Rochester, April 6, 2013

Dear Participants:

Welcome to the 32nd annual Rochester Symposium for Physics Students (RSPS). The RSPS was instituted to provide an opportunity for undergraduates to present an account of their own personal research at a meeting whose format was chosen to closely resemble those of professional scientific societies.

At these symposia, research projects are presented in talks or poster sessions by undergraduates representing many regional institutions. Topics include condensed-matter physics, atomic physics and optics, computational physics, astronomy, particle and nuclear physics, instrumentation and techniques, environmental physics, biological physics, medical physics, and educational physics. The abstracts of all the participants' papers are published annually in the RSPS proceedings and distributed to the participants. The information is also available on line at

http://www.pas.rochester.edu/news-events/rsps/2013/index.html.

Students who present these talks can list their RSPS presentation(s) on their resumes and show the above web page in their list of publications as an "On-line Published Abstract". We encourage students to follow up on their research with the aim of giving a presentation at a regular APS meeting (which now also has a special session on undergraduate research), and eventually follow up with a publication in a regular journal, or in the APS Journal of Undergraduate Research.

At Rochester, the Department of Physics and Astronomy and the Institute of Optics are jointly running two National Science Foundation (NSF) funded Research Experience for Undergraduates (REU) sites. We encourage you to apply to one of these summer programs. Examples of research projects, talks, publications and awards won by our REU participants can be found on our REU Web page:

http://www.pas.rochester.edu/special/reu/index.html

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

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

LIST OF SPEAKERS

NAME	LOCATION	TIME
Aprelev, Pavel	LOBBY	10:00
Bock, William J.	B&L 109	11:00
Brunetti, Matthew	B&L 106	10:30
Burgess, Carrie	B&L 109	8:45
Cheng, Xinru (Flora)	B&L 109	9:00
Conine, Kyle	B&L 106	11:15
Cothard, Nicholas	B&L 106	13:45
Degner, Brian	B&L 106	9:00
Earle, Alissa	LOBBY	10:00
Figueiredo Prestes, Nicholas	LOBBY	10:00
Freeman, Ryan	B&L 106	10:45
Fuller, Nicholas	B&L 106	9:15
Godfrey, Christopher	LOBBY	10:00
Guo, Siyang	B&L 109	11:15
Hanna, Sheila	LOBBY	10:00
Hartshaw, Garrett	LOBBY	10:00
Hathaway, Stephanie	B&L 109	13:30
Heuer, Peter	B&L 109	9:30
Kelleher, Colleen	B&L 106	11:00

NAME	LOCATION	TIME
Lambrides, Erini	B&L 106	9:45
Lauer, Colin	B&L 106	14:15
Lewalle, Philippe	B&L 109	9:45
Mann, Keith	B&L 106	9:30
McCann, Amy	LOBBY	10:00
McTague, Lindsay	B&L 109	13:45
Mehta, Jeremy	B&L 407	14:00
Mertzlufft, Joshua	B&L 407	13:30
Mihaylova, Dilyana	LOBBY	10:00
Morrow, Emily	LOBBY	10:00
Piccarreto, Taylor	B&L 106	13:30
Reynolds, Tyler	B&L 407	13:45
Richards, David	LOBBY	10:00
Rojec, Brett	B&L 109	9:15
Saldan, Adriana	B&L 109	10:30
Savery, Thaddeus	LOBBY	10:00
Schmidt, William	B&L 109	14:15
Spencer, Mark	B&L 106	8:45
Stuart, Rachel	B&L 109	10:45
Sullivan, Mark	B&L 109	14:00

NAME	LOCATION	TIME
van Dyne, Aaron	LOBBY	10:00
van Dyne, Aaron	B&L 106	14:00
Verde, Justin	LOBBY	10:00

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

PROGRAM

8:00 AM – 8:30 AM: REGISTRATION AND POSTER SETUP (B&L LOBBY)

8:30 AM: WELCOME (B&L 109)

Prof. Frank Wolfs, University of Rochester.

8:45 AM – 10:00 AM: SESSION IA. OPTICS, QUANTUM OPTICS, AND QUANTUM MECHANICS (B&L 109)

SESSION CHAIR: PROF. JOSEPH EBERLY, UNIVERSITY OF ROCHESTER

8:45 Polarization of Iridescent Shells
Carrie Burgess, Colgate University

9:00 Spatial Mode Encoding of Photons Using Spatial Light Modulators
Xinru Cheng, Colgate University

9:15 Using a Spatial Light Modulator to Create Poincare Laser Beam Patterns
Brett L. Rojec, Colgate University

9:30 Frequency-Stabilized External-Cavity Diode Lasers for an Undergraduate Teaching Laboratory Magneto-optical Trap
Peter Heuer, Maitreyi Jayaseelan, Justin T. Schultz, Marek Haruza, Azure Hansen, and Nicholas P. Bigelow, University of Rochester

9:45 Oscillations in Classical and Quantum Mechanics
Philippe Lewalle, Shantanu Agarwal, and Prof. Joseph Eberly, University of Rochester

8:45 AM – 10:00 AM: SESSION IB. INSTRUMENTATION (B&L 106)

SESSION CHAIR: PROF. MARK YULY, HOUGHTON COLLEGE

8:45 Refurbishment of the Houghton College Scanning Transmission Electron Microscope (STEM)
Mark Spencer and Brandon Hoffman, Department of Physics, Houghton College

9:00 Designing the Trigger Monitor for the LUX Dark Matter Detector
Brian Degner, Eryk Druszkiewicz, and Frank Wolfs, University of Rochester

9:15 Exploring the Capabilities of the Houghton College Cyclotron
Nicholas Fuller, Sylvia Morrow, and Mark Yuly, Department of Physics, Houghton College

9:30 Low activity Mössbauer Sources for Undergraduate Labs
Keith Mann, Emily Morrow, and Mark Yuly, Department of Physics, Houghton College

9:45 Laser Target Position Determination From Digital X Ray Images
Erini Lambrides, University of Rochester

10:00 AM – 10:30 AM: SESSION II. POSTER SESSION (LOBBY)

Construction of an Optical Tweezer Apparatus
Pavel Aprelev and Chad Orzel, Union College

Measuring the incidence of LIRGs among blue EDisCS Cluster Galaxies
Alissa Earle and Dr. Rose Finn, Siena College

Study of Electrodeposition of Bi-Fe-O Thin Films
N. F. Prestes*', H. F. Jurca', W. H. Schreiner', and D. H. Mosca', ' Federal University of Parana, * Vassar College

Testing the use of GPUs to calculate the two-point angular correlation function
Christopher Godfrey and Matthew Bellis, Siena College

Proof of Principle for Positioning System for Outdoor Robotics Applications
Sheila Hanna, Renee Bourgeois, and Dr. Michele McColgan, Siena College

Measuring the Cross Section for the $^{12}C(n, 2n)^{11}C$ Reaction in the 20-30 MeV Energy Interval
Garrett Hartshaw, Keith Mann, Tyler Reynolds and Mark Yuly, Stephen Padalino, Danae Polsin, Megan Russ, Michael Krieger, Collin Stillman, Angela Simone, Mollie Bienstock, and Drew Ellison, and Craig Sangster, Houghton College, SUNY Geneseo, and the Laboratory for Laser Energetics, University of Rochester

The Incidence of Dust-Obscured Star Formation in Nearby Galaxy Clusters
Amy McCann, John Moustakas, and Rose Finn, Siena College

