Physics Department

Professor Mary C. Wintersgill
Chair

Physics Department faculty and students were actively engaged in research and scholarship during the 2004-2005 academic year. Their efforts helped them keep current in their various areas of specialization, allowed them to expand the use of research-based teaching techniques in our classrooms and laboratories, and provided opportunities for midshipmen to develop as individual scholars.

The reports that follow describe studies in such traditional areas of physics research as acoustics, astronomy and astrophysics, atomic physics, condensed matter physics, nonlinear optics, nuclear structure physics, and planetary physics. They also relate work in a variety of interdisciplinary fields, including cognitive science, imaging and pattern recognition, materials science, optical communications and photonics. Additionally, they describe important efforts to understand how students learn physics and how to teach it more effectively.

External research sponsors included the National Science Foundation (NSF), the Office of Naval Research (ONR), the Research Corporation (RC), the Naval Research Laboratory (NRL), the Naval Surface Warfare Center (NSWC), and the National Center for Physical Acoustics (NCPA). Internal support came from the Naval Academy Research Council (NARC).

Our faculty shared the results of their efforts by publishing scholarly articles and making presentations at conferences. This year, physics faculty and students published 19 articles in refereed journals, 4 articles in conference proceedings, and four book chapters. In addition, they issued four faculty technical reports and one Trident Scholar reports. Finally, faculty, midshipmen, and their collaborators made 24 presentations at scientific conferences and other meetings, including some at international meetings in Canada, England, Fiji, the Netherlands, and Sweden.

As always, the scholarly bond between our faculty and students was close and productive. One Trident Scholar used a finite element scheme solved using FEMLAB to carry out a normal mode analysis of the Chesapeake Bay. One midshipmen developed a successful new Trident Scholar proposal, which he will carry out during the next academic year. Seven midshipmen participated in research projects in astronomy, acoustics, magnetic materials, and nuclear physics.

Sponsored Research

Modeling, Synthesis and Testing of New, High-Performance Polycarbonates for Transparent Armor Applications

Researcher: Professor John T. Bendler
Sponsor: Army Research Office (ARO) via the South Dakota School of Mines & Technology

The broad goal of this research is to use molecular modeling, synthesis, physico-chemical and small-scale mechanical testing of several new aromatic polycarbonate molecules to assess their potential for application in various U.S. ARMY personnel protection systems such as transparent armor for face shields, goggles, vehicle vision blocks, windshields, blast shields and aircraft canopies. This research represents the extension and application of discoveries made in the course of our National Science Foundation Grant. The NSF results included the successful design (using ab initio and force-field molecular computer modeling methods) and synthesis of several new monomers for polycarbonate polymerizations using the Suzuki coupling methodology and readily-available starting materials. This ARO research extends the NSF results to include new thermoplastic polymer analogues based on bisaryl monomers such as trifluoromethylated, siloxane, formal, and *geminal*-dimethyl analogues of

bis(biarylphenols). The primary focus and objective in this new work is to evaluate and test these novel polymer systems for enhanced high-impact mechanical properties, oxidative stability, UV resistance, flame resistance, laser light sensitivity, environmental and chemical stability, as well as improved aging and embrittlement resistance.

Synthesis, Modeling and Testing of Polymer Nanocomposites for Impact Protection

Researcher: Professor John T. Bendler
Sponsor: Army Research Office (ARO) via the South Dakota School of Mines & Technology

The scientific goal of this project is to provide improved, fundamental understanding of the role of molecular entanglements, nanoparticle-matrix interactions, and molecular motions on filler percolation thresholds, high strain rate impact performance, heat resistance and mechanical deformation mechanisms in nanoreinforced polymer resins. The approach is to use synthetic chemistry along with molecular theory and simulations to fabricate, model and test new reinforced polymers for soldier protection systems. The experimental and theoretical effort focuses on polycarbonate molecules which are extensively used by the U.S. Army for ballistic impact protection. Novel polycarbonates designed and synthesized by the PIs are utilized and filled with carbon nanotubes, mineral sheets, and silica particles, coated and uncoated. Sample preparation and modeling began last summer and testing has taken place at the Rodman Materials Center at ARL in Aberdeen, MD and is now also occurring at GE Global Research.

Properties of Fuel Cell, Battery, and Capacitor Materials

Researchers: Associate Professor Charles A. Edmondson and Professor John J. Fontanella
Sponsor: Office of Naval Research (ONR)

The long-term objective of this project is to provide basic studies of the structure, properties and dynamics of fuel cell, battery and capacitor materials and to link these to performance. The immediate objective for the battery and fuel cell portion of the project is to elucidate electrical transport in various ion-conducting systems with the goal of improving ion-exchange and electrolyte materials. This includes ion-conducting polymers and liquid and solid electrolytes. The fuel cell materials of most interest are liquid-free proton conductors. The battery electrolytes of interest are primarily lithium conductors though magnesium conducting polymers may also receive some attention. The capacitor materials of interest include both pure and nano-engineered polymers and ceramics. Work has begun on new dielectrics. Initially, materials such as the terpolymers developed by Zhang and co-workers at Penn State are being studied. In addition, new dielectrics created by Wnek and coworkers at Case will be studied when they become available. This work has been carried out in collaboration with the group at Hunter College where nuclear magnetic resonance (NMR) measurements have been performed.

