanoparticle monolayer on the surface of water, and then be deposited onto a silicon wafer. Repetition of this process will lead to the creation of the thin film, which consists of many monolayers stacked on one another. Martin Dann has started the preliminary work for the project and will continue the project. The preliminary work concentrates on analyzing the properties of magnetic nanoparticle candidates, band gap, and the fabrication of thin films. The continuation of this work will include the fabrication of more samples, as well as performing IV curve tests on the samples. These tests will determine how much power is put out from the solar cell given a known power input, giving the efficiency of the cell.

Physics in video games: Using numerical methods to simulate Newtonan physics
Timothy Dougherty, SUNY Oswego
Advisor: Carolina Ilie

An exploration into the physics of video games by implementing numerical methods through programming. There are several methods to consider when developing a physical system for a game, for instance Euler's method is an efficient method, which unfortunately is rarely viable. There also exist a few variations to Euler's method that give more functionality, such as semi-implicit Euler and implicit Euler. Each has different restrictions and advantages, but that not to say we only explore Euler's and its variations. Verlet integration is a useful method to calculate trajectories in a multiple particle system, which been utilized across many fields. Lastly we will study RK4, Runge-Kutta 4, a method developed by two German mathematicians. RK4 is by no means a perfect numerical method, but is a good general purpose integration technique. We investigate single-particle systems in two dimensions, and note the similarity to multi-particle systems in two dimensions. Adding a third dimension greatly increases the complexity of the simulation, we simply touch on the topic for today. A less formal discussion of a few important considerations in game development takes place, topics include varying refresh rates and PC specifications (the game should run the same for everyone, every time it is executed), and how communicating with a server introduces much more complexity.

Coincidence Efficiency of Sodium Iodide Detectors for Positron Annihilation
Thomas Eckert, Laurel Vincett, and Mark Yuly, Houghton College, SUNY Geneseo, Laboratory for Laser Energetics
Advisor: Mark Yuly

One possible diagnostic technique for characterizing inertial confinement fusion reactions uses tertiary neutron activation of ^{12}C via the $^{12}C(n, 2n)^{11}C$ reaction. A recent experiment to measure this cross section involved counting the positron annihilation gamma rays from the ^{11}C decay by using sodium iodide detectors in coincidence. To determine the number of ^{11}C decays requires an accurate value for the full-peak coincidence efficiency for the detector system. A new technique has been developed to measure this coincidence efficiency by detecting the positron prior to its annihilation, and vetoing events in which decay gamma rays other than the 511 keV annihilation gamma rays could enter the detectors. Measurements and simulation results for the absolute coincidence total and full-peak efficiencies are presented.
Funded in part by a grant from the DOE through the Laboratory for Laser Energetics.

Study of P-N Junctions and Metal-to-Metal Interfaces
Jeffrey Ellison, SUNY Brockport
Advisor: M Tahar

Various P-N junctions (Si/Ge, power/signal diodes) and metal-to-metal interfaces are studied using voltage controlled current source built using off-the-shelf components. Use of a floating voltage controlled current source eliminates common mode interferences allows precise measurements of I-V characteristics. Further the design of voltage controlled current source allows for the addition/superposition of a small AC (sine wave 13.0 Hz) current to a slow varying DC current (triangular wave 0.01Hz), which is used to obtain the dynamic conductance (dI/dV) of the junction and its dependence on the junction voltage. For the diodes, both current vs. voltage and the conductance vs. voltage exhibit switching (on/off) and hysteresis behavior between ramping up and down. The switching voltage is lower for Ge diode as compared to that of Si diode at ambient temperature and increases at T = 77K. For the metal-to-metal, the I-V is linear (Ohmic) with very small y-intercept and the conductance is constant down to T= 77 K with typical metallic behavior.

Design and Fabrication of a Small Single-Axis Acoustic Levitator
Grant Farrokh, Le Moyne College
Advisor: Dr. Stamatios Kyrkos

Acoustic levitation is the phenomenon of employing sound waves to stably suspend objects in midair. Using high intensity ultrasonic acoustic waves and a concave reflecting block, a standing wave is created in which samples can be held in place by acoustic radiation force in the stationary nodes of the wave. This has seen many practical applications as a means of contact-free handling of samples, and is more versatile than other forms of levitation due to the fact that virtually any non-gaseous mass can be levitated acoustically. A small tabletop system for producing this effect was designed and fabricated as part of a senior capstone project. The constructed levitator is being further developed for use in undergraduate experiments and physics demonstrations.

Performing Fowler Sampling and Removing Cosmic Ray Hits to Reduce Noise Numerically from Long-Infrared Detector Images
Chelsea Jean, Craig McMurtry, Meghan Dorn, Judy Pipher, University of Rochester
Advisor: Craig McMurtry, Judy Pipher

The University of Rochester Long-Infrared Astrophysics group works with 1024x1024 HgCdTe detector arrays to be developed for a passively cooled infrared space mission. The near-earth object camera (NEOCam) is a proposed infrared space mission for the purpose of discovering and characterizing potentially hazardous objects such as asteroids that are larger than 140 meters in diameter that orbit near the Earth. The tests that were performed in the numerical reduction were called Fowler Samplings. The Fowler images that were produced took average samples of data of sample up the ramp (SUTR) points.

