Rochester, April 17, 2010

Dear Participants:

Welcome to the 29th 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

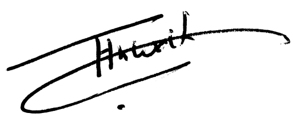
http://www.pas.rochester.edu/urpas/page/RSPS2010.

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/urpas/page/specialreu

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	TIME	LOCATION
Arnold, Laura	1:45 PM	B&L 109
Bagley, Micaela	10:15 AM	B&L 208
Brummer, Gordon	10:45 AM	B&L 109
Collazos, Steven	8:45 AM	B&L 106
Crown, Robert	10:45 AM	B&L 109
Dotson, Brandon	8:45 AM	B&L 109
Eells, Rebecca	10:15 AM	B&L 208
Eng, David	9:30 AM	B&L 106
Enos, James	9:00 AM	B&L 106
Erickson, Austen	10:15 AM	B&L 208
Faucett, Austen	9:15 AM	B&L 106
Fellows, Galen	9:00 AM	B&L 109
Geller, Josh	1:45 PM	B&L 106
Gresh, Daniel	2:00 PM	B&L 106
Gruszko, Julieta	2:00 PM	B&L 109
Hansen, Jennifer	10:15 AM	B&L 208
Jacome, David	10:15 AM	B&L 208
Joachim, Robert	11:15 AM	B&L 407
Kanbur, Shashi	11:00 AM	B&L 109
Keeler, Justin	11:00 AM	B&L 109
Knisely, Andrew	2:15 PM	B&L 106
Koehler, Katrina	10:15 AM	B&L 208
Kucherov, Victor	10:15 AM	B&L 208
Kuntz, Robert	11:15 AM	B&L 109
Kurvits, Jonathan	2:15 PM	B&L 109
Lankevich, Vladimir	11:30 AM	B&L 109
Lloyd, Phillip	9:15 AM	B&L 109
McElhone, Dale	9:30 AM	B&L 109
Neeley, Jillian	11:15 AM	B&L 109

Packard, Doug	2:45 PM	B&L 109
Richter, Isaac	11:30 AM	B&L 109
Richter, Kara	9:45 AM	B&L 109
Rivers, Christopher	10:00 AM	B&L 109
Robinson, Adi	11:00 AM	B&L 407
Sampson, Alicia	10:15 AM	B&L 208
Schroeder, Edward	2:30 PM	B&L 109
Sifain, Andrew	2:45 PM	B&L 106
Silvernail, Adam	10:15 AM	B&L 208
Tanabe, Iora	2:30 PM	B&L 106
Timian, Lindsay	10:00 AM	B&L 106
Watts, Claire	9:45 AM	B&L 106
Weinert, Benjamin	10:45 AM	B&L 407

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

PROGRAM

8.00 AM – 8.30 AM: REGISTRATION (B&L ENTRANCE)

8.30 AM: WELCOME (B&L 109)

Prof. Frank Wolfs
Department of Physics and Astronomy, University of Rochester.

8.45 AM – 10.15 AM: SESSION IA. INSTRUMENTATION (B&L 109)

SESSION CHAIR: PROF. YULY, HOUGHTON COLLEGE

8.45 am. Photo-dissociation of Supercritical Fluid Carbon Dioxide for Potential Use in the Production of Breathable Oxygen
Brandon Dotson, U.S. Military Academy at West Point

9.00 am. Introductory Physics Lab Development
Galen Fellows, The College at Brockport

9.15 am. Modeling an Electron Gun for an Electrostatic Accelerator
Phillip Lloyd, Houghton College

9.30 am. Empirical Physical Modeling of the Saxophone
Dale McElhone, University of Rochester

9.45 am. Faraday Rotation
Kara Richter, The College at Brockport

10.00 am. DENIED
Christopher Rivers, U.S. Military Academy at West Point

8.45 AM – 10.15 AM: SESSION IB. CONDENSED-MATTER PHYSICS (B&L 106)

SESSION CHAIR: PROF. POMPI, BINGHAMTON UNIVERSITY

8.45 am. Utilization of Localization of Phonons for Thermal Conductivity Manipulation
Steven Collazos, Binghamton University

9.00 am. In situ heating of a Substrate during Vapor Deposition
James Enos, The College at Brockport

9.15 am. Nucleation and Growth in near-Eutectic Sn-Cu Alloys
Austen Faucett, Binghamton University

9.30 am. Synchronization in Josephson junction arrays
David Eng, Colgate University

9.45 am. Terahertz Spectroscopy of the Single Molecule Magnet Manganese12 Acetate
Claire Watts, Colgate University

10.00 am. A Study of Tailored Oriented Thin Silver Films by X-ray Diffraction
Lindsay Timian, Houghton College

10.15 AM – 10.45 AM: SESSION II. POSTER SESSION (B&L 208)

The Morphology of Galactic Rings Exterior To Evolving Bars: Test Particle Simulations
Micaela Bagley, University of Rochester

Diffraction Patterns of Biological Systems
Rebecca Eells, Vassar College

Magnetic properties of the Esquel Pallasite
Austen Erickson, University of Rochester

Optical Pumping for Vibrational Cooling of NaCs Molecules
Jennifer Hansen, Grove City College

Python Graphical User Interface (GUI) for Control of the Levitated Dipole Experiment
David Jacome, Saint Peter's College

Quasielastic Neutron-Induced Deuteron Breakup
Katrina Koehler, Houghton College

Polarons in DNA Oligomers
Victor Kucherov, University of Rochester

Diffraction Patterns of Live E. elegans: Modling Techniques
Alicia Sampson, Vassar College

