Saturday Evening Poster Session

Presenter: Banerjee, Joy; Coe College
Poster Session: Saturday Evening
Title: A Solution Approach to High Alkali Content Borate Glasses
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Abstract: The glass forming range of alkali borates has been extended to R=5.0 (83 molar percent alkali oxide) using the solution method devised by Prof. Masao Kodama from Sojo University, Japan. This method entails the reaction between boric acid (H_3BO_3) and the alkali hydroxide, and the subsequent drying of the mixed solution in a drying oven till a precipitate is left. This precipitate is then melted and quenched to form glass. The densities and glass transition temperatures (T_g) were determined after the glass was made. We also performed other physical structure analysis such as Raman spectroscopy and Nuclear Magnetic Resonance. The structures of high alkali content borate glasses are currently being studied. We have obtained results for the entire alkali borate system including lithium, sodium, potassium, rubidium and cesium.

Presenter: Bustamante, Jennifer; Marquette University
Poster Session: Saturday Evening
Title: Transit: Search: The Hunt for Extrasolar Planets—A Study in Differential Photometry
Abstract: Multiple stars with orbiting planets were studied using differential photometry. The goal was to detect a periodic dimming of light that would confirm a transiting planet. Most of the data showed negative results. However, HD187123 showed a peculiar light curve on the night of June 29, 2004. Because a statistical analysis of this light curve did not match the light curve predicted by transitsearch.org, and there is a single anomalous data point, further observations are recommended. Thus far, the June 29th results have not been repeated, and the data of HD187123 remains inconclusive.

Presenter: Campbell, Sara; Coe College
Poster Session: Saturday Evening
Title: Physics Is Fun Night at Coe College: A Fantastic Event
Abstract: In December 2003 Coe College hosted its first annual Physics is Fun Night. With about 20 demonstrations geared towards kids in grades K–6, our outreach night was a huge success. The Coe Physics Club invited the tri-county community to come and invade our physics floor in the basement of Peterson Hall. Over 400 kids and parents showed up to learn about the wondrous world of physics. This presentation will include what worked and what didn t and our plans for a larger and much improved science night. For example, we are planning a new collaboration between Chemistry Club and Physics Club. Also, new demos have been obtained that are specifically geared towards elementary aged kids. The event was a great benefit to both Coe physics students and the Cedar Rapids area community.

Presenter: Cummings, Julian; Caltech
Poster Session: Saturday Evening
Title: Simulations of Dynamic Material Response to Strong Shocks using the Virtual Test Facility
Abstract: The Center for Simulating Dynamic Response of Materials at the California Institute of Technology is constructing a virtual shock physics facility for studying the response of various target materials to very strong shocks. The Virtual Test Facility (VTF) is an end-to-end, fully three-dimensional simulation of the detonation of high explosives, shock wave propagation, solid material response to pressure loading, and compressible turbulence. The VTF largely consists of a framework for parallel fluid solvers using Adaptive Mesh Refinement (AMR) techniques, a parallel solid mechanics package, a parallel shell element solver with algorithms to handle shell contact and fragmentation, and a set of numerical algorithms and communication schemes for coupling the fluid and solid/shell solvers together. In this presentation, we outline the basic goals of this multi-physics simulation effort, describe some of the high-performance computing techniques required to integrate such simulation codes, and highlight a few sample applications of the Virtual Test Facility.

Presenter: Foster, Margaret; *Physical Review* Editoral
Poster Session: Saturday Evening
Title: Biological Physics in *The Physical Review*
Abstract: The *Physical Review*, a professional journal for new results in physics,is published by the American Physical Society. Biological Physics is currently one of the fastest growing sections in *Physical Review E*. In 2003, there were approximately 400 submissions, an increase of about 10 percent over the previous year. Papers were submitted in a variety of fields: general theory and mathematical aspects, biomolecules, subcellular and cellular structure and processes, multicellular phenomena, properties of higher organisms, ecology and evolution. Manuscripts are considered without regard to national boundaries, and authors and referees come

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from the international community. Those of us who are editors feel strongly that our job is to provide a service to the scientific community. In a number of ways, we have tried to make *Physical Review* a home also for biologically inspired physics papers. For several years, papers in *Physical Review E* and *Physical Review Letters* have been indexed in *MEDLINE*. Since 2001, Part I of *Physical Review E* has been devoted to Soft Matter and Biological Physics. In a further attempt to serve the community, a survey of the members of the APS Division of Biological Physics was conducted in June of 2003. We will present information about the geographic distribution of authors and referees, the review process for the journal, and results from the survey. We welcome your comments.

