Annual

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

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

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
Alarie, Alicia	10:15 AM	LOBBY
Barenfeld, Scott	10:15 AM	LOBBY
Beyer, Jacob	8:45 AM	RB 202
Birrittella, Richard	1:45 PM	RB 238
Breindel, Alexander	8:45 AM	RB 226
Carranza, Raul	2:00 PM	RB 238
Degner, Brian	11:00 AM	RB 202
Dunn, Alex	2:45 PM	RB 238
Evans, Andrew	10:15 AM	LOBBY
Farbman, Karen	10:15 AM	LOBBY
Fuller, Nicholas	10:15 AM	LOBBY
Gardner, John	1:45 PM	RB 226
Gilchrest, Ian	11:00 AM	RB 238
Grossman, Kevin	1:45 PM	

NAME	TIME	LOCATION
Kuhl, Alexandria	11:30 AM	RB 238
Lankevich, Vladimir	9:00 AM	RB 226
Larkin, LeighAnn	11:15 AM	RB 202
Lasker, Eric	9:15 AM	RB 226

NAME	TIME	LOCATION
Schultz, Charles	2:15 PM	RB 226
Sise, Anna		

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

PROGRAM

8:00 AM – 8:30 AM: REGISTRATION AND POSTER SETUP (RB

8:45 AM – 10:15 AM: SESSION IB. BIOPHYSICS (RB 226)

SESSION CHAIR: PROF. STANLEY RADFORD (SUNY BROCKPORT)

8:45 Hole Transport in DNA
Alex Breindel, University of Rochester

9:00 New Simplified Model Designed to Investigate Anisotropic Coulomb Interactions between Charged Proteins: Validation by Comparison of the Electrostatic Potentials
Vladimir Lankevich, University of Rochester

9:15

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10:15 AM – 11:00 AM: SESSION II. POSTER SESSION (LOBBY RB)

Real Time-3D Sound Spatialization
Alicia Alarie, University of Rochester

11:00 AM – 11:45 AM: SESSION IIIA. HIGH-ENERGY AND NUCLEAR PHYSICS (RB 202)

SESSION CHAIR: PROF. JOHN CUMMINGS, SIENA COLLEGE

11:00 Optimizing Efficiency of the LUX Trigger System
Brian Degner, University of Rochester

11:15 Spin-dependent Forces in Heavy Quarkonia
LeighAnn Larkin, SUNY Brockport

11:30 Resistuino: An ultra pure water-monitoring device for the Daya Bay Core Neutrino Experiment
Kyle Turck, Siena College

11:00 AM – 12:00 PM: SESSION IIIB. CONDENSED MATTER PHYSICS (RB 226)

SESSION CHAIR: PROF. MOHAMMED TAHAR, SUNY BROCKPORT

11:00 Method for Building a Mutual Inductance Bridge for the Purpose Measuring Magnetic Susceptibilities
Chris Knupp, SUNY Brockport

11:15 Experimental Investigation of Silicon Powders using X-Ray Diffraction
Jordan Metz McLeod, SUNY Brockport

11:30 The Orientation Dependence of NBTI Degradation in pMOS FinFETs
James Pater, Siena College

11:45 Production and Characterization of Electrospun Nanofibers
Anna Sise, Union College

11:00 AM – 12:00 PM: SESSION IIIC. EXPERIMENTAL TECHNIQUES (RB 238)

SESSION CHAIR: PROF. MARK YULY (HOUGHTON COLLEGE)

11:00 Delay Line Detection
Ian Gilchrest, Siena College

11:15 Reducing Dose While Maintaining Image Quality for Cone Beam Computed Tomography
Peter Kroening, Houghton College

11:30 Physical Concepts of Ground Penetrating Radar
Alexandria Kuhl, SUNY Brockport

11:45 Multi-plate Chamber Construction and Operation
Jonathan Slye, Houghton College

12:00 PM: LUNCH (WEST ROOM, SIENA DINING FACILITY)

12:45 PM: "NEUTRINO PHYSICS EXPERIMENTS: IT'S BEEN AN EXCITING YEAR!", PROF. J. NAPOLITANO, RENSSELAER POLYTECHNIC INSTITUTE (RB 202)