The Design and Construction of an Interferometer for the Measurement of Strain in Thin Metal Films
Adam Silvernail, Houghton College

10.45 AM – 11.45 AM: SESSION IIIA. ASTRONOMY I (B&L 109)

SESSION CHAIR: PROF. ZYCH, SUNY OSWEGO

10.45 am. Astrophotography at The College at Brockport
Robert Crown, The College at Brockport

11.00 am. A Review of Student Research Projects undertaken on the SUNY Oswego International Research Experience for Students 2009
Shashi Kanbur, SUNY Oswego

11.15 am. A photometry and extinction module for Chimera
Jillian Neeley, Ithaca College

11.30 am. The Image Server in Chimera
Isaac Richter, University of Rochester

10.45 AM – 11.45 AM: SESSION IIIB. CONDENSED-MATTER AND BIOLOGICAL PHYSICS (B&L 106)

SESSION CHAIR: PROF. SEGALL, COLGATE UNIVERSITY

10.45 am. Collision of vortex and breather states in a Josephson array
Gordon Brummer, Colgate University

11.00 am. Refurbishing of Jeol 100cx Scanning Transmission Electron Microscope (STEM)
Justin Keeler, Houghton College

11.15 am. Investigation into the reduction of the rate of cooling in solutions of D_2O and H_2O
Robert Kuntz, Binghamton University

11.30 am. Investigation of de-Protonation of Proteins During Cluster Formation
Vladimir Lankevich, University of Rochester

10.45 AM – 11.30 AM: SESSION IIIC. HIGH-ENERGY AND NUCLEAR PHYSICS (B&L 407)

SESSION CHAIR: PROF. WOLFS, UNIVERSITY OF ROCHESTER

10.45 am. Study of Muon Reconstruction in a High Energy Electron-Positron Collider
Benjamin Weinert, University of Rochester

11.00 am. Analyzing Ge Detector Pulses Using a Moving Window Deconvolution Algorithm
Adi Robinson, University of Rochester

11.15 am. Decorrelation of Noise Signals at CUORICINO
Robert Joachim, Binghamton University

12.00 PM: LUNCH (MELIORA, SALON D)

12.45 PM: PHYSICS JEOPARDY (DEWEY 1-101)

1.45 PM – 3.00 PM: SESSION IVA. ASTRONOMY II (B&L 109)

SESSION CHAIR: PROF. KANBUR, SUNY OSWEGO

1.45 pm. Insights into protoplanetary disk evolution from a Spitzer IRS of NGC1333
Laura Arnold, University of Rochester

2.00 pm. A Compiled Catalogue of Ca II H & K Chromospheric Activity Measurements for FGK-type HD and HIP Stars
Julieta Gruszko, University of Rochester

2.15 pm. Planar Circular Restricted Three Body Problem (PCR3BP)
Jonathan Kurvits, University of Rochester

2.30 pm. Modelling Astrophysical Jets: Herbig-Haro Objects
Edward Schroeder, University of Rochester

2.45 pm. Spectroscopic Evidence of Accretion and Outflow Variation in a T Tauri Star
Doug Packard, Colgate University

1.45 PM – 3.00 PM: SESSION IVB. QUANTUM OPTICS (B&L 106)

SESSION CHAIR: PROF. KLING, U.S. MILITARY ACADEMY, WEST POINT

1.45 pm. Measuring Entanglement in Multi-Qubit Systems
Josh Geller, University of Rochester

2.00 pm. Design and Implementation of a Timing Control System for use in a Bose-Einstein Condensate (BEC) Experiment
Daniel Gresh, University of Rochester

2.15 pm. Effect of Polarization on Light Transmission through Media
Andrew Knisely, U.S. Military Academy at West Point

2.30 pm. Effect of interaction and anisotropic tunneling on superfluid-Bose glass transition of hardcore bosons in an optical superlattice
Iora Tanabe, Binghamton University

2.45 pm. Magnetic Trapping: An Anti-Helmholtz Configuration
Andrew Sifain, University of Rochester

3.30 PM: TOUR LLE (OPTIONAL)

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SESSION IA. INSTRUMENTATION

Photo-dissociation of Supercritical Fluid Carbon Dioxide for Potential Use in the Production of Breathable Oxygen

Brandon N. Dotson, Matthew E. Tullia, Walter D. Zacherl, John S. DeLong, and Thomas S. Spudich, U.S. Military Academy at West Point

There are several potential applications for carbon dioxide photo-dissociation, to include recycling systems to produce breathable oxygen gas. A possible optical solution may minimize waste and increase efficiency in the process. The ultimate goal of the project is to generate molecular oxygen from the photochemical breakdown of carbon dioxide in its supercritical state. It has been demonstrated that carbon dioxide can be broken down using a laser or lamp with a specific wavelength range to generate carbon monoxide and monoatomic oxygen, with the eventual production of molecular oxygen. While this process has been conventionally performed at lower temperatures and pressures with smaller yields, it is posed that the increased density resulting from the use of supercritical carbon dioxide shows the promise of higher yields, but will also better facilitate physical separation of the products. Moreover, supercritical fluid carbon dioxide has experimentally shown distinct absorption in the vacuum ultraviolet region that is not observed with gaseous carbon dioxide. The end goal of this research is to design an apparatus capable of generating breathable oxygen from the photo-dissociation process and overall reaction.