PRESENTER: France, Jeffrey; Rhodes College
POSTER SESSION: Saturday Evening
TITLE: Empirical Model of High-Latitude Magnetosphere-Ionosphere Energy Transfer Based on Satellite Data
ABSTRACT: At high latitudes there is strong coupling between the magnetosphere and the ionosphere. The interplanetary magnetic field (IMF) and the solar wind generate electric fields that result in the transfer of energy. Charged particles moving along geomagnetic field lines also lead to coupling as they pass through the upper atmosphere at high latitudes. This coupling produces a large amount of Joule heating. Since Joule heating is proportional to the transfer of electromagnetic radiation, the Poynting flux can be used to determine the energy flux. Based on the IMF magnitude and orientation, dipole tilt, magnetic local time, and latitude, we have created an empirical model, using data taken from the Dynamics Explorer 2 satellite, to predict the Poynting flux at high latitudes. The model will be used in a general circulation model for high latitudes.

PRESENTER: Gregg, Allison; University of Louisville; Invited, SPS Intern
POSTER SESSION: Friday and Saturday Evenings
TITLE: 2004 Analysis of ComPADRE Resources
ABSTRACT: ComPADRE is a web-based network of collections designed for faculty and students to find and share physics and astronomy teaching and learning resources. In the summer of 2004, an analysis was conducted to examine the content and structure of the ComPADRE resource database. The classification of materials by topic, grade level, and usage was studied. Our findings include large amounts of resources within general categories and few resources in others. The specific findings and recommendations for balance are discussed.

PRESENTER: Hein, Warren; American Association of Physics Teachers (AAPT)
POSTER SESSION: Saturday Evening
TITLE: Communities for Physics and Astronomy Digital Resources for Education (ComPADRE)
ABSTRACT: ComPADRE is a joint project of the American Association of Physics Teachers (AAPT), American Astronomical Society (AAS), American Physical Society (APS), and the American Institute of Physics/Society of Physics Students (AIP/SPS) funded through the National Science Foundation's National Science Digital Library (NSDL) initiative. The goal of ComPADRE is to make high quality digital resources available for the physics education community and provide a mechanism for developers of digital resources to make them available to the physics education community. The AIP/SPS component of the project is a website designed specifically for the use of undergraduate physics and astronomy students.

PRESENTER: Hemesath, Eric
POSTER SESSION: Saturday Evening
TITLE: Novel Techniques for Rapid and Versatile Prototyping
ABSTRACT: Rapid prototyping techniques were investigated to create hydrophobic polymer surfaces with lateral structure dimensions in the sub-100 micrometer length scale. This was attempted using a laser printer, polyethylene terephthalate (PET) films as a medium, and various chemical surface modification techniques which include: O_2 plasma treatment, selective dissolution, silanization chemistry with distinct silanes, electroless metal deposition, and ion etching. A Hewlett Packard (HP) 2100TN laser jet printer, pushed to the limit of its resolution (1200 dpi), was employed to create an array of printed dots as a mask for selective modification of the PET transparency surface topography. Several approaches were investigated, and the most precise patterns were generated through direct printer manipulation using HP s Printer Command Language (PCL) which resulted in ink-dots 80 m in diameter. Surface attached perfluorodecyltrichlorosilane (FAS) groups provided very hydrophobic surfaces, with static contact angles approximately 130 ± 5. Electroless copper deposition and ion etching techniques are currently being studied to facilitate the formation of rough surfaces, which may add to the dewetting properties of the PET film.

PRESENTER: Janeski, John; Rhodes College
POSTER SESSION: Saturday Evening
TITLE: Novel ultrasonic backscatter techniques for assessing bone density
ABSTRACT: There is increasing interest in developing ultrasonic backscatter techniques for detecting changes in bone density caused by diseases like osteoporosis. Objective: To measure two ultrasonic backscatter parameters, apparent integrated backscatter (AIB) and the frequency slope of backscatter (FSAB) using a broadband 7.5 MHz system. AIB represents the frequency averaged power in the backscattered signal and FSAB represents the slope of the frequency dependence of this power. Methods: Cubes of cancerous (i.e., spongy) bone with side lengths of 15 mm were prepared from the heads of 10 human femurs (seven donors). Data were col-

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lected by mechanically scanning the ultrasonic transducer over each bone specimen and acquiring the backscattered signals. These were post-processed to obtain a single value of AIB or FSAB for each specimen. In addition, the mass density of each specimen was measured by allowing the specimen to air dray for 24 hours and then dividing the mass of the specimen by its volume. Results: AIB and FSAB both demonstrated highly significant linear correlations with density, $p < 0.001$ and $p < 0.001$, respectively. Conclusion: AIB and FSAB are sensitive to changes in bone density, and may provide a useful new clinical technique for detecting and monitoring osteoporosis.