Single-emitter fluorescence in nanostructures for single-photon source applications
Dilyana Mihaylova, Justin Winkler, Svetlana Lukishova, and Zhimin Shi, University of Rochester

The Transverse Doppler Effect: A Possible Undergraduate Lab to Demonstrate Relativity
Emily Morrow, Keith Mann, and Mark Yuly, Department of Physics, Houghton College

Examining Parity Violation in Beta Decay using Gamma Ray Polarization
David Richards and Mark Yuly, Department of Physics, Houghton College

On the Perturbative Solution of Functional Differential Equations
Thaddeus Savery and Graziano Vernizzi, Siena College

A Monte Carlo Algorithm for Predicting RNA Secondary Structure
Aaron van Dyne and David Mathews, Roberts Wesleyan College and the University of Rochester

A Yb:KGd$(WO_4)_2$ Femtosecond Oscillator for Non-Linear Microscopy Applications
Justin Verde, Col. Kraig, and E. Sheetz, United States Military Academy, West Point

10:30 AM – 11:30 AM: SESSION IIIA. BIOLOGICAL AND MEDICAL PHYSICS (B&L 109)

SESSION CHAIR: PROF. SAMUEL AMBER, UNITED STATES MILITARY ACADEMY, WEST POINT

10:30 Establishing institution-specific action levels for EPID-based QA for IMRT at the URMC
A Saldan, D Rosenzweig, A Gray, R Meiler, D Clark, R Abu-Aita, M Schell, and D Cavanaugh, University of Rochester

10:45 Hole Transport in DNA: Part I
Alexander J. Breindel, Rachel E. Stuart, William J. Bock, David N. Stetler, Shane M. Kravec, and Esther M. Conwell, University of Rochester

11:00 Hole Transport in DNA: Part II
Alexander J. Breindel, Rachel E. Stuart, William J. Bock, David N. Stelter, Shane M. Kravec, and Esther M. Conwell, University of Rochester

11:15 Simulating Dynamics of Coupled Josephson Junction Neurons
Siyang Guo, Colgate University

10:30 AM – 11:30 AM: SESSION IIIB. CONDENSED MATTER AND SOLID STATE PHYSICS I (B&L 106)

SESSION CHAIR: PROF. BRANDON HOFFMAN, HOUGHTON COLLEGE

10:30 Frequency Synchronization and Non-Linear Dynamics in Josephson Junction Arrays
Matthew Brunetti, Colgate University

10:45 Fluxon Tunneling in Josephson Junction Arrays
Ryan Freeman, Colgate University

11:00 Rate constants of lithium molecules
Colleen Kelleher, Siena College

11:15 Magnetic Susceptibility Measurements
Kyle Conine, SUNY Brockport

11:30 AM – 12:30 PM: LUNCH (MELIORA, BALLROOM)

12:30 PM – 1:30 PM: PHYSICS JEOPARDY (B&L 109)

1:30 PM – 2:30 PM: SESSION IVA. ASTROPHYSICS (B&L 109)

SESSION CHAIR: PROF. JOHN MOUSTAKAS, SIENA COLLEGE

1:30 A Search for Rapid Emission Line Variations in Quasars from the SDSS
Stephanie Hathaway and Dr. Eric Monier, SUNY Brockport

1:45 The Firefly CubSat: Mission and Scientific Motivation
Lindsay McTague, Dr. Allan Weatherwax, and Dr. Matthew Bellis, Siena College, NASA GSFC

2:00 Visual Analysis of Models of the Inflation Field Potential
Mark Sullivan and Evan Halstead, Union College

2:15 Dielectric Material for a Radar Calibration Satellite
William Schmidt, Justin Vonsik, and Joshua Wilson, United States Military Academy, West Point and MIT Lincoln Laboratory

1:30 PM – 2:30 PM: SESSION IVB. HIGH ENERGY AND PARTICLE ASTROPHYSICS (B&L 106)

SESSION CHAIR: PROF. MATT BELLIS, SIENA COLLEGE

1:30 The Evolution of Time Dependent Non-asymptotically Flat Branes
Taylor Piccarreto, SUNY College at Cortland

1:45 Search for Dirac Monopoles with the CDF II Detector
Nicolas Cothard, Jonathan Lewis, Homer Wolfe, and Daniel Golden, University of Rochester, FNAL, The Ohio State University

2:00 Extracting Muon Momentum Scale Corrections for Hadron Collider Experiments
Aaron van Dyne, Arie Bodek, Willis Sakumoto, and Jiyeon Han, Roberts Wesleyan College and the University of Rochester

2:15 Building a Computer Cluster in Order to Simulate Dark Matter Interactions in Parallel
Colin Lauer and Christopher Wells, Department of Physics, Houghton College

1:30 PM – 2:15 PM: SESSION IVC. CONDENSED MATTER AND SOLID STATE PHYSICS II (B&L 407)

SESSION CHAIR: PROF. MOHAMMED TAHAR, SUNY BROCKPORT

1:30 An Evaporation Deposition System for the In-Situ Study of Thin Metal Films
Joshua Mertzlufft and Brandon Hoffman, Department of Physics, Houghton College

1:45 The Design and Construction of an Interferometer System for the Study of Thin Metal Films
Tyler Reynolds and Brandon Hoffman, Department of Physics, Houghton College

2:00 Vacuum Deposition and Characterization of Thin Indium Films
Jeremy Mehta, SUNY Brockport

SESSION IA. OPTICS, QUANTUM OPTICS, AND QUANTUM MECHANICS

POLARIZATION OF IRIDESCENT SHELLS

Carrie Burgess
Colgate University

Iridescent shells have piqued the curiosity of a range of scientists, who have analyzed aspects such as the structure and the scattering of light. However, few have analyzed how iridescent shells affect the polarization of light. I initiated this project under the direction of two professors (Professor Galvez and Professor Metzler), focusing on bivalves and gastropods. We looked at the differences in the polarization of two different wavelengths, varying polarizers and quarter wave plates in order to analyze how the polarization was affected.

SPATIAL MODE ENCODING OF PHOTONS USING SPATIAL LIGHT MODULATORS

Xinru Cheng
Colgate University

The goal of this project is to encode spatial modes onto classical light by using spatial light modulators (SLMs). We were able to generate patterns via a computer program and encode any Hermite-Gaussian mode of choice onto the SLM, creating many more photon states than achievable via polarization. We also used a second spatial light modulator to detect the modes encoded, to ensure we encoded the modes correctly. We generated superpositions of modes rotated by an arbitrary angle, in preparation for sending the beam through a single mode fiber for mode projection. In addition, we modulated the pattern encoded on the SLM to produce high-quality Hermite-Gaussian modes. This work is part of an ongoing effort at Colgate University to prepare photon pairs entangled in both polarization and spatial modes.

