

Annual

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 condensedmatter 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:

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

Frank Wolfs (Chair RSPS) 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 A M
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		

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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			

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

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-

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) **RSPS 2015**

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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 -

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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.

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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

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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

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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

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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-

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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

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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-

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(WCCC). The abundances of the carbon chains are enhanced at warm temperatures (30-

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 Ly! "1216 broad emission line (BEL), CIV "1549 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 Ly! 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

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 ""1548, 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 guasar spectra with a redshift z # 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 CIV. 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, \$N/\$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-

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

Portable, Directional Neutron Detector

CDT Cory Fish, CDT Brad Bachand, MAJTony Clark, MAJWill Koch, United States Military Academy at West Point Advisor: MAJTony Clark and MAJWill 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,

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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

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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

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source will be used in conjunction with a 40kV power supply. The motors for the motion of the & and 2& 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:

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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

LIST OF PARTICIPANTS

<u>Name</u>
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Grant Andrews
Alexander Arduini

Brad Bachand

Affiliation

Houghton College SUNY Potsdam Siena College United States Military Academy Faculty Undergraduate Student Undergraduate Student <u>Name</u>

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Name Kenneth Roffo Marie Romano Chad Schools Timothy Schuler Deep Shah Sherwin Shaju Joel Sims Ananya Sitaram Emily Sobel Ivory Stokes Hari Subedi Mohammed Tahar Steven Torrisi Laurel Vincett

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