The images have the readout noise corrected. Readout noise is a consequence of the imperfect operation of any physical electronic device and occurs from a voltage being induced by the charge of electrons transferred to a capacitor. The results led to a significant decrease in electrons per second that fluctuate throughout the images. These results were consistent across multiple infrared detector arrays and promising for the development of NEOCam.

Capillary Condensation Transitions and Meniscus: Parallel Planes, Nanotubes, and Wedges

Dylan J. McIntyre, Nicholas C. Jira, M. T. Romano, J. R. D'Rozario, M. Guedes-Duarte, T. Dougherty, and C.C. Ilie, SUNY Oswego
Advisor: Carolina C. Ilie

Herein, we investigate the behavior of vapor in confined media as it condenses into a liquid. Capillary condensation is studied in the presence of van der Waals forces. Three phases may occur in such a system: empty (no wetting occurs), film (a thin film of liquid forms), and full. We derived the grand free potential for the three phases, and the potential differences that occur in various substrate configurations. These potentials are used to explore the phase transitions, to find the triple point of a phase diagram and to show the possible coexistence between phases. By working with the potentials for film and empty phase and considering the symmetry and the boundary conditions in a gravitational free system, we obtain the shape of the meniscus of the liquid film between the two parallel plates. Other substrate shapes such as cylinders are also discussed and the meniscus is derived. We also present the wetting for the wedge. The wedge system behaves differently than planar or cylindrical systems. We discuss these differences and we present the shapes of the meniscus formed by filling for a few different substrate – liquid systems. We also discuss the phase transition between the empty and filled phase, which gives the evolution of the system. Understanding this phenomenon is especially important to the success of developing new nanoscale technologies, as surface effects become then more prevalent.

Evolution of the Composition of Dust in Protoplanetary Disks

Ingrid Koch, K.H. Kim, S.P. Fogerty, W.J. Forrest, Dan M. Watson, University of Rochester
Advisor: Dan M. Watson

Using the Spitzer Space Telescope's Infrared Spectrograph we have observed some 300 Class II young stellar objects in the Lynds 1641 dark cloud and the Orion Nebula Cluster within the Orion A cloud. The median age of these systems is less than 1 Myr. The spectra contain prominent spectral features of silicate dust in the associated protoplanetary disks. We analyzed the dust composition, using a two-temperature model roughly to represent contributions to the spectrum from inner (< ~1AU) and outer disk. In the model we included seven-grain species, two blackbody continua, and in certain cases a two part template for polycyclic aromatic hydrocarbon emission. This yielded mass

fractions of the dust-grain species. We compare these results to similar, previous studies of the older (2-3 Myr) systems in the Taurus cloud. We find that the mass fractions of large amorphous grains are similar in the two regions, as are the infrared spectral indices that characterize the degree of settling of dust to midplane, in agreement with theoretical expectations (e.g. Weidenschilling 1997). However, the two populations differ substantially -- typically by factors of 10 -- in the mass fractions of crystalline silicate grains. Taurus, when compared to Orion, has greater abundances of warm (inner disk) enstatite, cold (outer disk) forsterite and silica. Thus, although the evolution of grain size and vertical disk structure seems to take place on time scales considerably less than 1 Myr, the genesis of minerals takes longer: on a time scale similar to the ages of the Orion and Taurus star clusters. These results are in preparation for publication.

Design and Construction of a Cost-effective Atomic Force Microscope

Heidi Kroening, Jonathon Yuly, and Brandon Hoffman, Houghton College
Advisor: Brandon Hoffman

A low-cost atomic force microscope (AFM) design is under development at Houghton College. This AFM will be equipped with an eddy current spring dampening system, a modified “Johnny Walker” sample mount which allows the sample to approach the cantilever tip in a controlled way, and a laser system to detect cantilever movement. Linear transistor amplifier circuits will yield a cost-effective means of driving piezo-electric crystal control elements.

Capillary Condensation Transitions and Meniscus: Parallel Planes, Nanotubes, and Wedge

Dylan J. McIntyre, Nicholas C. Jira, M. T. Romano, J. R. D'Rozario, M. Guedes-Duarte, T. Dougherty, and C.C. Ilie, SUNY Oswego
Advisor: Dr. Carolina C. Ilie

Herein, we investigate the behavior of vapor in confined media as it condenses into a liquid. Capillary condensation is studied in the presence of van der Waals forces. Three phases may occur in such a system: empty (no wetting occurs), film (a thin film of liquid forms), and full. We derived the grand free potential for the three phases, and the potential differences that occur in various substrate configurations. These potentials are used to explore the phase transitions, to find the triple point of a phase diagram and to show the possible coexistence between phases. By working with the potentials for film and empty phase and considering the symmetry and the boundary conditions in a gravitational free system, we obtain the shape of the meniscus of the liquid film between the two parallel plates. Other substrate shapes such as cylinders are also discussed and the meniscus is derived. We also present the wetting for the wedge. The wedge system behaves differently than planar or cylindrical systems. We discuss these differences and we present the shapes of the meniscus formed by filling for a few different substrate – liquid systems. We also discuss the phase transition between the empty and filled phase, which gives the evolution of the system. Understanding this phenomenon is especially

important to the success of developing new nanoscale technologies, as surface effects become then more prevalent.

