XXVIII

April 4, 2009

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

Cosponsored by:
National Office of the Society of Physics Students; University of Rochester; National Science Foundation (REU Program); Department of Energy; U.S. Military Academy West Point

Rochester, April 4, 2009

Dear Participants:

Welcome to the 28th 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. RSPS 2009 is held this year at West Point. This will continue our recent tradition to host RSPS at locations away from Rochester every third or fourth year.

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/urpas/page/RSPS2009.

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. In 2006, RSPS was held for the first time at a location other than Rochester.

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

http://www.pas.rochester.edu/urpas/page/specialreu

LIST OF SPEAKERS

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NAME	TIME	LOCATION
Aikens, Kurt	2:45 pm	Bartlett Hall 211
Allen, George	8:45 am	Bartlett Hall 211
Ballard, Daniel	1:45 pm	Bartlett Hall 211
Coyle, Laura	9:00 am	Bartlett Hall 211
De Haas, Timothy	9:30	

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

PROGRAM

8.00 AM – 8.30 AM: REGISTRATION (BARTLETT HALL 202)

8.30 AM: WELCOME (BARTLETT HALL 211)

10.00 AM – 10.30 AM. POSTER SESSION
(HALLWAY OUTSIDE BARTLETT HALL 211)

Design and Construction of a Small Electron Accelerator
Stephen Thomson and Mark Yuly, Houghton College.

The (n, 2p) Reaction as a Probe for the Pre-existing Nuclear !$^{++}$ Component
Daniel Haas, Bethany Little, Steve Thomson, Steve Wallace, and Mark Yuly, Houghton College.

Study of the operational properties of the Capillary Plasma Electrode (CPE) discharges
Jose Lopez, David Jacome, and Wei-Dong Zhu, Saint Peter's College. Margaret Figus, Merck & Co., Inc. Kurt H. Becker, Polytechnic Institute of NYU.

Efficient Second Harmonic Generation (SHG) of Ti:sapphire Laser Using Non-Linear BBO Crystal
Roshita Ramkhalawon, University of Rochester, Kyle Taylor, University of Wisconsin-Stevens Point.

Jet Clustering Algorithms in CMS
Zhen Qi, University of Rochester.

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10.30 AM – 11.45 AM: SESSION II. APPLIED AND BIOLOGICAL PHYSICS
(BARTLETT HALL 211)

10.30 am. Defeat of chemical and biological IEDs
Christopher Rivers, West Point.

10.45 am. High-Energy Laser Weapons
Daniel Glusko and Ryan Townsend, West Point.

11.00 am. Photodissociation of Supercritical Carbon Dioxide
Brandon Dotson and Matthew Tullia, West Point.

11.15 am. Analysis of an aerosol-based geo-engineering proposal
Valerie A. Rapson and Robert S. Knox, University of Rochester.

11.30 am. Metabolic Energy Optimization in the Squid Giant Axon
Scott Douglas, Patrick Crotty, Colgate University.

12.00 PM: LUNCH (BARTLETT HALL 209 + 210)

12.45 PM: TOUR

1.30 PM – 3.00 PM: SESSION III. INSTRUMENTATION (BARTLETT HALL 211)

1.30 pm. Modernizing the Mossbauer Experiment.
Adi Robinson, University of Rochester.

1.45 pm.

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9.15 am. Quantum Interference Using Two Independent Sources

Justin Dove and Anthony Kolodzinski, Department of Physics, Adelphi University.
Advisor: Prof. Sean J. Bentley, Department of Physics, Adelphi University.

Quantum mechanics has been mysterious for its entire life. To unravel some of its secrets, many physicists test its effects on optics, such as Pfleegor and Mandel who demonstrated temporal interference between two attenuated lasers. Our study explores the possibility of producing double-slit interference in a similar manner.
This experiment uses two lasers of equal wavelength and polarization, prepared such that at the double slit one is directed through one slit and the other through the other slit, with effectively no overlap. We configure our apparatus such that the pattern from either individual source will appear at the same location in the detection plane. The lasers are then attenuated greatly so we transmit only one photon at a time.
Classically, one would not expect interference, due to lack of coherence between the sources. We explore the possibility of quantum interference by trying to erase any information that distinguishes the sources. If we are successful, a superposition state generating identical results as from a single broad, coherent source may be achieved. Alternatively, if a distinguishable mixture is formed, no interference should result. Ultimately, this experiment will address questions of knowledge of a state versus reality of a state.