A Medical Geology Investigation: Effects of Chronic Toxicity from Geologic Sources on a South Pacific Island's Indigenous Population

Researcher: Professor Douglas W. Edsall
Sponsor: 2004 Kinnear Fellowship

Medical geology is defined today as the science dealing with the relationship between natural geological factors and health in man and animals, and understanding the influence of ordinary environmental factors on their geographic distribution. The first mention of the link between geological materials and processes and medical conditions is found in the writings of Hippocrates and Aristotle. Health problems created through environmental contamination by various trace elements have become a concern worldwide. Such public health issues require field investigations to: identify and characterize natural and anthropogenic sources of harmful materials in the environment; predict the movement and alteration of disease causing agents with time and in space; and to understand how to prevent or minimize chronic (long term) exposure to the existing population. This project recognizes the interaction of geological materials and processes in the environment and the medical well-being of existing indigenous populations. By selecting an environment where there are fewer dietary, mobility or contamination influences, the cause-effect relationship will be easier to demonstrate. The availability of reliable public health statistics for member nations of SOPAC is generally poor. Therefore, this study adds important

geological and health data as well as establish a data collection methodology which, in turn, could lead to training SPO islanders in the collection and reporting of medical health statistics.

Optically Stimulated Luminescence (OSL) Dating of Diatoms

Researcher: Professor Douglas W. Edsall
Sponsors: 2004 Kinnear Fellowship
and Luminescence Dating Laboratory, Victoria University of Wellington, New Zealand.

The use of detrital inorganic crystalline silicates such as quartz and feldspar has provided a new avenue to age date continental and marine sedimentary deposits not previously amenable to direct dating. While O18/O16 isotopic analysis of skeletal tests of marine organisms has provided information on paleo-temperatures and their variability and thus insight into paleo-climates, there has not been developed a non-destructive accurate or simple direct method of age dating skeletal tests composed of amorphous silica. Carbon (C14) may provide an age under certain conditions for calcareous fossil tests, but there is no direct method of determining the absolute age of incorporation of a diatom test in a sediment. Our OSL dating of a fresh water and marine species of diatoms is a first. The OSL ages of the fresh water species was confirmed by OSL ages of associated volcanic ash stratigraphically above and below the diatom sequence. The marine specimens were associated with marine isotopic stage 5e (115 ka), but our OSL age suggests marine isotopic stage 11 (406 ka). Both stages, 5e and 11 have similar values. Work is continuing to verify our initial results and refine our techniques.

Properties of Glass-Forming Materials and Proton-Conducting Materials

Researchers: Professor John J. Fontanella, Professor Mary C. Wintersgill,
Professor John T. Bendler and Associate Professor Charles A. Edmondson
Sponsor: National Science Foundation (NSF)

The scientific goal of this project is to understand ion transport and dipole reorientation mechanisms in polymer electrolytes. It is generally agreed that ion-polymer and ion-ion interactions are of crucial significance in determining the ion transport properties. Both alkali metal salt-polyether complexes and proton-conducting materials such as hydrogels will be studied. Experimental information concerning both structural and dynamic properties (the free volume microstructure of the polymer matrices, the segmental motions of the polymer chains and the diffusional motions of the ions) over a wide range of temperature, pressure and time (frequency) will be obtained. In addition both modeling and computer simulations of the various systems are being carried out.

Characterization of Polymeric and Ceramic Foams and Their Adhesion to Metal Structures

Researchers: Commander Edward J. Tucholski, USN
and Robert E. Green, Jr., Materials Science and Engineering Department, The Johns Hopkins University
Sponsor: NASA Langley Research Center

Polymeric and ceramic foams and composites are bonded to metallic structures in spacecraft in order to protect the metals from structural degradation during reentry through the earth's atmosphere. A nondestructive field test to evaluate the bond between these materials is necessary to certify the spacecraft ready to fly. Using foam samples provided by NASA, several methods including acoustic resonance, microwave imaging, and x-ray backscatter will be evaluated to determine their viability to accomplish this task. The most promising methods will be studied to optimize their performance at detecting the smallest possible disbonds.