The Brain as a Universe: Misconceptions and Limitation in Brain Theories

Marie Romano, SUNY Oswego
Advisor: Carolina Ilie

I present herein some of the misconceptions and assumptions related to brain theories. Although the fields involved in tackling the problem of consciousness rapidly advance and change, and even though these different theories approach this problem holistically, there is still so much territory which is not well known. Neural networks do comply with what we know about the various physical laws, however this may not be enough to paint a complete picture of consciousness. It may be impossible to develop a all-inclusive scientific theory of consciousness due to misconceptions and approaches that are based on assumptions.

Modeling of Carbon Chain Anion Species of The Low-mass Protostellar Region L1527

Deep Shah, Georgs Hassel, Sherwin Shaj, & Alexander Arduini, CURCA
Advisor: George Hassel

Astrochemistry is the study of the chemical substances and species occurring in stars and interstellar space. Observations of the protostellar region L1527 reveal a unique composition including radicals, carbenes, and anions, and we consider model simulations with an enhanced reaction network to include anion chemistry. In this project, we worked to simulate the chemical composition of L1527, which was believed to be the product of warm carbon chain chemistry (WCCC) process. We calculated fractional abundances (with respect to nH) of C4H, C6H, C4H-, and C6H- as function of time and were plotted on the figures. After the addition of anions, the confidences level fits are comparable. The new species C4H- and C6H are fit by the models, but C4H is no longer a fit with this species. For future research, using distinctly different warm up models may resolve the issue with C4H.

Simulation of Deuterated Species of the Low-mass Protostellar Region L1527

Sherwin Shaju, George Hassel, Alexander Arduini, Deep Shah, Siena College
Advisor: George Hassel

Astrochemistry is a multidisciplinary effort that combines observational values, laboratory measurements of spectroscopy and chemical kinetics utilizing computational modeling in an effort to examine the synthesis and evolution of chemical species in astrophysical environments. This particular project involves including the chemistry of deuterium to existing models of the protostellar region L1527, which has a unique chemical composition thought to be the result of Warm Carbon Chain Chemistry

(WCCC). The abundances of the carbon chains are enhanced at warm temperatures (30-50 K) as a result of CH4 sublimation. New observations of L1527 include the deuterium-bearing analogs C4D and DC5N of previously observed C4H and HC5N, as well as CH3D, which provides more direct observational evidence for the undetectable CH4. The fractional abundances of the observed species will be calculated in respect to nH as a function of time. The addition of the deuterated species to the reaction network caused a general increase, then decrease in the fractional abundances for the overall trends of the graphs. It was also seen that higher temperatures caused a significantly greater decrease in fractional abundance for all deuterated species for all temperatures. Our observed results fit well with previously observed fractional abundances. The results indicate that adding deuterium to the reaction species did significantly decrease the experimental fractional abundances of the tested species. For future studies, additional model simulations may help optimize the best agreement with the observed composition.

Quantifying Forces on Strongly Absorbing Materials Rotating in Optical Traps

Ryan Kropas and Emily Sobel, SUNY New Paltz
Advisor: Catherine Herne

Optical trapping or "tweezing" is a laser-based method of micron-scale material manipulation, exploiting the forces produced by light refracting through small particles to capture them within a particular area (the trap). Biologists and chemists use this technology to handle large molecules, mix small volumes of liquids, and even build cell-scale machinery. In this research project, we use Laguerre-Gauss modes to create the trap and rotate the particles. Generating the Laguerre-Gauss modes is achieved through programming a spatial light modulator (SLM) with a holographic phase pattern. We work with several different combinations of particles (polystyrene latex, silica, mica, graphite, and vermiculite) and solutions (deionized water, SDS) to conduct experimental tests of the effective trapping and rotation of strongly absorbing materials. When a particle is sufficiently trapped, we apply an alternating current to a piezoelectric to oscillate the solution and quantify the trapping force that is present. We also perform theoretical calculations of trapping forces in laser modes carrying orbital angular momentum (OAM). Here, we present the results of our measurements and calculations and show the forces acting on the particles.

Modes and Q Factors of the Top Plate of Guitars

Ivory Stokes, University of Rochester
Advisor: Professor Mark Bocko

A laser scanning Vibrometer was used in an anechoic chamber to detect the resonant frequencies, modes, and quality factors (Q factors) of the top plates of four different acoustic guitars. The four guitars analyzed were a nylon-string classical Alvarez, and, in descending MSRP, a Taylor, Washburn, and JB Player. The resonant frequencies for corresponding modes were different for each model, as was expected with varying top plate/body shapes. The Alvarez classical guitar, because its construction was intended to be used for single tones (as opposed to chords), was found to have higher Q factors than virtually every corresponding mode of the conventional steel string guitars. Additionally, the quality of each steel string instrument's resonating capabilities was found to correspond to its relative price point.