9.30 am. Preliminary Analysis of RR Lyrae Light Curves in the Globular Cluster M15

T. De Haas and A. Missert, Department of Physics and Astronomy, University of Rochester.
Advisor: Prof. S. Kanbur, Department of Physics, SUNY Oswego.

RR Lyraes are found mainly in globular clusters in the halos of spiral galaxies. Knowledge of their absolute magnitudes as a function of metallicity leads to constraints on the theory of galaxy formation. Thus it is important to study RR Lyraes in a range of environments. We present an initial analysis of the BVI light curves of RRab stars in the metal poor Oosterhoff II globular cluster M15. Using Fourier analysis, we present the resultant period-color relations at minimum and maximum light and find the relation at minimum light is flat, though there is a large scatter. This has implications for the possible use of such a relation to determine the effect of interstellar reddening.

9.45 am. On the possible resonances of very high order modes in Cepheids

I. Richter, Department of Physics and Astronomy, University of Rochester, E. Antonello and L. Speroni, Osservatorio Astronomico di Brera.
Advisor: Prof. S. Kanbur, Department of Physics, SUNY Oswego.

Research on resonances between pulsation modes in Cepheids in the past twenty years have permitted an understanding of the characteristics of Fourier parameters of the light and velocity curves. A general assumption here has been that resonances occur between a pulsationally unstable fundamental (or first overtone) radial mode and a pulsationally stable low order radial overtone. Some observational and theoretical model results discussed here suggest the presence of other possible effects due to resonances between the fundamental mode and much higher overtones.

POSTER SESSION

Design and Construction of a Small Electron Accelerator

Stephen Thomson, Department of Physics, Houghton College.
Advisor: Prof. Mark Yuly, Department of Physics, Houghton College.

The Houghton College electrostatic electron accelerator consists of a small Van de Graaff generator and an accelerator column made from alternating high-density polyethylene and aluminum rings to create a uniform electric field. The accelerator column is evacuated to about 10^{-6} torr by a rotary forepump and a diffusion pump. To produce the electrons, an electron gun made from a 3RP1A CRT is located in the high-voltage terminal. The electrodes of the electron gun require user-controlled voltages for the anode, focus and intensity grids. Since the gun is located in the HV terminal, a microcontroller and amplifier circuit was designed to produce the required voltages and communicate with the user via a non-conducting fiber optic RS232 link. The remote control system is being tested using a cathode ray tube.

The (n, 2p) Reaction as a Probe for the Pre-existing Nuclear !$^{++}$ Component

Daniel Haas, Bethany Little, Steve Thomson, and Steve Wallace, Department of Physics, Houghton College.
Advisor: Prof. Mark Yuly, Department of Physics, Houghton College.

The ^{3}He(n, 2p)2n and ^{4}He(n, 2p)3n cross-sections are being measured as a means to explore the !$^{++}$ component of the nuclear wave function. Scattered protons on beam right pass through a magnetic spectrometer which measures their momenta. The spectrometer consists of an initial thin !E scintillator, two drift chambers, two permanent magnets and two thin rear scintillators. On beam left, an array of thin horizontal !E scintillator strips in front of a thick vertical array of plastic scintillators detects scattered protons in coincidence with the magnetic spectrometer

Study of the operational properties of the Capillary Plasma Electrode (CPE) discharges

David Jacome, Department of Physics, Saint Peter's College. Margaret Figus, Merck & Co., Inc. (Rahway). Kurt H. Becker, Polytechnic Institute of NYU.
Advisors: Prof. Jose Lopez and Prof. Wei-Dong, Department of Physics, Saint Peter's College.