USING A SPATIAL LIGHT MODULATOR TO CREATE POINCARE LASER BEAM PATTERNS

Brett L. Rojec
Colgate University

This study concerns itself with the polarization properties of Poincare beams, laser beams that contain all states of polarization along the transverse plane of the beam, and different methods of creating them. Rather than having the entire wave front (transverse plane) of the beam be entirely in phase, laser beams can be produced in which the relative phase of a point in the transverse plane can change with its spatial coordinates. If the change increases linearly with the azimuthal angle, but does not vary radially (a phase "winding"), the beam is referred to as a Laguerre beam. We generate two Laguerre-Gauss beams, give one of them a right circular polarization, and the other a left circular polarization, and recombine them. Because the phase difference between the beams is dependent on its spatial coordinates, the opposite polarization states combine differently to create many or all of the possible polarization states; a Poincare beam. The polarization states of this beam are arranged in a symmetrical pattern, which is dependent on the initial polarization states of the two Laguerre-Gauss beams, and the number of phase windings each has. In the past, the laser beam was sent through a slide, which imparted a phase winding on the beam, and made it a Laguerre-Gauss beam. The types of beams that can be generated are therefore limited to the number of slides available. However, a Spatial Light Modulator (SLM) is a reflective device that can control the phase of an incident beam of light by changing the index of refraction (speed of light) through each of its pixels. As this is controlled electronically, we can easily program the SLM to generate any type of phase pattern desired, including Laguerre-Gauss phase windings, greatly expanding the amount of beams and polarization patterns that we can create and study. We set up the SLM, and ensured that it was producing the phase and polarization patterns we expected. We also programmed it to display the phase that would result from the addition of two Laguerre-Gauss beams, giving a more complicated phase, and possibly a more complicated polarization pattern. By learning how to create so many polarization patterns, we can hopefully learn how to generate any arbitrary polarization pattern, and potentially encode information in the polarization of the light.

FREQUENCY-STABILIZED EXTERNAL-CAVITY DIODE LASERS FOR AN UNDERGRADUATE TEACHING LABORATORY MAGNETO-OPTICAL TRAP

Peter Heuer, Maitreyi Jayaseelan, Justin T. Schultz, Marek Haruza, Azure Hansen, and Nicholas P. Bigelow
University of Rochester

Two external-cavity diode lasers were built for an undergraduate teaching lab Rubidium Magneto-optical trap. The lasers were frequency stabilized and linewidth narrowed by locking to the D2 transition of a Rubidium 87 saturated absorption spectrum using a homemade locking circuit. Partially supported by NSF awards PHY-0851243, PHY-1156339 and the Donaldson Trust.

OSCILLATIONS IN CLASSICAL AND QUANTUM MECHANICS

Philippe Lewalle, Shantanu Agarwal, and Prof. Joseph Eberly
University of Rochester

We have used the established theoretical framework of harmonic oscillations in both classical and quantum physics to explore how the predictions of quantum theory deviate from those of classical theory, in phenomena such as the discrete energies found in the quantum oscillator. The ramifications of these differences become clearer through their application to specific examples, such as the canonical coherent states of the quantum oscillator, which mimic classical behavior as closely as the fundamental postulates of quantum mechanics allow. We have explored tools associated with the Hamiltonian formulation of mechanics, which are useful for "quantizing" classically understood systems. We are able to apply these theoretical concepts and procedures to specific physical cases, such as the inductor-capacitor (LC) oscillator. The experiments that are able to confirm or deny the predictions we obtain with these well known theoretical tools are also important. Our work is oriented towards understanding recent developments in the field of circuit quantum electrodynamics (circuit QED), in which researchers have been able to probe the quantum signatures of oscillators by observing their interactions with superconducting qubits, which can be built using superconducting Josephson junctions. This project was supported in part by NSF awards PHY-1156339 and PHY-1203931.

SESSION IB. INSTRUMENTATION

REFURBISHMENT OF THE HOUGHTON COLLEGE SCANNING TRANSMISSION ELECTRON MICROSCOPE (STEM)

Mark Spencer and Brandon Hoffman
Department of Physics, Houghton College

Houghton College is refurbishing a Jeol JEM CX-100 STEM for the study of thin metal films. The microscope is capable of scanning electron microscopy (SEM), transmission electron microscopy (TEM), electron diffraction, and backscattered electron microscopy, up to 800,000 × magnification. The original image capturing system projects the image onto a cathode ray tube (CRT) screen and takes a film exposure of the image. An interface is being developed to read the image directly from the microscope's electronics and manipulate and store it as a digital picture.

DESIGNING THE TRIGGER MONITOR FOR THE LUX DARK MATTER DETECTOR

Brian Degner, Eryk Druszkiewicz, and Frank Wolfs
University of Rochester

It is believed that over 90% of matter in the known universe is made of Dark Matter, a substance that only interacts with other particles through the weak nuclear and gravitational forces. To search for Dark Matter, the LUX Collaboration has built a large underground liquid xenon detector, and the University of Rochester group has designed the electronic trigger system for this detector. This presentation focuses on the recently developed Trigger Monitor for the LUX data acquisition system (DAQ) and electronic trigger system. The Trigger Monitor functions as a digital-to-analog converter for 8 NIM input signals and outputs a distinct voltage between -1.6V and 0V to the DAQ for any combination of the eight devices. This allows for the identification of which system, and what type of event, triggers the DAQ.

EXPLORING THE CAPABILITIES OF THE HOUGHTON COLLEGE CYCLOTRON

Nicholas Fuller, Sylvia Morrow, and Mark Yuly
Department of Physics, Houghton College

The Houghton College Cyclotron is currently capable of accelerating protons to 300 keV, and with an improved magnet power supply and cooling should achieve 400 keV. Low-pressure hydrogen or helium gas is introduced into the vacuum chamber where a filament, through electron collisions, ionizes the gas. The ions are accelerated in a spiral path of 72 mm maximum radius by an alternating RF electric field in a constant magnetic field of up to 1.2 T. The cyclotron's performance is being characterized for varying gas pressure, filament voltage, orbital radius and "dee" voltage. In the near future, low

energy nuclear reactions such as $D(d,n)^3He$ and $D(^3He,p)^4He$, as well as high-yield (p,γ) resonances like $^{19}F(p,\gamma)^{16}O$ and $^{31}P(p,\gamma)^{32}S$ may be studied.

LOW ACTIVITY MÖSSBAUER SOURCES FOR UNDERGRADUATE LABS

Keith Mann, Emily Morrow, and Mark Yuly
Department of Physics, Houghton College

Mössbauer experiments for undergraduates typically use radioactive sources measured in mCi, which excludes small institutions that do not have radioactive source licenses. In response to this need, we are developing a technique for producing inexpensive, low-activity, license-exempt Mössbauer sources. Cobalt in a solution of $CoCl_2$ in HCl containing approximately 1 mCi of ^{57}Co will be electroplated to a stainless steel foil and subsequently heated in a vacuum to about 1000 °C to allow the ^{57}Co atoms to permeate the crystal lattice of the steel substratum. Several different methods of measuring the temperature have been tested in order to ensure that the foil is heated to the optimal temperature. Once created, these radioactive sources will be tested using a standard Mössbauer apparatus with the long-term intention of using the Mössbauer effect to measure the transverse Doppler shift due to relativistic effects as an undergraduate lab.

LASER TARGET POSITION DETERMINATION FROM DIGITAL X RAY IMAGES

Erini Lambrides
University of Rochester

This presentation describes the algorithms used to determine a target's position from digital x-ray images taken on cryogenic target experiments performed on the Omega 60-beam UV laser system. It is found that a target must be about 5 microns to the center of the aim direction of the beams in order to implode with a variation of intensity less than 1%. The two mathematical methods employed for finding the position of a target are a matrix inversion algorithm and a non-linear least squares fit method. Both methods and their applications will be described in this presentation.