Dust Mineralogy Survey for T-Tauri Stars in Taurus-Auriga and Ophiuchus Region

Fan Wu, William Forrest, Shane Fogerty, University of Rochester
Advisor: William Forrest

This poster summarizes my work on instigating the crystallinity for protoplanetary disks in Taurus and Ophiuchus region. From 2013 Fall to 2014 Summer, I have reduced and analyzed around 200 Sprizter IRS spectra for targets in both Taurus and Ophiuchus. Using UR Two Temperature model, the crystallinity of each target can be obtained. Furthermore, we found a weak negative correlation between crystalline mass fraction and X-ray emission for T-Tauri stars in the Taurus region.

SEM-EDX Analysis of Aerosol Samples

Xuanhan Zhao, Union College
Advisor: Michael Vineyard

One of the important environmental issues in upstate New York is the acid rain problem in the Adirondack Mountains, which is associated with atmospheric aerosols. As a part of a systematic study to understand the transport, transformation, and effects of airborne pollutants in the Adirondack Mountains, we are performing an analysis of atmospheric aerosols collected at Piseco Lake. In previous work, we used proton induced X-ray emission (PIXE) spectrometry to measure the concentrations of elements in the aerosol samples as a function of the size of the particulate matter. The results of the PIXE analysis indicate significant concentrations of sulfur in small particles that can travel great distances and may contribute to acid rain. Here we report on the investigation of the small-particle aerosol samples using scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX) to obtain elemental information on individual particles. Many of the particles contain large concentrations of sulfur and oxygen that may indicate the presence of sulfur oxides from industry and coal combustion that are known contributors to acid rain, but they are not always in the same ratio. There are also many particles that contain significant concentrations of elements commonly found in soil (Al, Si, K, and Ca). The sample collection and analysis will be described, and the results will be presented.

SESSION IIIA. ASTRONOMY II

Quasar Emission Line Variability From Hubble Space Telescope Archive Data

Kasey Hogan, SUNY Brockport
Advisor: Dr. Eric Monier

Quasars, the luminous nuclei of active galaxies, exhibit spectra with both continuum and emission line features. The continuum arises from a hot accretion disk orbiting a supermassive black hole, while the emission lines are produced further out, in gas excited by the accretion disk. Using the Hubble Space Telescope Archive (HST), I measured and analyzed flux variations in low-redshift ($z < 1.7$) quasar spectra. The flux variations that I measured were for the Lyα λ1216 broad emission line (BEL), CIV λ1549 BEL, and continuum emission from the central ionizing source. I used quasars and active galactic nuclei (AGN) that have spectral data for at least two points in time to obtain flux ratios. I created a set of custom python scripts to quicken the process of analyzing raw HST spectral data. The results show a strong correlation to the flux variations for the Lyα BEL and the CIV BEL that suggests that these BEL regions are at similar distances from the central ionizing source. Less of a correlation is present for the continuum emission when compared with each BEL, this is consistent with the presence of a time lag due to the large distance between these regions. By using this statistical approach and continuing to build up a database of flux variability, I hope to obtain further information that will be useful in modeling quasar activity and structure.

Characterizing the variability of 4-10 Myr old T-Tauri stars in the Orion OB1 Association

Md Tanveer Karim, University of Rochester
Advisor: Dr. Cesar Briceno

Older T-Tauri stars are poorly understood even though they offer key insight to understanding stellar evolution of lower-mass (0.1 - 2 $M_{\odot}$) stars. We present a study of photometric variability of 2000 confirmed 4-10Myr T-Tauri stars in the Orion OB1 association using optical time-series from three different surveys: Centro de Investigaciones de Astronomía-Quest Equatorial Survey Team (CIDA-QUEST), Young Exoplanet Transit Initiative (YETI) and Kitt Peak National Observatory (KPNO). We investigated stellar properties such as rotation period and amplitude of variability based on star type and location to detect population-wide trends. We detected 143 periodic variables and 1057 irregular variables by investigating the light curves of these stars; the periodic properties of the remainder 800 stars are inconclusive because of few data points or ambiguous light curves. We found 12.4%Weak-line T-Tauri stars (WTTS) and 8% Classical T-Tauri stars (CTTS) to be periodic. We did not find any noticeable difference in rotation period between CTTS and WTTS. In contrast, our study provides observational evidence of rotational evolution between 4Myr and 10Myr stars - younger stars on average have slower rotation rate compared to older stars. We also detected significant larger magnitude variation in CTTS compared to WTTS, probably due to their protoplanetary disc.

C IV Absorbers in the Sloan Digital Sky Survey

Stephanie Robillard, SUNY Brockport
Advisor: Eric Monier

Quasars have significant luminosities and their cosmological redshifts, a direct result of the expansion of the Universe, make them ideal for studying the early Universe. As the most luminous objects in the Universe, they make excellent background sources for studying, via absorption lines, gas and galaxies that cannot otherwise be detected. The focus of this research is the strong C IV λλ1548, 1550 absorption line doublets due to intervening, intergalactic gas. C IV absorption is associated with galactic formation and so its incidence as a function of cosmic time offers insight into galactic formation and evolution. Using the Tenth Data Release (DR10) of the Sloan Digital Sky Survey (SDSS), we retrieved quasar spectra with a redshift $z \geq 1.5$ and a brightness magnitude cut of $i > 20$. We normalized the spectra, fit them with a continuum and calculated a redshift path length for each spectrum. We identified candidate C IV systems using an automated routine that searches for the characteristic 2Å separation doublet of C IV. After examining these candidate systems interactively to identify true systems, we measured the equivalent widths of the doublet lines. The resulting database will be used to calculate the number of C IV absorbers (N) as a function of redshift, $\partial N/\partial z$, for these stronger systems.