Various approaches have been pursued to create stable atmospheric pressure discharges by extending the lifetime of the diffuse phase of the discharge to hundreds of microseconds. Previous research showed that the stability of the diffuse mode is dependent on the frequency (in the kHz range), gas type power, mode of the excitation, and geometrical confinement. Some of the most promising approaches are based on the recognition of the arc formation in high-pressure plasmas can be avoided and stable high-pressure plasma can be generated and maintained when the plasma are spatially constricted to the dimensions of tens to hundreds of microns. The Capillary Plasma Electrode (CPE) discharge is stable to produce stable atmospheric pressure nonequilibrium plasma. The CPE is similar in design to the Barrier Electrode Discharge, but has perforated dielectrics. The configuration, aside from exhibiting a diffuse mode of operation, also exhibits the so-called "capillary jet" mode, in which the capillaries "turn on" and a bright plasma jet emerges from the capillaries. The capillary jets from adjacent capillaries overlap so that the discharge appears uniform when the electrode contains an array of holes. There appears to be a threshold frequency for the capillary jet formation, which is strongly dependent on the L/D ratio of the capillaries, where D is diameter of the capillary and L its length. However, the operating principles and basic properties of this behavior are not well understood. The current work explores these modes of operations of the CPE by characterizing the electrical and optical emission properties of this discharge by examining a multi-hole discharge as well as a single capillary discharge reactor.

Efficient Second Harmonic Generation (SHG) of Ti:sapphire Laser Using Non-Linear BBO Crystal

Roshita Ramkhalawon, Department of Physics and Astronomy, University of Rochester.
Kyle Taylor, Department of Physics and Astronomy, University of Wisconsin-Stevens Point.
Advisor: Prof. Nicholas Bigelow, Department of Physics and Astronomy, University of Rochester.

We describe the set up of a bow-tie optical resonator, which is used to produce efficient second harmonic generation (SHG) light. We obtain 426 nm light by frequency doubling a 852 nm Ti:sapphire laser using a non-linear BBO crystal. Supported by NSF.

SESSION II. APPLIED AND BIOLOGICAL PHYSICS
CHAIR: PROF. BODEK, UNIVERSITY OF ROCHESTER

10.30 am. Defeat of chemical and biological IEDs
Christopher Rivers, Department of Physics, West Point.
Advisor: LTC(P) Bryndol Sones, Department of Physics, West Point.

Project Mission Statement: Defeat chemical and biological IEDs by simultaneously interdicting delivery mechanisms and neutralizing the chemical and biological agents.
Desired Performance Goals:
Time of emplacement: less then 10 minutes.
Target Damage: inoperable upon execution of device.
Chemical/Biological Agent: Rendered safe in one hour.
Objective: The aim of the project is to use the Sandia Decon foam projected from a shaped charge to disable a chemical and biological IED as well as neutralize it. The device will be a quick reaction option to finding a chemical or biological device.

10.45 am. High-Energy Laser Weapons
Daniel Glusko and Ryan Townsend, Department of Physics, West Point.
Advisor: MAJ John DeLong and MAJ Walter Zacherl, Department of Physics, West Point.

We explored the feasibility of and requirements on a high-energy laser (HEL) weapons system used to detonate incoming 82 mm mortars. We considered the minimum irradiance needed to neutralize the round and explore what laser parameters are necessary to achieve this threshold. Beginning with relevant, contemporary values for power, wavelength, jitter, and beam quality, we use perturbations to see which parameters are most effective. We also assessed the impact of varied atmospheric conditions, to include those characteristics of a desert environment, a polluted urban environment in the mid latitude north, and a summer tropical climate. This is important as the United States military develops directed energy weapon systems to protect soldiers and assets around the world.

11.00 am. Photodissociation of Supercritical Carbon Dioxide

Brandon Dotson and Matthew Tullia, Department of Physics, West Point.
Advisor: Thomas Spudich, Department of Chemistry and Life Science, West Point.

Astronauts and sailors deployed in submarines require atmospheric scrubbers for their survival. An optical solution may minimize waste and increase efficiency for both missions. The goal of this research is to generate molecular oxygen from the photochemical breakdown of carbon dioxide in its supercritical state. While this process has been conventionally performed at lower temperatures and pressures with smaller yields, we posit that the increased density resulting from our processed use of supercritical carbon dioxide will not only allow for higher yields, but will also better facilitate physical separation of the photodissociated products based on relative solubilities in this acting supercritical solvent.