SESSION II. POSTER SESSION

CONSTRUCTION OF AN OPTICAL TWEEZER APPARATUS

Pavel Aprelev and Chad Orzel
Union College

Optical tweezers can be used to trap micron-scale particles in a focused laser beam and move those particles within the sample by either moving the beam or the stage. When the light is focused in a point it creates forces on dielectric objects that point towards the focal point. The magnitude and the span of the force are dependent on the size of the focal point of the beam, generally around 1µm. We used a fiber-coupled 2-watt infrared laser as the source of light. By controlling the position of the focal point of the beam relative to the stage, we are able to pick up 1µm plastic beads and move them around in 3D, using an electrically controlled stage. Using a LabVIEW program, we were able to move the stage at precise speeds and thus determine the forces within the focal point of the beam.

MEASURING THE INCIDENCE OF LIRGS AMONG BLUE EDISCS CLUSTER GALAXIES

Alissa Earle and Dr. Rose Finn
Siena College

Galaxies can be broadly grouped into two categories: red galaxies that don't form many new stars, and blue galaxies that are still converting gas into stars. What causes a galaxy to evolve from blue to red? One hypothesis is that the environment in which a galaxy lives, influences its ability to form new stars. Galaxy clusters, the densest galactic environments, are home to a large fraction of red, quiescent galaxies, yet astronomers are still trying to understand if the cluster environment causes blue, actively start-forming galaxies to evolve into red, passive galaxies. To better understand the cluster environment's impact on star formation, we are studying the incidence of actively star-forming galaxies in the ESO Distant Cluster Survey (EDisCS). Specifically, we are using infrared luminosity, a star-formation indicator. Our sample is at intermediate redshift ($0.42<x<0.96$) and includes 17 clusters, 7 groups and the surrounding field. Preliminary results are presented here.

STUDY OF ELECTRODEPOSITION OF BI-FE-O THIN FILMS

N. F. Prestes*', H. F. Jurca', W. H. Schreiner', and D. H. Mosca'
' Federal University of Parana, * Vassar College

The greatest interest in the study of multiferroic materials is the coexistence of the ferroelectric and ferromagnetic ordering of the compound [1]. The coupling between the electric and magnetic ordering, called magnetoelectric coupling, makes possible to control the ferroelectric polarization by a magnetic field, and conversely, the manipulation of magnetization by an electric field [2]. The charge and spin of the electron are the physical properties engendered in multiferroic behavior. Experimental and theoretical research has been carried out towards the development of artificial materials and heterostructures that show coupling between ferroelectric and ferromagnetic properties. The study of the deposition process of Bi-Fe-O thin films reflects the interest in optimizing parameters for the synthesis of $BiFeO_3$ films, which presents multiferroic antiferromagnetic ordering with high Néel temperature, characteristic interesting for application in electronic high temperatures [3]. Another interesting feature of $BiFeO_3$ is that, due to stresses in the crystal structure, thin films of this compound have an electrical polarization much greater than those recorded for the bulk form. We studied the electrochemical deposition because it is a simpler and faster alternative when compared to currently used methods (Laser Ablation Deposition and Molecular Beam Epitaxy). The films were synthesized by electrodeposition in commercial FTO (fluorine tin oxide) substrates using an acidic solution of bismuth nitrate and iron nitrate. The characterization of the samples was performed using X-ray photoelectron spectroscopy (XPS) and x-ray diffraction. We used XPS analysis to monitor surface stoichiometry of the deposited films and then we were able to adjust and optimize the relative concentrations of nitrate in the electrolyte solution. Our preliminary results show that the stoichiometry relation between the nitrates and the final concentrations in the films is not linear. Measurements of x-ray diffraction in the Bragg-Brentano geometry also showed the formation of more thermodynamically favorable phases alongside the formation of $BiFeO_3$ phase.

[1] N. Spaldin, R. Ramesh, Nature Materials 6, 1476 (2007)
[2] D. Khomskii, Physics 2, 20 (2009)
[3] T. P. Gujar et al., Applied Surface Science. 252, 3585 (2006)

TESTING THE USE OF GPUS TO CALCULATE THE TWO-POINT ANGULAR CORRELATION FUNCTION

Christopher Godfrey and Matthew Bellis
Siena College

Current models suggest that the Universe is composed of some mixture of baryonic matter, dark matter and dark energy. The gravitational attraction of baryonic matter and dark matter as well as the repulsive force of dark energy drive the evolution of large-scale structure in the Universe. As the Universe has cooled and evolved, matter, and more specifically, galaxies, have clustered together, forming a web like structure. The clustering of these galaxies can be quantified by using the Two-Point Angular Correlation Function (2ptACF). Calculating this quantity is extremely computationally intensive; the time to make the calculations scale as a factor of N^2 where N represents the number of galaxies in the dataset. With the use of GPUs (Graphical Processing Units), the total time to run these calculations is dramatically reduced. This work has tested the GPU implementation of the 2ptACF using data from N-body simulations and verified its consistency with previous computational approaches.

PROOF OF PRINCIPLE FOR POSITIONING SYSTEM FOR OUTDOOR ROBOTICS APPLICATIONS

Sheila Hanna, Renee Bourgeois, and Dr. Michele McColgan
Siena College

Progress of an outdoor robot positioning system will be presented. A minimum of three transmitters and a robot receiver are used to determine the location of the robot. A unique ultrasonic signal and a radio signal are sent to the receiver where the signal is interpreted. By using a unique signal for each transmitter and the difference between the two signals, the robot's location can be accurately calculated. The hardware for the beacons and receiver include the Arduino microcontroller, low pass filters, comparators, and A/D converters in addition to other circuitry.

MEASURING THE CROSS SECTION FOR THE $^{12}C(n, 2n)^{11}C$ REACTION IN THE 20-30 MEV ENERGY INTERVAL

Garrett Hartshaw, Keith Mann, Tyler Reynolds and Mark Yuly, Stephen Padalino, Danae Polsin, Megan Russ, Michael Krieger, Collin Stillman, Angela Simone, Mollie Bienstock, and Drew Ellison, and Craig Sangster
Houghton College, SUNY Geneseo, and the Laboratory for Laser Energetics, University of Rochester

The behavior of the (n, 2n) reaction in ^{12}C and other light nuclei is known with much less certainty than for heavy nuclei. The published cross section data for the $^{12}C(n, 2n)^{11}C$ reaction is bifurcated in the energy range of 20-30 MeV. An experiment to measure the $^{12}C(n,2n)^{11}C$ cross section for these neutron energies has been performed using the Ohio University Tandem Accelerator. Deuterons from the accelerator struck a tritium foil releasing neutrons via the $T(d, n)^4He$ reaction. Deuteron bombarding energies between 3.3-8.7 MeV resulted in neutrons with energies between 20-26 MeV. The geometry of the experiment was chosen so that the incident neutron energy would not vary by more than 0.5 MeV across the graphite target. After neutron bombardment, the decay of the ^{11}C nuclei by positron emission was measured with an array of NaI detectors to determine the activity of the carbon sample. The neutron fluence through the carbon was measured using a particle telescope to detect protons from the $^1H(n, p)$ reaction in a polyethylene target, allowing the absolute cross section for the $^{12}C(n, 2n)^{11}C$ reaction to be determined.
Funded in part by a grant from the DOE through the Laboratory for Laser Energetics.

THE INCIDENCE OF DUST-OBSCURED STAR FORMATION IN NEARBY GALAXY CLUSTERS

Amy McCann, John Moustakas, and Rose Finn
Siena College

Galaxy clusters are massive gravitational potential wells containing thousands of galaxies and large amounts of dark matter. Most galaxies within clusters have depleted their gas supply --- star formation has ceased --- and are therefore “red and dead,” whereas star formation in galaxies outside of clusters is widespread. What causes galaxies in the cluster environment to stop forming stars? To investigate this question, we are studying a sample of nine low-redshift clusters drawn from the Local Clusters Survey with multi-wavelength observations from the ultraviolet to the infrared. Our goal is to determine whether galaxies experience one final burst of enhanced, dust enshrouded star formation before falling into the cluster potential and “dying.”