Presenter: Lanctot, Matthew; University of North Carolina–Greensboro
Poster Session: Saturday Evening
Title: Dynamics of an excitable electric circuit
Abstract: An excitable system is characterized by a threshold above which positive feedback occurs, followed by a recovery and refractory phase during which the system returns to its sub-threshold (resting) state. Mathematical realizations of excitable systems include nonlinear systems of differential equations such as the relatively simple FitzHugh-Nagumo model and the more complicated Hodgkin-Huxley model for nerve signals. Our goal is to produce an excitable electric circuit that is versatile, predictable, easy to control, and relatively simple. We present results from a circuit that includes features similar to those found in the voltage-gated ion channels responsible for nerve signals. Such circuits are useful physical realizations of excitable systems. This research was supported by an award from Research Corporation and by a URA from UNCG.

Presenter: McMullin, Riley; Carthage College
Poster Session: Saturday Evening
Title: Spatial and Brightness Properties of Galaxies in SDSS
Abstract: Data obtained from the second release (DR2) of the Sloan Digital Sky Survey (SDSS) was used to analyze and map galaxies. Structured Query Language (SQL) was used to interrogate the database. Galaxies were classified by their absolute I-band magnitude and three-dimensional maps were constructed. The three-dimensional large-scale structure of bright and faint galaxies was examined in great detail. It was found that the overall clustering does not depend on absolute magnitude. The voids and sheets remain similar in size regardless of brightness. The voids are between 50 to 70 Mpc in size, and the sheets of galaxies between 100 to 150 Mpc in size, assuming a value of 70 km/s/Mpc for the Hubble constant. The number density of sampled galaxies, with absolute I-band magnitude between -24 and -17, is found to be 0.004 galaxies per Mpc3. By measuring the redshift-space distortion (Finger of God effect) in galaxy clusters, the typical velocity of galaxies in a cluster is found to be 1400 km/s. Assuming that this velocity is the result of acceleration in the gravitational potential well of the cluster, its mass is estimated to be 7×10^{14} solar masses.

Presenter: Meagher, Kevin; California State University–Chico
Poster Session: Saturday Evening
Title: Magnetic Insensitive Muon Detection
Abstract: Cosmogenic muons are a challenging and ever-present source of backgrounds for experiments involving particle detectors. In particular, in the next generation of beta-decay experiments to be performed with neutrons, the cosmogenic muons are the dominant contributor to backgrounds. For these neutron experiments, and for the UCNA experiment in particular, muon vetos that operate in magnetic fields on the order of 1 Tesla are required. A muon detector constructed by coupling optical fiber to a scintillator and detecting the light pulses with photomultiplier tubes or avalanche photodiodes is described. The fiber coupling and particular choices of photon detectors permits avoids the necessity for long, bulky light guides and makes them appropriate for a variety of experimental geometries.

Presenter: Olesiak, Martin; Coe College
Poster Session: Saturday Evening
Title: Physical Properties of Select Ternary Borovanadate Systems
Abstract: Over the period 2002-2004 I studied the physical properties of alkali and heavy metal oxide borovanadate glasses. The specific glass families studied included lithium sodium, potassium, and lead borovanadates. The data collected were the density and glass transition temperatures of many compositions within each glass family. The glasses were studied as functions of R, the molar ratio of the modifying metal oxide to boron oxide while keeping K, the molar ratio of vanadium pentoxide to boron oxide, fixed. I will discuss the resulting trends and try to explain their causes in terms of atomic level structural modifications. Also, I will describe our methods for making and testing the glasses.