Introductory Physics Lab Development

Galen Fellows, The College at Brockport

Two introductory physics laboratory experiments have been assessed and revised. In the first, we evaluated an experiment of objects' motion down an incline for its effectiveness in conveying concepts about inertia, kinetic energy (rotational, translational), potential energy and conservation of energy. The objects available commercially have the same radius but different masses (within +/-20%), which gets in the way of grasping the above concepts, e.g. mass, m, as linear inertia and moment of inertia, I, as rotational inertia. We modified an existing Rotational Inertia Laboratory to include/use locally made objects of same radius and mass, thereby singling out rotational inertia as the experimental variable. The rotational and center of mass translational accelerations and energies of cylinders, spheres, and rings, were determined theoretically and corroborated experimentally for the objects rolling down an incline. In the second, a Fluid Dynamics Lab (a cylindrical object free falling inside a tube) is being investigated for correlation of air resistance effects to object/tube geometry. Both experiments can be used for either demonstration or in-depth investigation of the relevant concept.

Modeling an Electron Gun for an Electrostatic Accelerator
Phillip Lloyd and Prof. Mark Yuly, Houghton College

An electrostatic accelerator, capable of producing electron beams of up to about 200 keV, is under construction at Houghton College. Previous designs utilized the electron gun from a 3RP1A CRT. Because these guns always inexplicably failed after a few hours of operation, it was decided to build a gun that could be easily disassembled and serviced. SIMION 7.0 simulation software was used to build virtual models of potential designs prior to construction, and to test and optimize the model after the gun was built. SIMION calculates electric fields by solving Laplace's equation and determines the trajectories of charged particles through those fields. The actual performance of the electron gun will be compared to the predictions given by the SIMION model.

Empirical Physical Modeling of the Saxophone
Dale McElhone, Mark Sterling, Mark Bocko, Department of Electrical and Computer Engineering, University of Rochester

Empirical physical modeling is a method of synthesizing realistic musical sounds by employing acoustical measurements from real instruments. In this method, the acoustic waves both interior to the instrument and radiated to the environment are computed through the simulation of a physical model. The two pieces of data required by the model are the acoustic impedance function and the radiation transfer function, both of which are unique to each fingering on a given instrument. When all fingering combinations have been measured, a physical model can be established for that instrument. In addition to these acoustic measurements, the synthesis model requires a description of the physics of the reed and interaction of the player's vocal tract with the instrument. This approach has been used to synthesize saxophone tones, and the model could be capable of producing the extended range of sounds that are possible on the family of saxophones, including altissimo, quarter tones and multiphonics.

Faraday Rotation

Kara M. Richter and M. Z. Tahar, The College at Brockport

In order to add to the variety of experiments available for the advanced physics lab, we have assembled an apparatus for investigating Faraday Rotation. This is the rotation of polarization axis of linearly polarized light as it travels through a medium in a magnetic field parallel to the propagation of the light. The apparatus is comprised of a magnet (3kGauss, 13 mm diameter hole through the center of poles), different wavelength lasers, polarizers (fixed and variable axis) and a photodiode with associated electronics. LabView is used to control a stepper motor (0.001 degrees per step) that drives the variable axis polarizer, as well as data acquisition of photodiode signal. The change in polarization of an incident laser beam traveling through a transparent sample in an external magnetic field correlates to the internal magnetic properties of the sample's material. We will describe how the Faraday Rotation occurs, derive the Verdet constant, and present a progress report.

DENIED

CADET Christopher Rivers, U.S. Military Academy at West Point

The DENIED project aims at providing the United States with a device that can simultaneously destroy and neutralize a potential chemical or biological WMD. The project measures the CABOX against the physical structure of a WMD as well as the neutralization of the agent contained inside the WMD. The testing results show that the CABOX is/is not a valid technology for further testing and eventual use in the field.

SESSION IB. CONDENSED-MATTER PHYSICS

Utilization of Localization of Phonons for Thermal Conductivity Manipulation

Steven Collazos, Michael Lawler, Binghamton University

Anderson proposed that electrons can be localized in conductors by a sufficient number of impurities. It turns out that this phenomenon of localization applies to waves in general (e.g. electromagnetic waves or acoustic waves). By exploiting the wave behavior of phonons, the quanta of elastic waves, we hope to localize them in lattices to reduce the contribution of the phonons to thermal conductivity. Should this localization of phonons occur, only electrons will transport thermal energy and this energy will be converted to electricity. In this presentation, we will show how phonons can be localized by the introduction of massive impurities. Additionally, we will show how localization arises in both one and two-dimensional models of phonons/elastic waves by directly calculating the normal modes of the system. Finally, we will conclude with a discussion of the implications of our results and future directions.

In situ heating of a Substrate during Vapor Deposition

James Enos, Dr. H. Trevor Johnson-Steigelman, Dr. Mohammed Tahar, The College at Brockport

During vapor deposition of a film, the film may not deposit evenly on the substrate. The film may form ‘islands’ which affect the thickness calculations. For example, resistivity measurements and grain size from X-Ray diffraction for the film will be different for a flat film and a non-continuous film containing islands. The goal of the project is to build a sample heater that would allow thermal annealing of the substrate. With the addition of thermal energy, the film can become more ordered, allowing for better thickness measurements and higher film quality. The thickness measurements and X-Ray diffraction peaks will be compared for annealed and non-annealed films of In.

Nucleation and Growth in near-Eutectic Sn-Cu Alloys
Austen Faucett and Eric Cotts, Binghamton University

Copper is a major constituent of most lead-free solders and thus its influence on the initial nucleation and subsequent growth of the solid phase is paramount in understanding SAC (SnAgCu) solders. The mechanism for nucleation and its influence on a sample's microstructure were studied. Reflowing 10mg samples of various compositions (0.025-1.0 at. % Cu) in a Differential Scanning Calorimeter (DSC) determined the influence of Copper on a specimen's undercooling. Further tests were conducted to measure any effect on the heterogeneous nucleation rate in the light of classical nucleation theory. Polarized micrographs (CPM) were taken after sectioning. Select samples were analyzed using scanning electron microscopy (SEM) and electron back-scattered diffraction (EBSD) to determine grain orientation and localized composition. Such micrographs indicate a plate-like fast growth mechanism that dominates in many samples over 0.1 at % Cu. Multiple twinning was also observed in some samples, suggesting that there might be multiple types of nucleation events for these compositions. Further results and future experiments will be discussed.