SINGLE-EMITTER FLUORESCENCE IN NANOSTRUCTURES FOR SINGLE-PHOTON SOURCE APPLICATIONS

Dilyana Mihaylova, Justin Winkler, Svetlana Lukishova, and Zhimin Shi
University of Rochester

We studied fluorescence of several types of single emitters emitting single photons at a time (colloidal quantum dots, single-walled carbon nanotubes and NV-color-centers in nanodiamonds) in different nanostructures including plasmonic nanostructures. We also did computer based modeling of the electric field enhancement in plasmonic porous nanomembrane and plasmonic bowtie nanoantennas.

THE TRANSVERSE DOPPLER EFFECT: A POSSIBLE UNDERGRADUATE LAB TO DEMONSTRATE RELATIVITY

Emily Morrow, Keith Mann, and Mark Yuly
Department of Physics, Houghton College

In the classic Pounds and Rebka General Relativity experiment of 1960, the Mössbauer effect was used to measure the gamma-ray frequency shift due to the gravitational potential energy. According to the equivalence principle, the same effect should occur in an accelerated system. An experiment to measure this effect is being assembled at Houghton College. Initial work has been done to produce a 1 mCi ^{57}Co source by electroplating ^{57}Co out of a cobalt solution onto steel foil, and heating the foil in a vacuum to 1000 °C. The source will be placed near the edge of a thin high-speed rotating steel disc enriched in ^{57}Fe. The 14.4 keV gamma rays from the ^{57}Co source will penetrate the disc and be detected by a CdTe x-ray detector on the other side. Varying the radial acceleration of the rotating absorber will change the characteristic energy of the resonance absorption, resulting in a change in the gamma transmission. To reduce background, a NaI detector will detect the 122 keV gamma ray from ^{57}Co in coincidence with the 14.4 keV gamma ray.

EXAMINING PARITY VIOLATION IN BETA DECAY USING GAMMA RAY POLARIZATION

David Richards and Mark Yuly
Department of Physics, Houghton College

One of the most revolutionary findings of the twentieth century was discovery that parity is not conserved in weak interactions. This prediction, published in 1956 by Lee and Yang, was confirmed in the classic 1957 experiment by Wu et al. In the original paper, Lee and Yang pointed out that parity violation might also be tested in $\beta\gamma$ correlation measurements of the circular polarization of the gamma ray emitted in beta decay. An experiment to measure this effect is being constructed at Houghton College. The transmission of ^{60}Co gamma rays through magnetized iron will be used to measure the circular polarization in coincidence with the electron emitted at 180°. The gamma rays will be detected using a high-purity germanium detector and beta particles by a silicon surface barrier detector. Asymmetry in the coincidence rate when the magnetic field is reversed will indicate parity violation.

ON THE PERTURBATIVE SOLUTION OF FUNCTIONAL DIFFERENTIAL EQUATIONS

Thaddeus Savery and Graziano Vernizzi
Siena College

All differential equations for relativistic dynamical systems are not ordinary differential equations (ODE), but functional differential equations (FDE) where the unknown functions and their derivatives are evaluated at different times. Currently, there are no general methods for solving FDEs, and a typical approximation is the so-called post-Newtonian approximation, where all equations are expanded in $1/c^2$ (c is the speed of light), yielding a system of solvable ODEs. In this work, we study the radius of convergence of such perturbative expansions. We compare the standard perturbative theory for linear ODEs and non-linear ODEs, with the case of a particular class of FDEs of the form $x'(t)=x(x(t))$, for which exact solutions are known. We compare the perturbative expansion with the actual solution, and we investigate the presence of singularities and a finite radius of convergence in such cases.

A MONTE CARLO ALGORITHM FOR PREDICTING RNA SECONDARY STRUCTURE

Aaron van Dyne and David Mathews
Roberts Wesleyan College and the University of Rochester

We developed a Monte Carlo simulation with replica exchange to sample RNA secondary structures, i.e. the set of base pairs. Current algorithms for predicting RNA secondary structure are successful in predicting RNA secondary structures, but these dynamic programming algorithms have difficulty predicting pseudoknotted structures. There are several replica exchange parameters that must be optimized. These parameters

are the temperature of the maximum replica, the number of replicas, and the frequency of exchange between replicas.

The algorithm is being tested on three classes of RNA, which are representative of a variety of RNA sequence lengths that are biologically relevant. These classes are tRNA, group I introns, and small subunit ribosomal RNA. The algorithm is iterative, and at each iteration a pair is either formed or broken. The free energy of the new structure is then computed and compared to the free energy of the previous structure. If the free energy is lower, then the new structure is accepted. If the free energy is higher, then the new structure is only accepted with some probability dependent on how close the energies are. Our first calculations are excluding pseudoknots. This allows us to compare the Monte Carlo-sampled base pairing probabilities to exact probabilities that can be determined with a dynamic programming algorithm partition function. Preliminary results suggest that the RMSD between the pairing probabilities predicted by the partition function and those predicted by Monte Carlo can approach the error limit of the underlying energy function. If optimal parameters can be found, the algorithm may be useful as a method of predicted pseudoknotted structures in the future.

A YB:KGD(WO_4)$_2$ FEMTOSECOND OSCILLATOR FOR NON-LINEAR MICROSCOPY APPLICATIONS

Justin Verde, Col. Kraig, and E. Sheetz
United States Military Academy, West Point

We present a home-built diode-pumped Yb:KGd(WO_4)$_2$ femtosecond oscillator. The ultrashort pulse laser system will serve as a flexible excitation source for a nonlinear microscopy platform. Our sub-cavity oscillator generates a 55 MHz femtosecond pulse train with an average power of up to 4W and a pulse width of ~260 fs. The cavity will be expandable to an extended 20 MHz configuration with a Pockels cell-based cavity-dumping arm that will enable the option of generating μJ pulses directly from the extended cavity. Exact pulse characteristics will be determined via second-order autocorrelation.

SESSION IIIA. BIOLOGICAL AND MEDICAL PHYSICS

ESTABLISHING INSTITUTION-SPECIFIC ACTION LEVELS FOR EPID-BASED QA FOR IMRT AT THE URMC

A Saldan, D Rosenzweig, A Gray, R Meiler, D Clark, R Abu-Aita, M Schell, and D Cavanaugh
University of Rochester

Portal dosimetry has been used successfully in the clinic for the quality assurance (QA) of intensity-modulated radiation therapy (IMRT) treatment plans, using clinical action levels previously defined by Howell et al. in 2008. At the University of Rochester Medical Center, a review of 3937 fields of 364 patients' treatment plans was undertaken to find institutional action level values unique to this clinic. Data analysis focused on the commonly used gamma parameter. Institutional averages and standard deviations were found for maximum gamma, average gamma, and percentage of a field's fluence area exhibiting a gamma value greater than 1.0. These observations were used to create action levels specific to this clinic, which are expected to reflect institution-specific aspects such as updated acquisition software and individual treatment planning styles. Results suggest that action levels for Portal Dosimetry-based IMRT QA should be adjusted based on individual institutions' experience.