Presenter: Quan, Alice; Middle Tennessee State University
Poster Session: Saturday Evening
Title: Building Primitives for the Model-Based System Engineering Design (MBED) Task
Abstract: At NASA's Jet Propulsion Laboratory, the Mission and Systems Architecture Section is developing new ideas and designs for space missions to explore the solar system. However, only a few options are considered in the early design for a space mission. The Model-Based System Engineering Design Task is developing tools to help evaluate more options initially before a

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design is selected, so as to increase the quality of our space missions. My objective was to help in the development, coding, and validation of a several primitive functions, the Radiation Dose Primitive, the Solar Surface Environment Primitive, and the Orbital Primitive. These models will help users rapidly and quantitatively evaluate different design options so that the best designs can be selected for further study.

Presenter: Rizzo, Benjamin; Marquette University
Poster Session: Saturday Evening
Title: Gamma Spectrum of a Sample of "Trinitite"
Abstract: After the test of the first atom bomb in 1945, a sample of trinitite, sand fused with the remainder of instrumentation, was collected from the crater at the Trinity site. The sample has decayed undisturbed for nearly fifty years. Using a sodium-iodine gamma energy counting system, the sample's energy spectrum was used to identify the sources of gamma radiation still present within the material almost 50 years after the test. From the remaining gamma activity, the gamma activity produced by the original test was determined and compared to existing data.

Presenter: Robinson, Paul; Principia College
Poster Session: Saturday Evening
Title: Computer Simulation of Solid State Atomic Oscillations
Abstract: Atomic nuclei were modeled as a one-dimensional chain of oscillators using Mathematica 5. Two different simulations were performed; one using a spring constant and the other the six-twelve law to govern the interactions between the oscillators. In the spring constant simulation as energy increased the amplitude of the oscillations around an initial chain length increased, but the average length of the chain remained constant. In the six-twelve law simulation, the average length of the entire chain adjusted to a new energy dependent equilibrium length. The six-twelve law was determined to be a better model for atomic oscillations than a spring constant in our simulations. The expansion and contraction of solids based upon their current energy state is a more accurate representation of nature.

Presenter: Sears, Stephanie; Eastern Michigan University
Poster Session: Saturday Evening
Title: Designing an Optical Probe for Laser Induced Fluorescence Observations In Plasma
Abstract: Understanding how ions move in a plasma is crucial to understanding over-all plasma behavior and properties. Observing ion movement (and by extension, ion velocity and temperature, as well as density) in a non-perturbative manner is necessary in order to obtain reliable results. Because the plasma is large, spatial resolution of the LIF signal is best achieved with a fiber optics probe. Two optical probes, one of which worked and one of which did not, were built and tested inside the plasma to see if LIF observation and diagnostics over a very small area was possible.

Presenter: Shores, Andrew; Rhodes College
Poster Session: Saturday Evening
Title: An Analytical and Numerical Approach to Predicting the Effects of Plastic Implants on Magnetically Induced Currents in the Body
Abstract: Magnetic Resonance Imaging (MRI) is one of the leading medical imaging techniques in use today. MRI machines use rapidly switched gradient magnetic fields to localize the NMR signals to produce an image. Time varying magnetic fields such as these induce electrical currents in the body that can cause cardiac and/or nerve stimulation. MRI-induced currents have been the subject of a number of recent studies, but the effects of plastic medical implants in the body on these currents are not well understood. In this study, we used an in vitro system to simulate the effects of implanted materials on magnetically induced currents in the body. The system consisted of Helmholtz coils used to simulate the time varying magnetic field, and a 15 cm circular dish of 0.85% sodium chloride to simulate the electrical conductivity of human tissue. A custom dipole electric field probe was used to measure the current density at any point in the sodium chloride. Measurements from throughout the dish were taken with and without plastic inclusions of varying geometries placed in the sodium chloride solution. These measurements were compared to analytical predictions based on Faraday s law and Coulomb's Law, and numerical predictions obtained using a commercial finite element analysis package (Maxwell 2D, Ansoft, Inc.). With no inclusions in the dish, the mean percent errors between measured current density and the predictions ranged from 7% to 10%. With an 8 cm half-disk of plastic placed in the dish, the mean percent errors between the measured current density values and the predictions ranged from 4.75% to 6%.