Synchronization in Josephson junction arrays
David Eng, Colgate University

Synchronization in systems of coupled oscillators is a very interesting phenomenon that appears in many natural systems. From swarms of fireflies flashing in unison, to the synchronous firing of neurons in the brain, synchronization is found all throughout nature. Josephson junctions are superconducting electrical circuit elements that oscillate at extremely high frequencies. This makes Josephson junctions an excellent subject for studying systems of coupled oscillators because long-term dynamics of oscillation can be determined by experiments that take place over very short time scales. The coupling strength in a system of oscillators is the main parameter that determines whether or not the system will synchronize. This research examines a specific geometry of Josephson junctions that we hope will allow us to control this coupling strength with an applied external magnetic field. Controlled coupling in a system of coupled Josephson junctions would allow deeper probing into the dynamics of coupled oscillators, and hopefully lead to a further understanding of these kinds of natural systems.

Terahertz Spectroscopy of the Single Molecule Magnet Manganese$_{12}$ Acetate
Claire Watts, Colgate University

Quantum Mechanics is one of the most important theories in physics today. But, how can we connect Quantum Mechanics from the microscopic to the macroscopic world? Single molecule magnets provide a perfect physical entity to study this and have many notable characteristics to motivate research. Single molecule magnets have a very high ground state spin, in our case this corresponds to a net spin of 10 (ranging from $S_z = -10$ to $S_z = 10$) and can be modeled by a double well potential. Single molecule magnets also exhibit strong magnetic anisotropy and display slow relaxation time to the ground states from the excited states signifying some sort of barrier between energy levels that results in interesting energy characteristics including quantum tunneling. In my research, both this Summer and continuing this Fall, I have studied the single molecule magnet Mn_{12} acetate using THz spectroscopy.
We have been probing our sample with THz pulses produced by a mode-locked Titanium Sapphire laser that emits 100 femtosecond pulses every 12 nanoseconds at a wavelength of 800 nanometers. After sending the THz pulses through our sample of Mn_{12} acetate, we are able to read the response as a function of frequency using a Silicon Sapphire antenna. By using Fourier Analysis, we are able to see at what frequencies the sample absorbed or emitted radiation. These digs and peaks in our data correspond to energy transitions taking place in the sample. The motivation of our research is to look into *why* we are seeing these energy transitions. The Hamiltonian of the system predicts a stable state, which is far from what we have observed so far. Additionally, our results from this summer have shown peaks at certain frequencies that far outweigh the corresponding absorptions. Further research is necessary to understand this behavior. With continued study, we can begin to fully understand what is happening at the quantum level in single molecule magnets.

A Study of Tailored Oriented Thin Silver Films by X-ray Diffraction
Lindsay Timian, Adam Silvernail, and Prof. Brandon Hoffman, Houghton College

The transition from fcc(111) to fcc(100) crystalline orientations of tailored oriented Ag thin films ranging in thickness from 1nm to 1000nm was studied. The films were deposited via electron beam evaporation onto a silicon substrate in a high vacuum chamber. Addition of a Ti adhesion promoter layer of on both sides of the Ag film sharpened the transition, as compared to film thickness. Also, the percentage of the film's volume that transitioned to fcc(100) increased with anneal temperature and time.

SESSION II. POSTER SESSION

The Morphology of Galactic Rings Exterior To Evolving Bars: Test Particle Simulations

Micaela Bagley, Ivan Minchev, Prof. Alice Quillen, University of Rochester

The morphology of the outer rings of early-type spiral galaxies is compared to integrations of massless collisionless particles initially in nearly circular orbits. Particles are perturbed by a quadrupolar gravitational potential corresponding to a growing and secularly evolving bar. We find that outer rings with R1R2 morphology and pseudorings are exhibited by the simulations even though they lack gaseous dissipation. We compare the morphology of our simulations to B-band images of 9 ringed galaxies from the Ohio State University Bright Spiral Galaxy Survey, and we find a reasonable match in morphologies to R1R2' pseudorings seen within a few bar rotation periods of bar formation. Some of the features previously interpreted in terms of dissipative models may be due to transient structure associated with recent bar growth and evolution.

Diffraction Patterns of Biological Systems

Rebecca Eells, Alicia Sampson, Rahul Khakurel, Kate Susman, Jenny Magnes, Vassar College, Physics and Astronomy Department

The goal of using laser light to study biological systems was to find an inexpensive and accurate alternative to microscopy. The diffraction patterns created by a laser beam traveling through an optical cuvette of C. elegans can be used to study the movement and position of the worms as they pass through the beam of light. The possible orientations of the worms can be modeled using the mathematical programming system Matlab. Matlab can also be used to take the fast Fourier transform of the modeled worms to model a diffraction image. The modeled diffraction image can be compared to the raw images to determine the actual orientations of the worms as they pass through the beam of light.