HOLE TRANSPORT IN DNA: PART I

Alexander J. Breindel, Rachel E. Stuart, William J. Bock, David N. Stetler, Shane M. Kravec, and Esther M. Conwell
University of Rochester

Transport of a hole along the base stack of DNA is relatively facile for a series of adenines (As) paired with thymines (Ts) or for a series of guanines (Gs) paired with cytosines (Cs). However, the speed at which a hole was found to travel was much too small to make useful semiconductor-type devices. Quite recently it was found that replacing one of the electronegative nitrogens (N3 or N7) with a carbon and a hydrogen, thus turning A into deazaadenine, increased the hole speed in what was A/T by a factor 30. To study the effect of the substitution we have carried out simulations for the wavefunction of a hole on an A/T oligomer with As modified by replacing N3 or N7, or both, with C-Hs. The simulations were carried out using QM/MM and the code CP2K. We find, for either N, or both, replaced, the wavefunction of the hole behaves similarly to that of a hole on A/T in being delocalized immediately after hole insertion for up to ~20fs, and then becoming localized on one of the modified As. The time for localization could be decreased by placing additional water within ~1.8 Å of N3 or N7, encouraging the formation of hydrogen bonds with these nitrogens. Because of their positive charge the hydrogen bonds tend to repel holes. However, these bonds were found to decay on a fs time scale, thus unlikely to affect the hole hopping, which occurs on approximately a ns scale in A/T. Replacement with a C-H of one or both of the electronegative Ns, along with the structural changes that result, is expected to decrease the activation energy and thus account for the larger hole hopping rate in the deaza-modified DNA.

HOLE TRANSPORT IN DNA: PART II

Alexander J. Breindel, Rachel E. Stuart, William J. Bock, David N. Stelter, Shane M. Kravec, and Esther M. Conwell
University of Rochester

Transport of a hole along the base stack of DNA is relatively facile for a series of adenines(As) paired with thymines (Ts) or for a series of guanines (Gs) paired with cytosines (Cs). However, the speed at which a hole was found to travel was much too small to make useful semiconductor-type devices. Quite recently it was found that replacing one of the electronegative nitrogens (N3 or N7) with a carbon and a hydrogen, thus turning A into deazaadenine, increased the hole speed in what was A/T by a factor 30. To study the effect of the substitution we have carried out simulations for the wavefunction of a hole on an A/T oligomer with As modified by replacing N3 or N7, or both, with C-Hs. The simulations were carried out using QM/MM and the code CP2K. We find, for either N, or both, replaced, the wavefunction of the hole behaves similarly to that of a hole on A/T in being delocalized immediately after hole insertion for up to ~ 20fs, and then becoming localized on one of the modified As. The time for localization could be decreased by placing additional water within ~ 1.88 Å of N3 or N7, encouraging the formation of hydrogen bonds with these nitrogens. Because of their positive charge the hydrogen bonds tend to repel holes. However, these bonds were found to decay on a fs time scale, thus unlikely to affect the hole hopping, which occurs on approximately a ns scale in A/T. Replacement with a C-H of one or both of the electronegative Ns, along with the structural changes that result, is expected to decrease the activation energy and thus account for the larger hole hopping rate in the deaza-modified DNA.

SIMULATING DYNAMICS OF COUPLED JOSEPHSON JUNCTION NEURONS

Siyang Guo
Colgate University

Aiming to understand group behaviors and dynamics of neural networks, we propose an analog circuit model that mimics biological neurons using superconducting Josephson junctions. The Josephson junction neuron has been previously shown to be a fast, accurate circuit model for biological neurons. In this study, we further analyzed the dynamics of the Josephson junction neuron by constructing a coupled system and comparing the results with that of spatially coupled Hodgkin-Huxley neurons. We observed a phase-flip bifurcation in the coupled Josephson junction neurons by numerical simulation of the circuit model, and constructed a bifurcation diagram for changing coupling strength between the two neurons using phase response curve and spike phase difference map. We observed similar phase-flip bifurcation in spatially coupled Hodgkin-Huxley neurons. We plan to fabricate the coupled Josephson junction neurons circuit and test the numerical results from this study experimentally.

SESSION IIIB. CONDENSED MATTER AND SOLID STATE PHYSICS I

FREQUENCY SYNCHRONIZATION AND NON-LINEAR DYNAMICS IN JOSEPHSON JUNCTION ARRAYS

Matthew Brunetti
Colgate University

We begin with a brief treatment of the concept of frequency synchronization and a description of the locally coupled Kuramoto model (LKM) that we use as the theoretical basis for our experiments. In such a system, the coupling strength determines how quickly and to what degree a system of oscillators will synchronize, if at all. Normally, this parameter is dependent entirely upon the geometry of the circuit being used. Our experiment deals specifically with using an applied external magnetic field (flux) to change the value of the coupling strength, with the hope that we will be able to observe a varying degree of frequency synchronization between our junctions.

FLUXON TUNNELING IN JOSEPHSON JUNCTION ARRAYS

Ryan Freeman
Colgate University

We are studying fluxon dynamics in Josephson junction arrays, specifically looking for evidence of quantum tunneling of the fluxons. Recent experiments have yielded data on the switching currents of the junctions (current at which the fluxon begins to move) that shows evidence of the transition from thermal activation to quantum tunneling of the fluxon. However, we have also come across a possible confound in that our devices may not have been reached the coldest temperatures that we believed. After lowering the applied current by a factor of 3, data from new experiments suggests that we no longer have issues with our cooling procedure and gives further examples of possible fluxon tunneling.

RATE CONSTANTS OF LITHIUM MOLECULES

Colleen Kelleher
Siena College

A great deal of information can be obtained about molecular theory in general by using the lithium molecule ($^7Li_2$) as a model, since it is the simplest molecule besides H_2. In this project, we used high-powered pulsed lasers to excite Li_2 to high energy levels and observed its collisions with an inert gas. The excited Li_2 emits a certain frequency spectra upon decaying back down to a lower energy level, and the Li_2 in collisionally populated energy levels decays back down to a slightly different energy level. We observe these frequencies using a CCD camera and a monochromator, and based on the size of the signal observed, we can determine rate constants. These rate constants are the probability of transfer from one molecular state to another, which tells us about the molecular interactions and structure. This data will be used to extend a study done previously which compared rate constant data from a continuous wave laser to a pulsed laser.

MAGNETIC SUSCEPTIBILITY MEASUREMENTS

Kyle Conine
SUNY Brockport

In studying the magnetic properties of materials, one measures their susceptibility or response to an applied magnetic field. The applied field is generated by a solenoid (primary coil), where a sample is placed and a secondary coil is used to measure the mutual inductance between the coils as “modulated” by a sample. For sensitivity purposes, another secondary coil is used for cancelling out the induced voltages in the two secondary coils, leaving that due to the sample, which is inside one secondary coil, while the other is empty. A set of coils, consisting of one primary and two secondary coils, has been constructed using insolated 42.5 AWG Cu wire and a modified small lathe. That provides us with the capability of making these measurements. Putting an AC current through the primary coil generates a time varying magnetic field that in turn induces roughly equal voltages in the secondary coils. These induced voltages would cancel were it not for the sample presence in one of the secondary coils. This minute imbalance is recorded with a Lock-In-Detector and can be related to the sample’s magnetic and electric properties. These Measurements are taken while the sample’s temperature is swept between 1 and 4 K, in a liquid He bath and/or can be raised up to 80 K in vacuum, while the coils’ temperature is maintained at 4.2 K by the external He bath. This allows for magnetic and electronic phase transition studies.