1:45 PM – 2:30 PM: SESSION IVA. ASTRONOMY II (RB 202)

SESSION CHAIR: PROF. BRANDON HOFFMAN (HOUGHTON COLLEGE)

1:45 Photometric Capabilities of the SUNY Brockport Observatory
Kevin Grossman, SUNY Brockport

2:00 Classifying Planetary Spectra and the Search for an Earth Analog Using Artificial Neural Networks
Nathan Levine, Siena College

2:15 Herschel spectroscopy of protostars in Orion: Far-infrared CO emissions
Vincent Yu

SESSION IA. ASTRONOMY I

INTERGALACTIC MGII ABSORBERS IN THE SLOAN DIGITAL SKY SURVEY

Jacob Beyer and Eric Monier
SUNY Brockport

Absorption lines observed in quasar spectra allow us to study the evolution of gas and galaxies in a way that is independent of imaging techniques. In this submission, I describe my work on a catalog of absorption lines due to singly ionized magnesium (MgII) atoms, seen in quasar spectra. Magnesium is produced during nucleosynthesis in massive stars, and enriches the gas of a galaxy when it is ejected in supernova explosions. MgII is an in

RR LYRAE STARS IN THE GLOBULAR STAR CLUSTER IC 4499

Ana Mikler, Andrea Kunder, and Francis Wilkin
Union College and Cerro Tololo Interamerican Observatory, Chile

Observations of the globular cluster IC4499 were taken with the 1-m telescope at Cerro Tololo. These observations were combined with archival data to study the variable star population with CCD photometry. Using U,B,V,R,I passbands, the magnitudes and pulsation period have been measured for all 97 RR Lyrae stars in the cluster. Using these periods, we have also constructed light curves in all passbands available. We also compared the obtained magnitudes of the RR Lyrae stars with those reported by Walker[1]. The distribution of stars on the horizontal branch is compared with estimates from theoretical models and used to determine color limits to the intersection of the instability strip and the horizontal branch.

[1] Walker, A., 1996, Astron. J 112, 2026

DERIVING THE AGES OF THE OLDEST WHITE DWARFS: A BAYESIAN ANALYSIS

Erin O'Malley, T. von Hippel, and R. Finn
Siena College and Embry-Riddle Aeronautical University

We present a Bayesian analysis of 130 SDSS cool white dwarfs with optical and infrared photometry, a subset of which also has trigonometric parallax measurements. Instead of a step-wise progression of fitting a temperature, mass, and age for each star (as is done in

two-temperature analysis has shown that the inner region of the disk is comprised predominantly of small-

SESSION IB. BIOPHYSICS

HOLE TRANSPORT IN DNA

Alexander Breindel
University of Rochester

Hole transport in DNA is important because a moving hole can affect the chemical behavior of the DNA. It also been recognized as having the potential to allow creation of very small biologically based electronic devices, but the rate of hole transport is too low for useful devices. Recent research has found, however, that replacing adenine with 7-deazaadenine increases the hole-hopping rate significantly. My research has been aimed at finding out why this rate increase occurs and what mechanisms determine the hopping rate in DNA. I worked on preparing a computer model of 7-

is non-repulsive, despite the high positive charge on the molecules. Typical docking configurations barely involve protonation or deprotonation of surface residues. The obtained PMF between folded lysozyme molecules is consistent with the location of the liquid-liquid coexistence, but produces dimers that are too short-lived for clusters to exist, suggesting lysozyme undergoes conformational changes during cluster formation.

EFFICIENCY OF SYNCHRONIZATION OF ENTORHINAL CORTEX LAYER II STELLATE CELLS

Eric Lasker
Colgate University

It is generally accepted that synchrony in various regions of the mammalian central nervous system is important. The metabolic energy demands on a system that is attempting to synchronize stands as a gap in experimental data. Using realistic models of networks of entorhinal cortex layer II stellate cells, this study examines the dependence of energy consumption and synchronization time on various parameter ranges of network attributes including: network topologies, coupling strengths and homogeneity, noise and oscillation frequencies. Similar parameter sweeps were performed in order to create phase response curves for locations of interest. By looking at the problem of synchronization through these two lenses we hope to discover robust local extrema in our data in either or both energy and time demands of our system.