Magnetic properties of the Esquel Pallasite

Austen M. Erickson, J. A. Tarduno, R. D. Cottrell, Dept. of Earth and Environmental Sciences, Dept. of Physics and Astronomy, University of Rochester

Pallasites are stony-iron meteorites consisting mainly of olivine crystals suspended in an iron-nickel matrix. One theory holds that pallasites are formed from the intrusion of a liquid iron-nickel core into the solid silicate mantle of a parent body. The magnetic properties of the olivine crystals could help provide insight into the veracity of this explanation. The olivine crystals may contain magnetic inclusions that record useful information regarding magnetic fields present in the parent body. The best recorders of magnetic information are single domain in nature; domain structure of magnetic inclusions can be identified by observing their hysteresis properties. Olivine crystals were prepared from a sample of the Esquel pallasite. Crystal fragments were often stained or coated with non-olivine minerals, which required cleaning to remove. An Alternating Gradient Force Magnetometer (AGFM) was used to measure hysteresis properties, and a Superconducting Quantum Interface Device Cryogenic Rock Magnetometer was used to measure the natural remanent magnetization of the samples. Preliminary data indicate single domain carriers in select olivine crystals that carry records of strong ancient fields. This project is a presentation of preliminary results and was supported in part by NSF award PHY-0851243 during a summer REU at the University of Rochester.

Optical Pumping for Vibrational Cooling of NaCs Molecules

Jennifer L. Hansen*, Patrick Zabawa, Amy Wakim, Nicholas P. Bigelow, University of Rochester and *Grove City College

A frequency filter for a broadband laser source has been developed for use in vibrational cooling of NaCs molecules. It removes frequencies that excite molecules out of the ground vibrational state, cooling the sample by optical pumping, so that a high percentage of molecules accumulate in the ground vibrational state. I designed and set up an effective filter, and completed a Monte Carlo simulation to model this technique. This project was supported in part by NSF award PHY-0851243.

Python Graphical User Interface (GUI) for Control of the Levitated Dipole Experiment

David Jacome, Darren Garnier, Paul Woskov, Jay Kesner, Mit, Saint Peter's College, Columbia University, MIT

The Levitated Dipole Experiment (LDX) is used to study the confinement properties of plasmas in a magnetic dipole field. In LDX a superconducting coil is levitated for up to 3 hours within a large vacuum chamber to produce the confining dipole field. The plasma experiments take place during this time, with ~ 10 second plasma shots, one shot every ~ 5 min. MDSplus software is used to run the experiment and store the data. The software is currently controlled by command line operations. Since levitation time is limited, it's important to maximize efficiency and accuracy of experimental operations. Here, we present a Graphical User Interface (GUI) to efficiently control the operation of the experiment. The need for a GUI that integrates the MDSplus data cycle, cell access control, and routine experimental parameter controls is necessary. The GUI program provides a simple method for monitoring and setting experiment parameters. Python is used as the primary language to run the commands. A program called XRCed distributed by wxPython works as a visual tool.

Quasielastic Neutron-Induced Deuteron Breakup

Katrina Koehler, Peter Kroening, Jonathan Slye and Prof. Mark Yuly, Houghton College, Massachusetts Institute of Technology, University of Kentucky, and Los Alamos National Laboratory

The quasielastic scattering experiment was performed by a collaboration of researchers from Houghton College, MIT, the University of Kentucky and Los Alamos National Laboratory in the summer of 2009 on flight path 15R in the WNR facility at the Los Alamos Neutron Science Center. The cross-section for the d(n,np) reaction at intermediate incident neutron energies, ranging up to 800 MeV, was measured. Scattered protons from deuteron breakup are detected by a magnetic spectrometer consisting of a thin ΔE scintillator, three drift chambers, two permanent magnets, and two thin rear scintillators. An array of nine two-meter high plastic scintillators detects scattered neutrons.

Polarons in DNA Oligomers

Victor Kucherov, Colin Kinz-Thompson, Professor Esther Conwell, University of Rochester

The transport of holes on short DNA duplexes containing adenine (A) and thymine (T) pairs capped with a "hole donor" and interspersed with a "hole acceptor" molecule has been the focus of intense recent study. It has been shown in both theoretical and experimental research that a hole on an A/T duplex exists as a polaron, peaking on the A side and extending two to three As in either direction. Our project focused on the work of Zeidan et al., who utilized photoinduction of the hole donor perylenediimide chromophore (P) and the base guanine (G) as a hole acceptor in duplexes P-AnGAmG, for values of n ranging from 0 – 4, 6 and the total number of As and Gs adding to 7. Their work analyzed the percentage yield of charge separation (P--AnG+AmG) versus hole recombination (P-AnGAmG) created for each sequence with initial hole injection on the first A (P--A+An-1GAmG). It was found that when n was increased from 0 (labeled in their paper 1G) to 3 (4G), the percentage of holes making it to the first G dropped from 100% to 19% (within 5% accuracy).

Diffraction Patterns of Live E. elegans: Modling Techniques

Alicia Sampson, Rebecca Eells, Rahul Khakurel, Kate Susman, Jenny Magnes, Vassar College

We explored diffraction patterns of live C. elegans and utilized Matlab to devise a matrix layering technique for modeling purposes. Our objective is to monitor and compare crawling and swimming locomotory movement of C. elegans.

The Design and Construction of an Interferometer for the Measurement of Strain in Thin Metal Films

Adam Silvernail and Prof. Brandon Hoffman, Houghton College

An interferometer is being constructed at Houghton College that will be used to measure the pattern of interference created by the superposition of light waves incident on a thin metal film and a reference mirror. A uniform wavelength 4" collimated beam of light will illuminate an entire sample and the interference pattern will be captured by a CCD. The position of the reference mirror will oscillate via piezo-electric ceramic. Each pixel will be processed individually to produce a topographical image of the sample surface. The resulting superposition data can be used to calculate the curvature of the thin film and from that the stress of the film in real time.