11.15 am. Analysis of an aerosol-based geo-engineering proposal

Valerie A. Rapson, Department of Physics and Astronomy, University of Rochester.
Advisor: Prof. Robert S. Knox, Department of Physics and Astronomy, University of Rochester.

By modeling a simulated series of volcanic eruptions that place large amounts of aerosols into the stratosphere, T. Wigley has made a quantitative estimate of the influence that aerosol geo-engineering would have on the overall temperature of the surface of the planet. We are able to simulate these results by linearly superimposing a four-box energy balance model solution upon itself, a solution that includes atmosphere-ocean coupling and that accurately models the eruption data from Mount Pinatubo. Negative surface feedbacks are needed to accurately handle the Pinatubo eruption. For a 1,000-year series of annual eruptions, we find a maximum temperature drop of –1.05˚C at the surface, in disagreement with the Wigley model, which predicts –5.25˚C. We believe that that model cannot simultaneously make such a large prediction and agree with the short-term observational data.

11.30 am. Metabolic Energy Optimization in the Squid Giant Axon

Scott Douglas, Department of Physics and Astronomy, Colgate University.
Advisor: Prof. Patrick Crotty, Department of Physics and Astronomy, Colgate University.

Action potential transmission in the squid giant axon can be successfully modeled using the model formulated by Hodgkin and Huxley in 1975 (the HH model). Each parameter in the HH model corresponds to a set of interacting biophysical properties of the neuron; by adjusting the parameters of the HH model and measuring the energy efficiencies in simulated neurons, we discover what parameters are optimized in real neurons and infer that evolution selected neurons to have these optimum parameters. Exploration of sodium/potassium equilibrium strength space yields a potential energy efficiency maximum near biological values.

SESSION III. INSTRUMENTATION
CHAIR: PROF. YULY, HOUGHTON COLLEGE

1.30 pm. Modernizing the Mossbauer Experiment.
Adi Robinson, Department of Physics and Astronomy, University of Rochester.
Advisor: Prof. Frank Wolfs, Department of Physics and Astronomy, University of Rochester.

In the 1950's there were numerous attempts to observe gamma-ray resonance in gases. Most of the attempts failed, due to energy loss to recoil. In 1957, Rudolf Mössbauer was able to observe resonance in solid iridium, which raised the question of why gamma-ray resonance was possible in solids, but not in gases. Mössbauer proposed that for the case of atoms bound in a solid, under certain circumstances, a fraction of the nuclear events could occur essentially without recoil. He attributed the observed resonance to this recoil-free fraction of nuclear events. Mössbauers' discovery was rewarded with the Nobel Prize in Physics in 1961. As part of the creation of the Advanced Nuclear Science Education Laboratory at the University of Rochester, we have developed a modern version of the classic Mössbauer experiment. Our experiment is based on the classic skeleton of the original experiment in which a radioactive source vibrates on a loudspeaker, but the electronics is replaced with state-of-the-art digital signal processing technology. A digital processing system, designed by Wojtek Skulski, is used to process the data from the ionization counter and the speaker system.

1.45 pm. Refurbishing a Scanning Transmission Electron Microscope
Dan Ballard and Brandon Hoffman, Department of Physics, Houghton College.
Advisor: Prof. Mark Yuly, Department of Physics, Houghton College.

A JEOL 100CX Scanning Transmission Electron Microscope (STEM) is being refurbished for the purpose of exploring microstructures of thin metal films. A number of issues involving the vacuum system have been addressed. Modification of the electronics has allowed for more efficient troubleshooting techniques.

2.00 pm. Characterizing the Performance of the Houghton College Cyclotron
Daniel Haas, Department of Physics, Houghton College.
Advisor: Prof. Mark Yuly, Department of Physics, Houghton College.