SESSION IVA. ASTROPHYSICS

A SEARCH FOR RAPID EMISSION LINE VARIATIONS IN QUASARS FROM THE SDSS

Stephanie Hathaway and Dr. Eric Monier
SUNY Brockport

Quasars are among the most distant and luminous objects in the universe. Models suggest that their luminosity results from an accretion disk of gas surrounding a supermassive black hole, while "clouds" of gas further out are ionized by the disk and are therefore seen in emission. The purpose of this research was to search for changes in emission line fluxes from hydrogen and carbon over timescales of a few hours. Such changes could result from flares of ionizing radiation on the disk that later reach the more-distant emission line region. We identified a sample of 74 bright, high-redshift ($z > 3.3$) quasars from the Sloan Digital Sky Survey Database (SDSS), and split each publicly available quasar spectrum into its individual sub-exposures. We present preliminary results from our measurement and analysis of the continuum and emission line fluxes in the sub-exposures of these 74 quasars.

THE FIREFLY CUBSAT: MISSION AND SCIENTIFIC MOTIVATION

Lindsay McTague, Dr. Allan Weatherwax, and Dr. Matthew Bellis
Siena College, NASA GSFC

Lightning discharges represent the release of enormous amounts of energy and are associated with familiar and powerful manifestations near the Earth's surface: thunder, a bright flash, and a powerful current that can shatter trees and turn sand to glass. Lightning may also give rise to x ray and gamma-ray bursts, and unlike the well-known flashes of light and claps of thunder, these energetic rays are channeled upward and can be detected only from space.

The NSF Firefly CubeSat mission is designed to study Terrestrial Gamma ray Flashes (TGFs), their link to lightning, and their effect in producing energetic electrons that may become stably trapped in the inner radiation belt. In addition, a related mission called FireStation will be part of the STP-H4 platform on the International Space Station; FireStation relies heavily on existing flight experience from the NSF-funded Firefly CubeSat mission, with some modifications to interface and sensors.

This presentation will focus on the Firefly and FireStation mission design, as well as important lessons learned in the development, testing, and design process. Future developments in CubeSat-class spacecraft for measurements of energetic radiation will be discussed. These space-based platforms are unique in that they represent the first experiments to contain instruments for detecting TGFs and very low frequency radio waves (VLFs), as well as examining the photon emissions from lightning, all integrated into one platform. Since Firefly has not yet been launched, the design and integration process is still underway. The work presented here details the assembly of the satellite and the preparation for its launch in the summer of 2013, together with preliminary simulations of the Bremsstrahlung and particle physics processes related to the production of TGFs.

VISUAL ANALYSIS OF MODELS OF THE INFLATION FIELD POTENTIAL

Mark Sullivan and Evan Halstead
Union College

The inflation field controls the rate at which the universe expands. A function known (perhaps misleadingly) as the inflation field potential determines the strength of this field at the various times in the life of the universe. In this talk, I will discuss the three models that cosmologists currently believe describe the inflation field potential, and a method of testing these models by comparing them to current experimental findings.

DIELECTRIC MATERIAL FOR A RADAR CALIBRATION SATELLITE

William Schmidt, Justin Vonsik, and Joshua Wilson
United States Military Academy, West Point and MIT Lincoln Laboratory

A novel concept for a high reflectivity radar metric and signature calibration satellite is presented. Dielectric materials are selected to produce high retroreflectivity at optical and RF wavelengths. RF retroreflectivity guarantees visibility to the radar, while optical retroreflectivity enables laser tracking for precise metric calibration. The satellite will be set on a polar orbit, as this will allow it to have a lengthy time of visibility with an altitude of 700-900 kilometers. This will maximize the number of ground sensors that will have an adequate amount of time to make calibrations. The satellite must have a minimum RCS of 5 decibels (dBsm) for a range of frequencies between 3 and 35 Gigahertz (GHz) in order to outperform a metallic sphere of 0 dBsm that has been performing a similar function since the 1970s. MATLAB models are employed to determine the most effective packing fractions between alumina and silica to optimize RCS. We have conducted RF measurements using a network analyzer in order to verify the MATLAB simulations. The design process included MATLAB simulation, the preparation of test samples of alumina and silica, the verification of their densities, and the verification of the MATLAB code itself.

SESSION IVB. HIGH ENERGY AND PARTICLE ASTROPHYSICS

THE EVOLUTION OF TIME DEPENDENT NON-ASYMPTOTICALLY FLAT BRANES

Taylor Piccarreto
SUNY College at Cortland

In superstring theory, p-branes are solutions whose properties explain facets of physics in dimensions higher than three. The number "p" is the dimensionality of the brane, so a 0-brane is a point, a 1-brane is a string and so on. Some such branes may be thought of as higher dimensional black holes, others may be interpreted as universes parallel to ours, each with their own physical structure. In this work, we study a class of 2-branes in five dimensional (four space + one time) supergravity theory with the strange characteristic of having non-asymptotically flat spacetimes. That is, their gravitational field increases, rather than decreases, as one moves further away from them. The static version of such objects has been previously studied in the literature. In this work, however, we assume time dependence and discuss the behavior of the branes when coupled to the superstring fields that live in five dimensions; known as the universal hypermultiplet. By comparing the curvature of the metric to the energy content in five dimensions, one can pinpoint the properties of the hypermultiplet and figure out how they contribute to the dynamical motion of the 2-brane.

SEARCH FOR DIRAC MONOPOLES WITH THE CDF II DETECTOR

Nicolas Cothard, Jonathan Lewis, Homer Wolfe, and Daniel Golden
University of Rochester, FNAL, The Ohio State University

We report the results of a direct search for Dirac magnetic monopoles using the CDF Run II detector at Fermilab. Monopoles within this model are produced via a mechanism similar to Drell-Yan pair production, are highly ionizing, and experience magnetic forces parallel to the magnetic field. We employ a dedicated trigger, which requires large light pulses in the scintillators of the time-of-flight system, and which remains highly efficient to monopoles while consuming a negligible fraction of the available simulation is used, and a specialized offline event reconstruction examines the central drift chamber for tracks consistent with highly ionizing particles that do not curve in the plane perpendicular to the magnetic field. Limits presented here are for magnetic monopoles with masses between 100 and 700 GeV.

EXTRACTING MUON MOMENTUM SCALE CORRECTIONS FOR HADRON COLLIDER EXPERIMENTS

Aaron van Dyne, Arie Bodek, Willis Sakumoto, and Jiyeon Han
Roberts Wesleyan College and the University of Rochester

The full data set from CDF Run II is the best opportunity to make a precise measurement of the electroweak mixing angle using the decay of Z-bosons to dimuon pairs. The proton-antiproton collisions of the Tevatron allow for a more precise measurement than the proton-proton collision of the Large Hadron Collider. The CDF Run II data set has now been corrected, so that an accurate measurement of the electroweak mixing angle can be made in the future. First, a set of cuts were applied to the full CDF Run II data set as well as a Monte Carlo simulation of the signal to maximize the amount of signal while minimizing the amount of background in the data. An additive correction was applied to correct for misalignment and a multiplicative correction was applied to correct for magnetic field strength. These corrections were initially determined based on the mean of the reciprocal of the transverse momentum of muons from Z boson events, and then further corrected based on the Z-mass distribution. Following these corrections, there was good agreement between the forward-backward asymmetry in the data and reconstructed level. In addition, reference plots including phi in the Collins-Soper frame show good agreement between data and simulation. The angular-weighted forward backward asymmetry will allow an accurate measurement of the electroweak mixing angle in the future. The technique was published in A. Bodek, A. van Dyne, J. Y. Han, W. Sakumoto, A. Strelnikov, European Physical Journal C 2012, Volume 72, Number 10, 2194
This project was supported by NSF award PHY-1156339.