PH DEPENDENCE OF BOVINE !B CRYSTALLIN VIRIAL COEFFICIENT

Kaho Long
Rochester Institute of Technology

Recent work has shown that interactions between !-crystallin proteins located in the eye can contribute to the formation of cataracts. Of the techniques available one of the most useful for measuring the interactions is the second virial coefficient, B2, where the virial coefficients quantify the low concentration deviations from ideal solution thermodynamics. To measure the virial coefficient of the !B-crystallin proteins static light scattering was used. From the light scattering measurements the value of the molecular weight was determined to be (22659±1220) (mean ± std. dev.) grams/mole, which does agrees within twice the standard deviation to the sequenced value of 20992.7 grams/mole for single !B-crystallin proteins. The dimensionless second virial coefficient, B2, at a pH of 4.4 was measured to be (8.11±0.99) which is greater than that predicted from the model of hard spheres and hard sphere dimers suggesting a more repulsive interaction as expected at this pH from prior work in this lab.

ADDING COUPLING TO THE JOSEPHSON JUNCTION NEURON MODEL

Maximilian Miller
Colgate University

We consider an analog model of a single neuron made of superconducting circuits utilizing Josephson Junctions. This model is unlike other current models because it is not a computer simulation, but rather a parallel analog model; because of this, it is orders of magnitude faster than computer models. However, it would be useful and realistic to extend this model to systems of several neurons, and eventually, a neural network analogous to a human brain. Using the known equations of motion, we are currently performing simulations of multiple coupled neurons, each with a long axon chain.

SESSION II. POSTER SESSION

A POSSIBLE $^{12}C(n,2n)^{11}C$ TOTAL CROSS SECTION MEASUREMENT

Andrew Evans, Keith Mann, and Mark Yuly
Houghton College

Tertiary neutron production can be used as an indicator of the burn fraction of a deuterium-tritium pellet in inertial confinement fusion reactions. One way to monitor tertiary neutrons is by carbon activation using the $^{12}C(n,2n)^{11}C$ reaction, which has a threshold of 20.3 MeV and so is insensitive to primary neutrons produced in the DT reaction. However, the cross section for this reaction is not well known. Several different experimental techniques for measuring $^{12}C(n,2n)$ have been exa4.5 (e) 0]4o Q q 0.25 p0.2 (e)0.cactquewi

COHERENT BEAM STIMULATED PARAMETRIC DOWN CONVERSION IN QUANTUM INTERFEROMETRY

Anna Gura, Richard Birrittella, and Christopher C. Gerry
Lehman College

A few years ago, Kolkiran and Agarwal (Optics Express 16, 6479, (2008)) studied the prospect of using the light generated via coherent beam stimulated parametric down-conversion for performing ultra-sensitive phase-shift measurements in quantum optical interferometry. The detection scheme they proposed was to perform coincident photon counts on the two output beams of the interferometer. However, it has been shown that another detection scheme, that being the measurement of photon number parity on just one of the output beams can serve as a universal technique to improve interferometric measurements for almost all conceivable input quantum states. In this work, we investigate the application of that technique for the states generated by coherent beam stimulated parametric down-conversion. We study the phase conditions and joint photon number distributions necessary to approach the highest level of sensitivity allowed by quantum mechanics, the so-called Heisenberg limit.

CAPTURE OF IRREGULAR SATTELITES VIA BINARY PLANETESIMAL EXCHANGE REACTIONS IN MIGRATING PLANETARY SYSTEMS

Imran Hasan, Alex Moore,

in sample galaxies are compared as a function of cold gas content, galaxy type, and position in the group and compared to those of galaxies located in other environments. We find that galaxies in the NGC 5846 group have lower mean star formation rates and gas content compared to isolated galaxies. Truncated star formation similar to that of galaxies in the Virgo cluster is seen in several NGC 5846 galaxi