Characterizing the Outflow Energetics of the 'Cloverleaf' Quasar Using Broad Absorption Lines

Daniel P. Burdette, SUNY Brockport
Advisor: Eric M. Monier

Quasi-stellar radio sources, or quasars, are extremely luminous active galactic nuclei (AGN) that have proven to be very useful probes of the early universe due to their high redshifts. As AGN, quasars rest at the center of galaxies, emitting radiation via a disk of accreting matter surrounding a central supermassive black hole. Further surrounding the accretion disk is the broad line region, modeled by gas clouds rotating at high velocities that partially cover the inner components. About 10% of quasars show spectral broad absorption lines (BALs) due to high-velocity gas outflowing from the broad line region. Such outflows may play a major role in feedback to the host galaxy's evolution. One such BAL quasar, Q1413+1143, has been deemed the 'Cloverleaf' due its gravitationally lensed nature. The four different sightlines toward this object have been used for a number of different studies of the Cloverleaf itself, as well as the intervening intergalactic medium. In this contribution, we examine time variability in the BALs of the Cloverleaf to estimate the location of the outflowing gas relative to the central black hole and accretion disk. This study will characterize the BALs of the cloverleaf quasar using data from two different observation times of the Hubble Space Telescope to determine if the Cloverleaf quasar's outflow is a feedback mechanism to its host galaxy.

SESSION IIIB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES I

Neutron Transport Analysis of Small Module Reactors to Support U.S. Army Energy Requirements at Forward Deployed Locations

CDT Joseph L. Brown and CDT Zachary D. Lewis, United States Military Academy
Advisor: LTC Ken Allen

This work explores possible US Army uses for nuclear energy by conducting a broad literature search concerning modern Small Module Reactors (SMRs), currently being produced by various companies in support of a Department of Energy initiative. We investigate the feasibility of portable nuclear reactors for use by the Army in isolated areas. Such reactors could be used in Forward Operating Base sustainment or disaster relief and humanitarian aid operations.

While SMRs show promise, they are still a long way from being portable. Still, their relative ease of manufacture, inherent safety features, and low maintenance requirements may offer some appeal to the Army. Longer reactor fuel cycles could reduce the requirements for land-based fuel convoys in areas such as Iraq and Afghanistan. Our efforts will focus on a 17 x 17 fuel assembly, common in the literature.

We use MCNP6 to calculate the neutron non-leakage probability of an assembly. We developed two methods to achieve this. The first relies upon the six-factor formula definition of the multiplication factor. The second relies upon an F1 tally output interpretation. We compare the outputs of the two methods and suggest future work to be done.

Establishing a Laser Induced Breakdown Spectroscopy System for Post-Detonation Nuclear Forensics Applications

CDT Jordan A. Blanchard, CDT Eddie T. Ortega, and CDT Taylor M. Richard, United States Military Academy
Advisor: LTC Chad Schools

In the event of a nuclear terrorist attack on American soil the United States government has an attribution system in place to trace the nuclear material and device design back to its origin. Post detonation nuclear forensics is one part of this attribution system but traditional methods of radiochemistry can take a month to complete the analysis required. Reducing the required time to process ground and air samples collected near the detonation site is critical to ensuring the viability of our post-detonation nuclear forensics capabilities.

Analysis near the debris collection site using Laser Induced Breakdown Spectroscopy (LIBS) may be able to provide real time isotopic and elemental data needed to determine information about the nuclear materials and design. The current research effort focuses on the construction of a LIBS system with the future goal of analyzing the strengths and weaknesses of deploying a LIBS system with sample collection teams. Our presentation will highlight our current understanding of LIBS components as well as progress with developing our own system at the United States Military Academy.

Noise Analysis in Terahertz Spectroscopy

James Buttner, Colgate University
Advisor: Beth Parks

In this talk I will discuss my current research on the effects of noise in Terahertz (THz) spectroscopy. I will begin by giving a brief background of THz spectroscopy such as what it is and why it is useful and important. I will describe how the apparatus works and some of the potential sources of noise. Finally I will share the Matlab simulations we are using to model the noise in the system and our findings so far of the effect of noise on our data.

High-Throughput Electric Field Induced Second Harmonic Generation in Highly-Monodisperse Microdroplets

Julian Girard, ENS Cachan, University of Michigan
Advisor: Professor Abdel El Abed, Son Nguyen

The droplet-based microfluidics laboratory at Ecole Normale de Cachan, headed by Professor Abdel El Abed, is developing a method of conducting Electric Field Induced Second Harmonic Spectroscopy (EFISH) on highly monodisperse microdroplets. The goal of this endeavor is to achieve high rate sensing of monodisperse microdroplets; a highly beneficial application for Lab-on-a-chip (LOC) biological and chemical experimentation. Highly monodisperse microdroplets were produced at rates exceeding 1000 Hz in 30 micron PDMS microchannels controlled by a micro-liter-precise piezo pumping system. A 100 fs pulsed Ti:Sapphire laser was used to induce second harmonic (SH) radiation from stationary trapped droplets, composed of nonlinear solution to maximize SH response. The SH response under variation of applied electric field magnitude, electric field frequency, and excitation wavelength was cataloged in the form of two-dimensional cross-sectional scans calibrated to the SH frequency. As SH theory suggests, a strong dependency of the measured SH response on these variables was observed. Future work will involve conducting SH spectroscopy on mobile droplets at high throughput in order to accommodate LOC experimental designs.