SESSION IIIA. ASTRONOMY I

Astrophotography at The College at Brockport

Robert Crown, The College at Brockport

This project introduces practical astrophotograhpy for imaging the night sky. Imaged objects include the moon, stars, planets, and nebulae. The images were obtained using the observatory at the College at Brockport, a CCD camera specifically intended for astrophotography, and digital image processing software. Operation of the camera is also discussed, including the electronics and the Physics. The results are quality pictures, and a functional apparatus (telescope, camera, and software).

A Review of Student Research Projects undertaken on the SUNY Oswego International Research Experience for Students 2009

Shashi M. Kanbur, Jillian Neeley, Alex James, Eamonn Moyer, Peter Thompson, SUNY Oswego, Ithaca College, SUNY Geneseo, University of Rochester

We review 3 research projects undertaken by students on the NSF sponsored International Research Experience for Students 2009.

a) We present multiphase PC/PL relations using OGLE III Cepheid data and compare these with state of the art hydrodynamical models of Cepheids. This is an ainnovative way of comparing models and observations and will lead to new insights in the field of Cepheid pulsation. We find clear evidence of nonlinearity in the Cepheid PC/PL relaqtion. This poses a new challenge for theoreticians.
b) We present Period-Color and Period-Amplitude Relations for Galactic Globular Clusters M3/M15. This research has led to a successful observing proposal using NOAO facilities that will greatly expand the data available.
c) We present preliminary estimates of Hubble's constant using linear/nonlinear Cepheid PL relations with OGLE III data.
d) We present results of nonlinearity tests on the Cepheid PC/PL relations in NGC 4258 and find the PL relation is linear whilst the PC relation is nonlinear. These results appear to be inconsistent.

A photometry and extinction module for Chimera

Jillian Neeley, Alex James, Eamonn Moyer, Peter Thompson, Brandon Gilfus, Antonio Kanaan, Paulo Henrique da Silva, Shashi Kanbur, Ithaca Collece, SUNY Geneseo, University of Rochester, Federal University of Santa Catarina, SUNY Oswego

We describe photometry, extinction and database modules for the robotic telescope control system Chimera and present some images and some data taken of the pulsating Cepheid EV Sct taken with this system. We also present some preliminary results of extinction coefficients taken with this system. We also present a digital image of the Galactic Open Cluster M25. This cluster can only be seen from the Southern Hemisphere but this image was taken from SUNY Oswego using Chimera to control the LNA telescope in Minas Gerais, Brazil.

The Image Server in Chimera

Isaac Richter, Antonio Kanaan, Paulo Henrique da Silva and Shashi Kanbur, University of Rochester, Federal University of Santa Catarina, SUNY Oswego

One of the biggest obstacles in modern astronomical observation is the need to station a human operator at the telescope during observations. For observing projects requiring systematic studies of the sky over long periods, having an automated system to take the observations would allow researchers to continue to collect a month's worth of data without needing to spend 30 nights at a telescope.

The Chimera Observatory Automation System is a project aimed at developing the requisite software for an intelligent autonomous robotic observatory. While such software exists, our goal is to develop a modular observatory control system that can be given additional functionality simply by writing a new Python module. End-user observatories will be able to add support for new equipment by writing a simple Python interface if one doesn't already exist. Chimera is also set up for remote operation, allowing an observatory to be controlled from anywhere in the world, and individual instruments to be connected to separate but networked computers. Many of the modules and much of the overall framework had already been written by Paulo Henrique da Silva and Antonio Kanaan before we began our summer 2008 IRES program.

We will present the theory of how Chimera works, discuss the implications of a completely autonomous telescope, and demonstrate the software in action.

SESSION IIIB. CONDENSED-MATTER AND BIOLOGICAL PHYSICS

Collision of vortex and breather states in a Josephson array

Gordon Brummer, Colgate University

A Josephson Junction is made of a very thin insulator (~10 angstroms), placed between two superconducting metals. In superconductors, charge is carried by Cooper-pairs, which can be described by a single wave function. A Josephson Junction is described by a phase, which is defined as the difference of the cooper-pair phases on either side of the insulator. The phase of the junction is important, because it drives all measurable quantities, specifically current and voltage. When a current is applied across a Josephson Junction, the dynamics exhibit nonlinear behavior. This nonlinearity has been well studied in systems of one Josephson Junction, however this nonlinearity gives rise to unexpected states in arrays of Josephson Junctions. My research involves two such nonlinear states called a breather state, and a vortex state; and what can happen when these two nonlinear states collide.

Refurbishing of Jeol 100cx Scanning Transmission Electron Microscope (STEM)

Justin Keeler and Prof. Brandon Hoffman, Houghton College

A Jeol 100cx STEM is being refurbished for use in future thin film research at Houghton College. Vacuum pumps were cleaned and repaired and non-functional automated valve controls were bypassed with manual controls. Condenser lenses were repaired and aligned to facilitate the operation of the secondary electron microscopy (SEM) module of the Jeol 100cx. The final stage of the project will consist of the digitization of the data collected by the STEM.