Presenter: Sinclair, Paul; Rhodes College
Poster Session: Saturday Evening
Title: Solving Tough Integrals using the Monte Carlo Technique
Abstract: Research into the condensation of ionic systems requires calculating a six dimensional integral that relates the number of free ions to the number of neutral molecules. Regular methods of integration, such as using the software Mathematica prove inadequate. Instead we use Monte Carlo Integration that uses random sampling of the integrand to estimate its average. Multiplying by the limits of integration for each variable then yields an estimate of the integral with accuracy that depends on the number of sam-

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pled points. The process is easily expanded to multiple dimensions and gains in accuracy over other methods (for the same computation time) as the number of dimensions increase. The error is estimated by looking at the variation in the final answer for different trials. We wrote a C++ program to evaluate our integral. To generate random numbers for sampling we used a random number generator called the Mersenne Twister. Due to the severely spiked nature of the integrand, we developed weighting methods for each variable to get a better sampling of the spikes and thus reduce sampling errors. Running the final program for 125,000,000 sampled points and 100 trials at each value of temperature, we achieved accuracy to within 0.2%.

PRESENTER: Stimatze, Justin; California State University–Chico; 2003 SPS Intern
POSTER SESSION: Saturday Evening
TITLE: Numerical Simulation of Bi-Maxwellian Electron Distribution Function Formation in Low Pressure Capacitively Coupled Plasmas
ABSTRACT: Radio frequency plasma discharges are commonly used in materials processing for techniques such as etching and film deposition. These techniques are critical for the fabrication of modern integrated circuits, where precise control of discharge characteristics is required. Better control of plasma uniformity and parameters can be achieved by maintaining the plasma at low pressure (< 10 mTorr). At low pressure, the electron energy distribution function (EEDF) is typically bi-Maxwellian and originates from both collisionless heating and nonlocality. Using particle-in-cell simulations of low pressure capacitively coupled plasma, we will discuss recent experimental data concerning the origins of the bi-Maxwellian EEDF.

PRESENTER: Wagner, DJ; Grove City College
POSTER SESSION: Saturday Evening
TITLE: A New Contextually Relevant Course for Non-Physics Majors
ABSTRACT: The Science of Information Technology (ScIT) has been offered at Rensselaer since 1999, with much success. This course, which has no prerequisites beyond high school physics, focuses on the physics behind the operation of Information Systems. The course blends topics commonly covered in introductory courses with their IT application and with topics not typically addressed at the introductory level. For example, refraction is discussed in the context of optical fibers, and induction discussed in the context of magnetic storage. Students also learn about giant magnetoresistance, the foundation of modern hard drives. This poster will discuss the course and the on-line materials available for use in either a similar course or to bring relevance to a more traditional course.

PRESENTER: Wamathaga, Wathanu; Denison University
POSTER SESSION: Saturday Evening
TITLE: The Structure & Evolution of a Low-Mass Star-Forming Region: IRAS 16293
ABSTRACT: Wathanu Wamathaga, Steven Doty (Denison University)
In order to understand the structure of a star-forming region, it is important to understand the factors that affect its evolution. In the past, one-dimensional models have been used to study the chemical evolution of species that remain static at constant density and temperature. Unfortunately, these models are not very accurate. In reality, star-forming regions have complex density and temperature patterns and dynamic processes, which affect their structure. In this project, we compare two dynamic chemical models (Shu and Larson-Penston) with a static model, to assess the impact of velocity on the chemical evolution of IRAS 16293. We find that there are significant structural differences between dynamic and static models.

PRESENTER: Weiler, Kevin; Marquette University
POSTER SESSION: Saturday Evening
TITLE: The Dependence of the Common Envelope Evolution Efficiency on Binary Star System Parameters
ABSTRACT: Cataclysmic variables (CVs) are a class of interacting binary star systems. A CV consists of a white dwarf that is accreting material from a low-mass, main-sequence donor star. In the formation of CVs, a phase of evolution known as the “common envelope” phase occurs during which a significant amount of mass and angular momentum is shed from the binary. This is accomplished by transferring energy from the orbit into an envelope which is common to both stars. The efficiency of this transfer is parameterized by a quantity known as alpha. Population synthesis studies of CVs have assumed thus far a constant alpha, independent of quantities such as the masses of the stars, and their state of evolution. This parameter is generally set equal to 1. In this study, I examined a relationship between alpha and one of the binary parameters, the mass of the donor star. A Monte Carlo population synthesis code was used to to generate a theoretical population of Galactic CVs that are forming at the present epoch. The specific relationship that was examined is alpha proportional to the mass of the donor star. This is the first study to examine any dependence of alpha upon binary parameters.