SESSION IIIA. HIGH-ENERGY AND NUCLEAR PHYSICS

OPTIMIZING EFFICIENCY OF THE LUX TRIGGER SYSTEM

Brian Degner, Eryk Druszkiewicz, Mongkol Moongweluwan, and Frank L. H. Wolfs
University of Rochester

In the construction of the Large Underground Xenon (LUX) detector, the Rochester group has developed a trigger system that selects the events for the data acquisition system to record. For WIMP studies, the goal of this trigger system is to accept all WIMP candidate events inside the fiducial volume with the correct S1 and S2 signatures and reject all events outside the fiducial volume. The efficiency of the trigger is limited by the number of trigger channels that are available (16) for the 122 LUX PMTs. This requires that the signals from 7 or 8 PMTs are summed and the sum signal is sent to the trigger system. Using a computer model of the trigger system and simulated S2 events, we determine how different variables affect the S2 trigger efficiency. For example, we determine how changing the lower threshold for the input signals from both the PMTs inside and outside the fiducial volume affects the efficiency. We also investigate how the PMT summing configuration affects the S2 trigger efficiency and determine the optimum summing configuration.

SPIN-DEPENDENT FORCES IN HEAVY QUARKONIA

LeighAnn Larkin
SUNY Brockport

A quarkonium, a bound state of a quark and an anti-quark, can provide insight into the interaction of quarks and the structure of nuclear matter. Heavy quarkonium can be modeled straightforwardly using a combination of variational and perturbative techniques. Using a FORTRAN code, which computes energy levels of the b-anti-b quarkonium system, I have investigated spin-dependent interactions occurring between the quark and the anti-quark, and how these forces affect the energy spectrum.

RESISTUINO: AN ULTRA PURE WATER-MONITORING DEVICE FOR THE DAYA BAY CORE NEUTRINO EXPERIMENT

Kyle Turck and Dr. John Cummings
Siena College

Resistuino is a custom resistivity and temperature monitor system. This system uses an Arduino Mega board in conjunction with an Arduino Ethernet Shield and a circuit board designed by Kyle Turck with assistance from Joe Kujawski and Dr. John Cummings at Siena College. This device will be used to monitor the ultra pure water in the muon veto detectors of the Daya Bay Core Neutrino Experiment in Daya Bay, China. We chose to design and build a custom monitoring system to help reduce the budget of the

experiment. A similar commercially produced system would about $75,000, Resistuino will cost between $2,500 - $5,000 to produce, with an accuracy of 10%.

SESSION IIIC. EXPERIMENTAL TECHNIQUES

DELAY LINE DETECTION

Dr. Allan Weatherwax, Joseph Kujawski, Robert Carroll, Steven Atkinson, Shane McMahon, and Ian Gilchrest
Siena College

The Goddard Thermal Electron Capped Hemisphere Spectrometer (G-TECHS) is an instrument concept intended for sounding rocket applications. Siena College is working on a novel method of processing information from electron spectrometer receiver anodes using delay line techniques and inexpensive COTS electronics.

Electron spectrometers use a variety of techniques to determine where the amplified electron cloud falls onto a collecting surface. One traditional method divides the collecting surface into sectors and uses a single detector for each sector. However, as the angular and spatial resolution increases, so do o do i(i(i(i 0.) -.2 (i) -38.1pp0 0 Tm /T5.6(o0.2 (ngul) 0.2

PHYSICAL CONCEPTS OF GROUND PENETRATING RADAR

Alexandria Kuhl
The College at Brockport, SUNY

This research is to study the physics behind ground-penetrating radar (GPR) for better understanding and interpretations of GPR imaging. GPR is a surveying tool that can

SESSION IVA. ASTRONOMY II

PHOTOMETRIC CAPABILITIES OF THE SUNY BROCKPORT OBSERVATORY

Kevin Grossman and Eric Monier
SUNY Brockport

The Observatory at the College at Brockport contains a fixed 10” Meade telescope and a CCD camera for capturing images. In this contribution, I describe my efforts to characterize the photometric accuracy that can be achieved at the campus site. Photometry is the measurement of the apparent brightness of astronomical objects. Precise measurements of stars are necessary, for example, if the goal is to measure brightness variations over time. While some stars vary naturally, others are “eclipsed” by