Portable, Directional Neutron Detector

CDT Cory Fish, CDT Brad Bachand, MAJ Tony Clark, MAJ Will Koch, United States Military Academy at West Point
Advisor: MAJ Tony Clark and MAJ Will Koch

The Department of Physics and Nuclear Engineering at West Point is downsizing the typical Dark Matter Time Projection Chamber system into a one-person portable, directional, fast-neutron detector. In the world of tracking Special Nuclear Material, two primary signals are used: gamma rays and neutrons. Gamma ray detectors are predominantly suited for detection of Highly Enriched Uranium (HEU), while neutron detectors are better suited for the detection of Weapons Grade Plutonium (WGPu). Historically, inspectors use detectors with a Helium-3 target gas due to its significant cross section to thermal neutrons. However, the cost of Helium-3 has grown several orders of magnitude, and the sensitive energy range for Helium-3 requires a moderated signature from WGPu, destroying information in the process. This detector uses Helium-4 as a target gas. While operating at a much lower sensitivity, the Helium-4 is most sensitive to higher energy ranges, in general agreement with the energy range from a spontaneous fission source. Further, the recoil of the alpha particle provides second order directional information. Once many tracks are collected from a single neutron source, the distribution of track angle can be plotted and fit with an expected recoil distribution to determine the direction to the WGPu source.

SESSION IIIC. NUCLEAR AND PARTICLE PHYSICS

Measuring Parity Violation in Cobalt-60 Decay

Paul Lashomb and Mark Yuly, Houghton College
Advisor: Mark Yuly

An experiment is being performed to measure parity violation in 60Co beta decay. Any asymmetry between the right and left-handed circularly polarized gamma rays emitted at 180° to the beta particle in the 60Co beta decay reaction is an indication of parity violation. A beta-gamma coincidence circuit counts gamma rays transmitted through an iron core that is magnetized either parallel or antiparallel to the direction the gamma ray is travelling. Since the Compton scattering cross-section for circularly polarized gamma rays depends on the spin orientation of the electrons in the magnet, an asymmetry in the count rate when the electron and photon spins are parallel and anti-parallel indicates parity violation. While only initial measurements have been made to date, in the future it should be possible to measure the asymmetry to within approximately 5%.

A table top demonstration of general relativity using the Mössbauer effect
Emily Morrow, August Gula, and Mark Yuly, Houghton College
Advisor: Mark Yuly

In the classic Kündig experiment of 1963, the Mössbauer effect was used to measure the gamma-ray frequency shift due to the transverse Doppler effect. According to the equivalence principle, the transverse Doppler effect, which is the shift in frequency due to the effect of general relativity on time, should occur in an accelerated system just as in a gravitational field. An experiment to measure this effect is being assembled at Houghton College. Initial work has been done to produce a 5 μC 57Co Mössbauer source by electroplating 57Co onto a thin stainless steel foil, and heating the foil in a vacuum to approximately 1000 °C. The source will be placed near the edge of a thin high-speed rotating steel disc. The 14.4 keV gamma rays from the 57Fe daughter nucleus will penetrate a steel disc and be detected by a CdTe x-ray detector on the other side. Varying the radial acceleration of the rotating absorber will change the characteristic energy of the resonance absorption, resulting in a change in the gamma transmission. This change can be described by time dilation in accelerated system according to general relativity. To reduce background, a NaI detector will detect the 122 keV gamma ray from 57Fe in coincidence with the 14.4 keV gamma ray. Currently, work has been focused on producing the Mössbauer source.

Materials Testing Using Non-Radiating Techniques
CDT Trent Jones, United States Military Academy
Advisor: Dr. Terence Tarnowsky

This project was developed to investigate whether alpha particles can be used to simulate neutron material damage without activating the materials being tested. It was hypothesized that high energy alpha particles (> 4.5 MeV) could be used to damage materials, acting as a substitute for neutrons. Previous studies exposed zirconium alloy and gold foils to alpha particle radiation for periods of 330 and 1010 minutes, respectively. A tabletop scanning electron microscope was used to visually inspect the materials. Though some blistering and cracking was observed in the samples, the damage could not be differentiated from machining striations and markings. Recently, polished samples of zirconium foil were obtained using 400-800 grit sanding paper and polishing with a diamond slurry as small as 1 micron. Chemical polishing or etching can be considered in the future. The ultimate goal is to definitively determine if alpha particles can be used as a substitute for neutrons to test cladding materials used in nuclear reactors and avoid creating additional radioactive waste via testing procedures.