Investigation into the reduction of the rate of cooling in solutions of D_2O and H_2O

Robert Kuntz and James Brownridge, Binghamton University

The mechanism by which the rate of cooling in solutions of D_2O and H_2O can be greatly reduced is well understood. In a previous study it was shown that the addition of a small amount of D_2O into H_2O, up to 2% D_2O in 1 liter of H_2O, will suppress the thermal conductivity of the resulting solution as it is cooled. The effect appears to only be present during the mixing process of the D_2O into the H_2O and is not a property of the stable state solution once thoroughly mixed. The mechanism behind the effect is hypothesized to be the result of opposing temperature and density gradients. The vertical distribution of D_2O in H_2O has been measured using infrared spectroscopy in order to calculate the density gradient; thermocouples were used to calculate a temperature gradient. Further study into the time evolution of these gradients and their effect on the thermal conductivity of the mixed solution is the subject of current research

Investigation of de-Protonation of Proteins During Cluster Formation

Vladimir Lankevich and Dr. Vassiliy Lubchenko, University of Rochester, University of Houston

Interactions between protein molecules govern most physiological processes and many important laboratory procedures. The formation of unwanted protein complexes may lead to serious pathological conditions such as sickle cell anemia. Mesoscopic clusters of a protein-rich solution have been recently observed in protein solutions. These clusters are likely nucleation sites for protein aggregates, such as crystals or sickle cell anemia fibers. The microscopic origin of the mesoscopic clusters is not known. Preliminary results indicate the clusters result from the formation of long-living protein complexes stabilized at high protein concentration. The mechanism of the formation of such complexes in solutions of the protein lysozyme is the subject of the present study. Because of the high net charge +7 and little dielectric screening, the lysozyme molecules are subject to strong Coulombic repulsion, which would suppress complex formation. We propose that de-protonation of surface residues occurs when the protein-protein distance is small, which leads to a decrease in the repulsion between the proteins and thus facilitates complex formation. GROMACS software package is used to test this hypothesis by means of direct molecular modeling. The objective of the molecular dynamics simulation is to establish whether the hydrogen bonds between protons and surface residues of the protein are destabilized in the presence of another protein molecule. As part of estimating the electric field stemming from this other protein-molecule, we are also employing the GROMACS package to establish whether the dielectric constant of the several water layers confined between the two protein-molecules significantly differs from its bulk value.

SESSION IIIC. HIGH-ENERGY AND NUCLEAR PHYSICS

Study of Muon Reconstruction in a High Energy Electron-Positron Collider

Benjamin Weinert, Professor Steven Manly, University of Rochester

With the advancements in modern technology it is possible to dig deeper and deeper into the quantum world. Currently a new particle collider design, the International Linear Collider (ILC), is in the works. The ILC is a linear collider that shoots electrons and positrons at each other at 500 GeV. The main purpose of the ILC is to research any discoveries made by the LHC, but in a lot more detail. These discoveries could range from measuring the properties of the Higgs boson, looking for light supersymmetric particles that could be candidates for dark matter, and measuring the number of, size, and shape of any extra dimensions if they exist. This project focused on the muon system of the SiD detector at the ILC. By constructing a muon reconstruction program it is possible to recreate the muon tracks of the original event. This makes it possible to differentiate muon tracks from that of minimum ionizing particles, like pions, that make it to the muon system. It will also help to eliminate background events that come from outside of the detector. This project was supported in part by NSF award PHY-0242483.

Analyzing Ge Detector Pulses Using a Moving Window Deconvolution Algorithm

Adi Robinson, University of Rochester

High-resolution gamma-ray spectroscopy requires the use of germanium detectors. Germanium detectors have a built-in preamplifier that generates a pulse that features a very short rise time and a long exponential decay. The pulse can be sent through a spectroscopic amplifier in order to shape it into a unipolar signal that can be digitized using a peak-sensing analog-to-digital converter. In theory, one should be able take the preamplifier signal, capture the waveform, and use software to extract the energy from the waveform. In this talk I will discuss an algorithm converts the captured waveforms using the Moving Window Deconvolution (MWD) method. The optimization of this method for the processing of germanium detector signals will be presented.

Decorrelation of Noise Signals at CUORICINO

Robert Joachim - Binghamton University and Dr. Riccardo Faccini – INFN

The CUORICINO experiment utilized a series of crystals arranged in a tower. Located throughout this tower were fifty-six separate detectors. Each time an event triggered one detector to record data, all the other detectors were triggered to record as well. Hence a majority of the data taken was simply a result of noise. It was hypothesized that due to the crystal's arrangement, the noise on certain channels would correlate with the noise on other channels. A program was created which determined the correlation between the detectors. Using this information, the noise signals on other detectors were used to improve data taken when a detector recorded an event. This procedure had positive results, decreasing the noise power spectrum on several channels as well as increasing the signal to noise ratio.

SESSION IVA. ASTRONOMY II

Insights into protoplanetary disk evolution from a Spitzer IRS of NGC1333

Laura Arnold, University of Rochester

We add to previous Spitzer-IRS mid-infrared surveys of the Taurus, ChamaeleonI and Ophiuchus regions, by studying the spectra of about 50 young stellarobjects (YSOs) in NGC1333. With a median age of less than 1 million years,NGC1333 is a young star forming region. Data from the IRS provide a new,young perspective on the timescale of many phenomenon which affectproptoplanetary disk and envelope evolution, such as degree of settling andcomposition of the disk as well as the formation of gaps or clearings.

A Compiled Catalogue of Ca II H & K Chromospheric Activity Measurements for FGK-type HD and HIP Stars

Eric E. Mamajek and Julieta Gruszko, Department of Physics & Astronomy, University of Rochester

We present a compiled catalog of chromospheric activity (log(R'HK)) measurements for HIP and HD catalog stars with B-V color between 0.4 and 0.9 (approximately F3 through K2 types). The catalog contains mean log(R'HK) values and basic astrometric and photometric data for 2697 stars, 2065 of which have absolute magnitudes within 1 mag of the main sequence. Chromospheric activity measurements come from 15 previously published surveys. Using the activity-rotation-age calibrations of Mamajek & Hillenbrand (2008), we also estimate fiducial activity ages for the main sequence sample with B-V colors between 0.5 and 0.9. With a preliminary analysis of these ages, we find a possible period of increased star formation, occuring 3 Gyrs ago. We plan to do further analysis of this feature, and on maintaining the compilation as a "living" document to incorporate log(R'HK), measurements from future surveys.