HERSCHEL SPECTROSCOPY OF PROTOSTARS IN ORION: FAR-INFRARED CO EMISSIONS

Vincent Yu, Manoj Puravankara, and Dan Watson
University of Rochester

Infrared spectroscopy is a powerful tool to probe the excitation conditions and chemical compositions of warm (~300 K) and hot (~1000 K) gas in the vicinity of protostars. We obtained 57-190 #m spectra of 32 protostars in the Orion Molecular Cloud Complex as part of the Herschel Orion Protostar Survey. These protostars span a large range of luminosities (1-300 solar luminosities) and display different line emission profiles. We modeled and analyzed the CO rotational emission lines seen in the far-infrared spectra to constrain the density and temperature of the emitting gas. We searched for correlations between these physical conditions of the gas and protostellar properties such as the bolometric luminosity and temperature. We will present the results of this study and discuss the implications for our understanding of the early stages of star formation.

SESSION IVB. EXPERIMENTAL AND TEACHING TECHNIQUES

THE MONOCHROMATOR

John Gardner
SUNY Brockport

The goal of this project is to refurbish an old Monochromator and optimize it for use in future labs. The device was tested to ensure basic functionality and to determine the best way to approach the project. A detection circuit was built to allow data from the device to be collected by a computer. This was done using a photodiode to detect changes in light and an operational amplifier to boost the signal. LabView software was used to interpret the data sent to the computer and create an output file that could be easily understood. The data collected during tests was then analyzed in order to establish the limitations of the device and its possible uses in future labs. These tests included viewing the light spectra of various gases such as Sodium, Hydrogen and Deuterium. A lab manual containing directions and lab experiments was written to assist future students.

FINDING CONNECTIONS: REGENTS VS AP IN THE COLLEGE CLASSROOM

Stephanie Kinney, Dr. Rose Finn, and Dr. Michele McColgan
Siena College

Faculty in the Siena College Department of Physics and Astronomy have been administering the Force Concept Inventory (FCI) test to General Physics classes for the past several years. It is used to determine the Hake scores (actual gain/ potential gain) for every student that enters and leaves the classroom. As part of the assessment, the students

SESSION IVC. QUANTUM OPTICS

PAIR-COHERENT STATES AND QUANTUM OPTICAL INTERFEROMETRY
Richard Birrittella, Christopher C. Gerry, and Jihane Mimih
Lehman College

Quantum optical interferometry can approach the ultimate limit of sensitivity in phase-

QUANTUM RANDOM WALKS IN PHOTONIC WAVEGUIDE LATTICES

Christopher Mullarkey[1], Dr. Stefan Preble[2], Dr. Andrew Robinson[1], and Dr. Edwin Hach[1]
[1] Department of Physics, Rochester Institute of Technology
[2] Department of Microelectronic Engineering, Rochester Institute of Technology

The ability to describe the evolution of quantum states of light is key to designing devices that exploit quantum entanglement as a part of their operation. Here the formal Bloch-wave solution to an arbitrary photon field state evolving in a waveguide lattice is presented. A program that integrates the Schrödinger Equation via the Taylor Method is described that allows for the evolution of an arbitrary superposition state to be simulated in this system. Whereas the single photon case mimics the trajectory of a classical field state, a result verified by simulations using the Beam Propagation Method, any higher number of photons can give rise to quantum interference and is properly described as a quantum random walk. Though in general the final state is in a very complicated superposition, it will also be shown that desirable quantum behavior, such as Hong-Ou-Mandel interference, appears in this continuous system.

GENERATING A FOUR QUBIT LINEAR CLUSTER STATE

out Bell Inequality measurements and observed $S=2.412 \pm 0.113$. This is a clear violation of the Bell Inequality by over 3 standard deviations, disproving local Hidden Variable Theories (HVT's). We also demonstrated that a quantum mechanical state yields a classical result in interferometry. Using a light beam attenuated down to the single photon level, the interference pattern was measured to emulate that of a classical diffraction pattern.

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LIST OF PARTICIPANTS

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