BUILDING A COMPUTER CLUSTER IN ORDER TO SIMULATE DARK MATTER INTERACTIONS IN PARALLEL

Colin Lauer and Christopher Wells
Department of Physics, Houghton College

A cluster of two Apple IMacs was built for the purpose of simulating Coulomb-like simulations between Dark Matter (DM) particles in an N-body simulation. Several test simulations were run in order to test the performance time of the cluster. The cosmological simulation code GADGET-2 was used to run the simulations and TORQUE Resource Manager was used to build the cluster. The cluster and software are not limited to DM simulations and could be used to simulate other exotic cosmologies.

SESSION IVC. CONDENSED MATTER AND SOLID STATE PHYSICS II

AN EVAPORATION DEPOSITION SYSTEM FOR THE IN-SITU STUDY OF THIN METAL FILMS

Joshua Mertzlufft and Brandon Hoffman
Department of Physics, Houghton College

With applications of thin films primarily in microelectronics and also emerging applications in the energy industry, it is desirable to have a greater understanding of the underlying characteristics of the films. This project is focused on the design and construction of an ultra-high vacuum physical vapor deposition system that may be used to produce graded thin films on substrates that have been cleaned by an interior ion-mill. The system will also enable researchers to study the effects of annealing in-situ using an associated Michelson-Morley interferometer. The sample heater's heat shield incorporates an infrared mirror to reflect radiant heat back to the sample while transmitting visible light from the interferometer.

THE DESIGN AND CONSTRUCTION OF AN INTERFEROMETER SYSTEM FOR THE STUDY OF THIN METAL FILMS

Tyler Reynolds and Brandon Hoffman
Department of Physics, Houghton College

A laser interferometer system is currently under development at Houghton College for thin metal film analysis. Films are produced by thermal evaporation under high vacuum. In order to measure the curvature of the films at elevated temperatures, the laser interferometer generates a topographical map of each film using a three-inch diameter collimated beam of light and several optics components. The interferometer will be attached directly underneath the deposition chamber, allowing for the films to be measured without breaking vacuum. Using the relationship between curvature and temperature, the stresses of the films can be calculated.

VACUUM DEPOSITION AND CHARACTERIZATION OF THIN INDIUM FILMS

Jeremy Mehta
SUNY Brockport

Thin indium films have been deposited on glass using vacuum vapor deposition. Pressure values and film thickness were monitored during the growth process. The deposition conditions can have an effect on the film's thickness and crystal size, which in turn affect the electrical properties of the film. Analyzing the relationships between the growth environment and the resulting characteristics of the films is important when studying the film's electrical properties. The resulting thin films were then analyzed using X-ray

diffraction and Hall Effect measurements to determine the crystallite size, film thickness, and mobility.

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LIST OF PARTICIPANTS

Name		Affiliation
Marissa Adams	Undergraduate Student	University of Rochester
Samuel Amber	Faculty	United States Military Academy, West Point
Pavel Aprelev	Undergraduate Student	Union College
Matthew Bellis	Faculty	Siena College
Danielle Berish	Undergraduate Student	Siena College
William J. Bock	Undergraduate Student	University of Rochester
Renee Bourgeois	Undergraduate Student	Siena College
Matthew Brunetti	Undergraduate Student	Colgate University
Carrie Burgess	Undergraduate Student	Colgate University
Grantley Bynum-Baim	Undergraduate Student	University of Rochester
Xinru (Flora) Cheng	Undergraduate Student	Colgate University
Nicholas Cothard	Undergraduate Student	University of Rochester
Sean Daigler	Undergraduate Student	Houghton College
Brian Degner	Undergraduate Student	University of Rochester
Tony Dimino	Undergraduate Student	University of Rochester
Alissa Earle	Undergraduate Student	Siena College

Name		**Affiliation**
Joseph Eberly	Faculty	University of Rochester
Nicholas Figueiredo Prestes	Undergraduate Student	Vassar College / Federal University of Parana (BR)
Victoria Finch	Undergraduate Student	Houghton College
Kyle Flemington	Undergraduate Student	Houghton College
Janet Fogg-Twichell	Staff	University of Rochester
Ryan Freeman	Undergraduate Student	Colgate University
Nicholas Fuller	Undergraduate Student	Houghton College
Christopher Godfrey	Undergraduate Student	Siena College
Siyang Guo	Undergraduate Student	Colgate University
Sheila Hanna	Undergraduate Student	Siena College
Meghan Harrington	Undergraduate Student	Siena College
Garrett Hartshaw	Undergraduate Student	Houghton College
Stephanie Hathaway	Undergraduate Student	SUNY Brockport
Peter Heuer	Undergraduate Student	University of Rochester
Brandon Hoffman	Faculty	Houghton College
Talal Hussain	Undergraduate Student	University of Rochester
H. Trevor Johnson-Steigelman	Faculty	SUNY Brockport

Name		**Affiliation**
Md. Tanveer Karim	Undergraduate Student	University of Rochester
Colleen Kelleher	Undergraduate Student	Siena College
Erini Lambrides	Undergraduate Student	University of Rochester
Colin Lauer	Undergraduate Student	Houghton College
Philippe Lewalle	Undergraduate Student	University of Rochester
Christina Loniewski	Staff	University of Rochester
Ian Love	Undergraduate Student	Houghton College
Keith Mann	Undergraduate Student	Houghton College
Amy McCann	Undergraduate Student	Siena College
Lindsay McTague	Undergraduate Student	Siena College
Joshua Mertzlufft	Undergraduate Student	Houghton College
Dilyana Mihaylova	Undergraduate Student	University of Rochester
Emily Morrow	Undergraduate Student	Houghton College
Sylvia Morrow	Undergraduate Student	Houghton College
John Moustakas	Faculty	Siena College
Jennifer Newcombe	Undergraduate Student	Houghton College
Ethan Ocock	Undergraduate Student	Houghton College

Name		**Affiliation**
Taylor Piccarreto	Undergraduate Student	SUNY Cortland
Tyler Reynolds	Undergraduate Student	Houghton College
David Richards	Undergraduate Student	Houghton College
Brett Rojec	Undergraduate Student	Colgate University
Adriana Saldan	Undergraduate Student	University of Rochester
Thaddeus Savery	Undergraduate Student	Siena College
William Schmidt	Undergraduate Student	United States Military Academy, West Point
Dillon Skeehan	Undergraduate Student	University of Rochester
Mark Spencer	Undergraduate Student	Houghton College
Rachel Stuart	Undergraduate Student	University of Rochester
Mark Sullivan	Undergraduate Student	Union College
Pooja Suresh	Undergraduate Student	University of Rochester
Stephanie Swartz	Undergraduate Student	University of Rochester
Mohammed Tahar	Faculty	SUNY Brockport
Aaron van Dyne	Undergraduate Student	Roberts Wesleyan College
Justin Verde	Undergraduate Student	United States Military Academy, West Point
Justin Vonsik	Undergraduate Student	United States Military Academy, West Point

Name		**Affiliation**
Frank Wolfs	Faculty	University of Rochester
Mark Yuly	Faculty	Houghton College
Dale Zych	Faculty	SUNY Oswego

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