Recovering from Saturation
Jun Yin, University of Rochester
Advisor: Frank L. H. Wolfs

Many cosmological observations suggest the existence of dark matter and dark energy. One candidate for dark matter is the Weakly Interacting Massive Particle (WIMP). The 7-ton LUX-Zeplin (LZ) detector, the next generation dark matter experiment to be constructed at the Sanford Underground Research Facility (SURF) in South Dakota, focuses on observing dark matter by detecting the interactions between WIMPs and liquid xenon atoms. The scintillation light generated during these interactions is observed with photomultiplier tubes, amplified, and digitized, before being analyzed. The detector is optimized for small energy depositions (a few keV), but a good measurement of the background requires us to be able to handle large energy deposition (a few MeV). Due to the dynamic range of the electronics, large energy depositions may produce saturation in some of the captured waveforms. This work describes our first effort to reconstruct the properties of saturated waveforms. The results of simulations will be compared with the results obtained with prototypes of our electronics.

SESSION VIA. CONDENSED MATTER AND BIOLOGICAL PHYSICS

3D Printed Prosthetics
Joseph Fairley, Siena College & InMoov
Advisor: Dr. John Cummings

Through 3D printing technology and the invaluable resource of open-source collaboration, I was able to analyze the critical elements of a potential prosthetic arm so that the usability and durability of the device could be assessed. It became conclusive that the grip strength of the hand was sufficient enough that when compared to an everyday action such as lifting a ball off of a table, the resulting current needed for the action could sufficiently be supplied by the interaction of a muscle impulse with a computer interface. The conclusive results gave reassurance towards the overall usability of a 3D printed prosthetic device. Upper-limb prosthetic devices can be revolutionized through 3D printing technology and can be adequately designed for everyday use.

Projected Thoughts: Liquid-Crystal-Display (LCD) to Cathode Ray Tube (CRT) to Projected Matrix
Annmarie Pryor and Theresa Vaughan, Siena College and Wadsworth Center
Advisor: Theresa Vaughan

Brain Computer Interface (BCI) technology is essential for communication with individuals with nervous system disorders that render them unable to speak. The BCI visual spelling task at-home system currently uses a LCD monitor. A previous study by Jennifer King indicated there was no significant effect on the amount jitter produced by a

LCD monitor or a CRT monitor on individuals results. To enhance the at-home experience, we explore whether or not the jitter would significantly affect the results when using a projector by collecting electroencephalographic (EEG) data from subjects. We then add jitter to the data in order to predict at what point the jitter might affect the results from the various screens. Our data continue to show no significant difference in the accuracy of the results, supporting our claim that a projected image can be substituted for an image on a LCD monitor in a BCI visual spelling task.

Analysis of Annealed Indium Films

Kathryn Coghlan, SUNY Brockport
Advisor: Dr. Johnson-Steigelman

Indium is a very malleable metal, that when oxidized, becomes a semiconductor used in a variety of applications including cooling devices, solar cells, and temperature sensors. In this experiment we will examine how temperature affects the growth pattern and crystal structure of metallic indium. This research involves the growth and analysis of annealed and non-annealed Indium films. Each sample was analyzed using Atomic Force Microscopy and X-Ray Diffraction and then the samples were compared to each other. The annealing process has resulted in a change in surface appearance as well as preferred orientation of the crystallites within the samples. The surfaces of our samples are more uniform and seem to be layering in specific step sizes. The preferred orientation is with the <101> face parallel to the surface.

Growth and Oxidation of Indium Thin Films

Amanda Landcastle, SUNY Brockport
Advisor: H. Trevor Johnson-Steigelman

The crystallinity of indium thin films alters when heated due to oxidation, resulting in an indium oxide film. X-ray diffraction (XRD) and atomic force microscopy (AFM) are used to examine the change in crystallinity of the indium thin films under different heating conditions. Indium oxide is typically grown via sputtering techniques. If Indium oxide could be produced by vacuum deposition of indium with subsequent oxidation, it could provide an easier and more cost efficient method of growth for future applications.

Synchronization of Josephson Junction Neurons

Matt LeGro, Colgate University
Advisor: Kenneth Segall

There is one non-linear system that is utilized by every living being at all times without exception: the neural network. While the behavior of an individual neuron is well documented, the collective behavior of neurons cannot be determined through a sum of its parts. The goal of this project is to demonstrate the benefits (computation speed and power consumption) of using non-linear superconducting Josephson Junctions circuits in simulating coupled neuron behavior. A superconducting chip has been fabricated in conjunction with Hypres, Inc., allowing for the experimental study of behavior of two coupled Josephson Junction neuron circuits. Thus far success has been met in observing a phase-flip bifurcation in the synchronization of two neurons for varied coupling parameters, a behavior expected for time-delayed coupled oscillators. For a small change in the neuron's bias current, a complete synchronization state reversal has been observed. This may indicate the ability to study both inhibitory and excitatory neurons using one fabricated chip.