Planar Circular Restricted Three Body Problem (PCR3BP)

Jonathan Kurvits, Alexander Green, Prof. S. Rajeev, University of Rochester

We investigate two related problems in the Planar Circular Restricted Three Body Problem (PCR3BP):

1. The path of minimum force connecting two points in phase space,
2. The most probable path connecting two points in phase space for a particle experiencing random forces.

We then show that these two paths are in fact the same if the random force is small. Using numerical methods, we find paths to the moon that minimize the square of the applied force.

Modelling Astrophysical Jets: Herbig-Haro Objects

Edward R.A. Schroeder, Professor Adam Frank, University of Rochester

During star formation, young stellar objects (YSOs) accrete material from a surrounding envelope onto a central object. The combined effects of conservation of angular momentum and magnetic fields result in streams of material ("jets") emerging from the poles of the object that interact with the heterogeneous interstellar medium (ISM). When observed in emission lines, these jets are referred to as Herbig-Haro (HH) objects. We study these objects computationally, hoping to better understand how the jets are affected by inhomogeneities, or "clumps," within the jet itself. We utilize the AstroBEAR code, developed by the Computational Astrophysics Group at the University of Rochester. AstroBEAR is a modular hydrodynamic and magnetohydrodynamic (MHD) code environment designed for astrophysical applications, based on the BEARCLAW package developed at the University of North Carolina by Sorin Mitran. With AstroBEAR, we are able to run simulations in three dimensions (3D) of HH objects in the hope of revealing the nature of their complex morphology, kinematics, and emission line spectra.

Spectroscopic Evidence of Accretion and Outflow Variation in a T Tauri Star

Doug Packard, Colgate University

We will be using the HeI 1.083 μm line to study the variation of accretion and outflow processes in TW Hya, a T Tauri star. TW Hya is a 10 Mya sun-like star with a proto-planetary disk, and is therefore a very good candidate for gaining insight into the past of our own solar system and star. Spectroscopic studies in the past have revealed prominent blue-shifted absorption features, indicative of a strong outflow or wind, while red-shifted components of the line are evidence of the infalling gas accreting onto the star. We will be correlating our observations of these features to the rotational phase and simultaneous observations of a mass-accretion-indicating feature. This will allow us to test theoretical models of angular momentum transport in star formation.

SESSION IVB. QUANTUM OPTICS

Measuring Entanglement in Multi-Qubit Systems

Josh Geller, University of Rochester

Entangled multi-qubit systems are studied, considering the difference between pure and mixed states by manipulating the coherence and population elements of two- and three-qubit density matrices via phase averaging. A special case of phase averaging is the X-density matrix, for which we compute the Concurrence, a two-party entanglement measure calculable from the density matrix. We use an entangled Bell State, or "Schrodinger Cat" state, to demonstrate what is meant by measuring entanglement with Concurrence. This project was supported in part by NSF award PHY-0851243.

Design and Implementation of a Timing Control System for use in a Bose-Einstein Condensate (BEC) Experiment

Daniel N. Gresh, Professor Nicholas P. Bigelow, University of Rochester

A high-precision timing system is required not only to create a BEC, but also to perform experiments on it and control steady-state operations in the lab. I designed, implemented and upgraded the major hardware and logical pieces with microsecond precision on up to 100 digital and analog channels. Supported by NSF award PHY-0851243 and ARO.

Effect of Polarization on Light Transmission through Media

Samual Stedman and Andrew Knisely, U.S. Military Academy at West Point

The purpose of this experiment is to determine how a beam of light's polarization affects propagation through different media. Light of various polarization states is directed through media of increasing densities and is analyzed in transmission.

Effect of interaction and anisotropic tunneling on superfluid-Bose glass transition of hardcore bosons in an optical superlattice

Iora Tanabe, Theja De Silva, Binghamton University

We have studied the superfluid-Bose glass quantum phase transition of hardcore bosons in an optical superlattice in two dimensions. Such a system can be created experimentally by superimposing two optical lattices with different periodicity. In this system, tunneling and energy mismatch between wells can be controlled by laser intensity. After mapping the bosonic Hamiltonian into a spin Hamiltonian, we use a variational approach to study the effect of anisotropic tunneling and nearest neighbor interactions on phase boundaries between the superfluid and insulating phases. We will discuss the system parameter dependence on superfluid density and show that various phases can co-exist in the presence of an underlying harmonic trap.

Magnetic Trapping: An Anti-Helmholtz Configuration

Andrew Sifain, University of Rochester

Magnetic entrapment allows for further investigation of molecules and atoms. The goal is to create a device that creates a magnetic field that possesses a local minimum, pushing the atoms towards a saddle point in their energy thereby creating a "trap." Thus far, the simplest configuration suitable for the trapping experiments are anti-Helmholtz coils; where two coils, parallel to one another, have current running through them and the direction such that the current in one loop opposes that of the other in order to create a magnetic minimum at the center. An analysis of this configuration has led to a better understanding of the optimal positioning and radial dimensions of these coils, as well as information on the detailed geometry of the magnetic fields within the loops. Using the calculated magnetic field profile we are able to characterize the trap in terms of the characteristic oscillation frequencies for trapped particles. The phenomena of spin-flips that can happen near the magnetic field minimum must be considered and has led to an adjustment in the configuration, namely, the addition of a so-called Ioffe-Pritchard loop, which constrains the atoms so that the chance of gaining energy through a change in spin is eliminated. The next step is to further understand the limitations of the trap. Specifically, what types of parameters greatly affect the chance of trapping or of eventual escape as well as practical matters such as the electrical power that must be provided?

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