The Houghton College Cyclotron briefly accelerated hydrogen ions for the first time in 2007 before a discharge from the filament to the chamber wall damaged the glass insulation and "dee" electrode. To prevent this from happening again, a new vacuum chamber and 15 cm diameter "dee" electrode were designed and constructed. Once placed between the poles of a 1.1 T electromagnet, low-pressure gas is released into the chamber where a filament, through electron collisions, ionizes the gas. The ions are accelerated by an alternating RF electric field and are forced to travel in a spiral path by the electromagnet. The new chamber and "dee" has successfully accelerated protons, molecular hydrogen and helium. Eventually, the $d(d,n)^3He$ reaction will be used to produce neutrons for use in small-scale nuclear experiments.

2.15 pm. Effect of Thresholds on Noise and Jet Energy in ECAL
Dan Gresh, Department of Physics and Astronomy, University of Rochester.
Advisor: Prof. Regina Demina, Department of Physics and Astronomy, University of Rochester.

Thresholds on the Electromagnet000F1.alo0 0 i8g 000 50 0 0.AL

2.30 pm. Observation of Fluxon Diffusion in a Josephson Junction Array
Kelly Henderson, Department of Physics and Astronomy, Colgate University.
Advisor: Prof. Ken Segall, Department of Physics and Astronomy, Colgate University.

We study fluxon dynamics in Josephson junction arrays. We are working to observe fluxon diffusion with the aid of a lock-in amplifier in order to extract the nano-scale device signals from an extremely noisy environment. Using the lock-in amplifier as a slope detector we were able to reproduce the features in the IV curve of a SQUID. From these data we were able to estimate the uncertainty in a lock-in signal measurement and the minimum measurable resistance.

2.45 pm. Design and Construction of a High Vacuum Thin Film Evaporation Chamber
Kurt Aikens and Brandon Hoffman, Department of Physics, Houghton College.
Advisor: Prof. Mark Yuly, Department of Physics, Houghton College.

A high vacuum deposition chamber is being built at Houghton College for the production and study of thin metal films. Up to four electron-beam heated crucibles will evaporate metal atoms, which will then adsorb onto a silicon substrate, forming the film. Evaporation rates may be monitored via crucible temperatures or direct measurement of the ionized flux. The chamber will feature a computer-controlled shield enabling the deposition of samples with varying thickness gradients and an ion gun for substrate cleaning and ion beam assisted deposition (IBAD).

LIST OF PARTICIPANTS

Name		Affliation
Kurt Aikens	Undergrad	Houghton College
George Allen	Undergrad	Siena College
Thomas Anderson		

Thomas Lainis	Faculty	West Point
Wes Laurion	Undergrad	State University of New York at Oswego
Jonathan Lent	Undergrad	Houghton College
Edwin Li	Undergrad	Adelphi University
Phillip Lloyd	Undergrad	Houghton College
Ronald Maldonado	Undergrad	Saint Peter's College
Tony Maldonado	Undergrad	Saint Peter's College
Anne Nagy	Undergrad	West Point
Raymond Nelson	Faculty	West Point
Sylvia Nicholis	Undergrad	Adelphi University
Erin O'Malley	Undergrad	Siena College
David Penskar	Undergrad	West Point
Michael Pfenning	Faculty	West Point
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Trevor Quirk	Undergrad	Siena College
Roshita Ramkhalawon	Undergrad	University of Rochester
Valerie Rapson	Undergrad	University of Rochester
Isaac Richter	Undergrad	University of Rochester
Christopher Rivers	Undergrad	West Point
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Adam Silvernail	Undergrad	Houghton College
Bryndol Sones	Faculty	West Point
Caroline Spencer	Undergrad	West Point
Sam Stedman	Undergrad	West Point
Lisa Taylor	Undergrad	West Point
Stephen Thomson	Undergrad	Houghton College
Linday Timian	Undergrad	Houghton College
Ryan Townsend	Undergrad	West Point
Matthew Tullia	Undergrad	West Point
Kyle Turck	Undergrad	Siena College
Lee White	Undergrad	West Point
Raymond Winkel	Faculty	West Point
Frank Wolfs	Faculty	University of Rochester
Michael Wood	Faculty	Canisius College
Mark Yuly	Faculty	Houghton College
Walter Zacherl	Faculty	West Point
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