Microhardness and Atomic Disorder of the *Balanus Amphitrite* Exoskeleton

Charles Hamilton, Colgate University
Advisor: Prof. Rebecca Metzler

The barnacle species *Balanus amphitrite* possesses a hard calcerous exoskeleton that is formed through an unknown mechanism of biomineralization. This mechanism incorporates chemical compounds from the surrounding environment that seem to enhance the mechanical properties of the substance by introducing a certain level of atomic disorder. Analysis of the relationship between these characteristics of the exoskeleton can be studied with microindentation and the creation of Attenuated total reflectance-infrared spectroscopy (ATR-IR) grinding curves. Differences were found between the microhardness of the different parts of the exoskeleton and the following relationship or relative hardness values was hypothesized: operculum > baseplate > parietal plate. We also show that there are distinct levels of atomic disorder throughout the parts of the exoskeleton that exhibit the relationship: operculum > baseplate > parietal. Additionally, it was found that all parts of the exoskeleton have much higher levels of atomic disorder than geologic calcite. This indicates that the methods of biomineralization that*Balanus amphitrite* uses to form the different parts of its exoskeleton may be different or that the difference may lie in the surrounding microenvironment. A further understanding of this mechanism would help give insight into biomineralization methods of other species, improve the overall understanding of the barnacle, and help further efforts into materials-properties research. In the future, more research into different mechanical properties as well as a more quantitative analysis may also provide more insight about this phenomenon.

SESSION VIB. INSTRUMENTATION/EXPERIMENTAL TECHNIQUES II

The Design and Construction of an X-ray Diffractometer for the Study of Thin Metal Films

Jordan Cady and Brandon Hoffman, Houghton College
Advisor: Brandon Hoffman

A Bragg-Brentano θ-2θ X-ray diffractometer is being constructed at Houghton College to map the microstructure of textured, polycrystalline silver films. A Phillips-Norelco X-ray source will be used in conjunction with a 40kV power supply. The motors for the motion of the θ and 2θ arms, as well as a Vernier Student Radiation Monitor and other safety monitors, will all be controlled by a program written in LabVIEW.

Design and Construction of a Laser Interferometer to Study Thin Metal Films

Sean Daigler and Brandon Hoffman, Houghton College
Advisor: Brandon Hoffman

A phase-stepping laser interferometer is under construction at Houghton College to study thin metal films. The interferometer will be mounted under a deposition chamber, where thin metal films are deposited. While the sample is still under vacuum inside the deposition chamber, the laser interferometer will capture a series of interference patterns with a webcam. The set of pictures are taken as a reference mirror moves, producing stepped changes in the interference pattern. The series of pictures are analyzed using a LabView program to create a topographical image of the surface which will be a measure of curvature and will allow for calculation of stresses within the film.

The Construction of a Deposition Chamber for the in-situ Study of Thin Metal Films

Kyle Flemington and Brandon Hoffman, Houghton College
Advisor: Brandon Hoffman

A vacuum chamber with an evaporation system necessary to make thin metal films in high vacuum is being constructed at Houghton College. In order to evaporate the metal, a physical vapor deposition process is used. This chamber will have the capability to make gradient films for the study of the effect thickness has on texture transformation. It will also include an evaporation rate monitor with a similar design to an ion gauge. In order to ensure deposition onto clean substrates, an ion mill will be used.

A Study of Weak Magnetic Focusing

Sylvia Morrow and Mark Yuly, Houghton College
Advisor: Mark Yuly

The small cyclotron at Houghton College loses most of its beam current to collisions with the dee and chamber walls. The magnet pole tips re being altered to produce a more gradual increase in the radial magnetic field component with radius, which will improve weak magnetic focusing by creating a restoring force that gradually increases in strength to return ions to the central orbit plane. Moreover, the field index value n=0.2 must not occur inside the maximum ion orbit radius to avoid coupled resonances. A computer model of the magnet and chamber was developed to test modifications of the magnet pole tips to achieve these results. A two dimensional cross-section of the magnet was modeled using Poisson Superfish, the results of which were used to track ions with the Simion 8.0 code. This model indicates the best chamber design is to replace the current aluminum chamber lids with ferric stainless steel lids with radius 2.2 cm larger than the dee. The steel lids direct the magnetic field lines radially outward, resulting in a more gradual linear change in field all the way to the outside edge of the dee. This new design doubles the theoretical maximum kinetic energy to 900 keV, but at these higher energies the ions do not reach the maximum radius before falling out of phase because of the large number of required orbits. Results of the computer model will be compared with analytical results using a simplified model.

Measurement of the Primary D-T and D-D Ion Temperature Using Neutron Time of Flight Spectra in Inertial Confinement Fusion Experiments

Shuchen Wu, University of Rochester
Advisor: C. Forrest, C. Stoeckl

The ion temperature is an essential parameter in diagnosing ICF implosions. The 13.4m neutron time of flight diagnostic has the ability to measure ion temperature from both D-D and D-T fusion reaction. In this study we developed a forward-fitting technique to measure both the D-T and D-D ion temperature from ICF implosions using a single line-of-sight. The technique uses iteration of forward-fit model to extract the best approximate fit through the minimization of the error sum. Using this technique, measurement of ion temperature result in better than 10% accuracy for both D-T and D-D reactions. Comparison between the forward-fit approach and conventional method shows a disagreement for the inferred ion temperature by more than 25%. The discrepancy between the two approaches suggests the conventional measurement from fitting gaussian is limited to thin scintillator detectors, while forward-fit method works on detectors with various thicknesses.

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