Search for Wobbling Excitations in ^{174}Hf and ^{171}Ta

Researcher: Assistant Professor Daryl J. Hartley
Sponsor: National Science Foundation (NSF)

Nuclei exist in various shapes, such as spherical, prolate (like a football), oblate (like a doorknob), and octupole (like a pear). All of these shapes are similar in one aspect, they have an axis of symmetry for their mass distribution. A nucleus with no symmetry axis (referred to as triaxial) is rarely seen – in fact only one nucleus (^{163}Lu) has had this shape confirmed. If such a nucleus is rotated it would have a wobbling motion, similar to the spinning of an asymmetrical top. Observing wobbling motion is in fact the most conclusive way to confirm triaxial shapes. The experiment at the international facility, Gammasphere (where approximately 67% of beam time requests are denied), was to produce high-spin states in ^{174}Hf, which recent theory suggested could have triaxiality at high spin and excitation energy. Unfortunately, there was no conclusive evidence for wobbling; however, it was determined that the possible configuration in ^{174}Hf that may be triaxial is much more complex than that seen in ^{163}Lu. This information is quite useful for theorists as they try to understand the exact conditions necessary for nuclei to possess asymmetrical shapes. In September 2004, I also led a Gammasphere experiment to produce high-spin states in ^{171}Ta to see if signs of triaxial deformation could be seen in this nucleus. Over 200 new gamma rays could be associated with this nucleus and structure of ^{171}Ta is more well defined as a result. However, there is no evidence of wobbling bands in this nucleus either. Therefore, it appears that the N = 100 gap (which would stabilize the nuclear shape with asymmetry) may not exist.

Probing Nucleon Spin Structure via Electron Scattering from Polarized Helium-3

Researcher: Assistant Professor Kevin L. McIlhany
Sponsor: National Science Foundation (NSF)

BLAST (Bates Large Acceptance Spectrometer Toroid) is a detector located twenty miles north of MIT at the Bates laboratory. The BLAST physics program calls for several years of data taking scattering polarized electrons from polarized internal gas targets at an electron energy of one GeV. The scattering process that ensues is used to probe nuclear and sub-nucleon structure. The work supported by the Summer 2004 inter-sessional Naval Academy Research Council (NARC) grant allowed Prof. McIlhany to travel to Bates to continue efforts towards installing the helium-3 internal gas target. Several basic goals were laid out at the beginning of the summer which were subsequently completed by the end of the period the grant allowed. Midshipman 2/c Lawrence Herman, USN attended the MIT-Bates laboratory for a three week period during the summer of 2004 and was trained in laser usage as well as helped in calculating the stray magnetic field for a poorly wound toroidal magnet. Two broad goals were established early on which were completed satisfactorily for summer 2004. The highest polarization achieved at MIT occurred during July (65%). This polarization is consistent with the highest polarizations achieved in competing laboratories around the world, ushering in the period when the BLAST Helium-3 target could be used as a production target. This milestone was the completion of the previous four years attempts to stabilize the target to a degree that high polarization could be achieved. Combinations of techniques including spanning the parameter domain for maximal influence, designing a feedback loop using motorized mirror controllers as well as building infrastructure to minimize environmental constraints were employed. The second goal was to participate in the BLAST collaborations activities as the detector was being commissioned and production level data began to be collected.

Spacewatch Survey of the Solar System

Researchers: Assistant Professor Jeffrey A. Larsen and Dr. Robert S. McMillan, University of Arizona
Sponsor: NASA Planetary Astronomy Grant

Spacewatch is an asteroid survey concerned with statistical properties of all types of asteroids, particularly the Near-Earth Asteroids. This ongoing grant supports the operations of Spacewatch pertaining to scientific studies of asteroids in the Solar System. The project has included writing a positional linking package which will be run in the Naval Academy's CADIG center. The results of this linking package will be short arc orbits for 20,000 asteroids which will help to study the distribution of smaller (fainter) asteroids in several populations of current research interest. The analysis of this data will occur with Dr. Robert Jedicke (University of Hawaii) and Dr. Jim Scotti

(University of Arizona) later in the summer. In addition, the project aims to detect a large planet hypothesized to exist in the outer solar system including modification of the planetary detection software and performing computations when the equipment to facilitate the image transfer from Arizona arrive.

Spacewatch Survey and Study of Hazardous Asteroids and Comets

Researchers: Assistant Professor Jeffrey A. Larsen and Dr. Robert S. McMillan, University of Arizona
Sponsor: NASA Near Earth Object Observation Grant

Spacewatch is an active contributor to the Near Earth Asteroid hazard study both in terms of discoveries and orbit refinement observations. Over the activity period efforts have been principally focused on supporting ongoing operations, including performing several astrometry (positional) and photometry (brightness) calibrations for the two telescopes Spacewatch operates, tuning and testing the automated motion detection routines, and supporting recent electronic noise abatement efforts. During prediscovery observations of asteroid 2004 MN4 (MPEC 2004-Y70) were made which removed the asteroid from its standing as the most hazardous near-Earth asteroid discovered to date. The entire 2004 MN4 story can be found at http://neo.jpl.nasa.gov/news/news146.html and http://neo.jpl.nasa.gov/news/news148.html. This story also received a lot of popular press coverage as well, including the London Times (18 April 2005), Astronomy (28 December 2004) and even Page 1A of the Washington Post (8 April 2005) since the asteroid may in the long term still present a threat to the planet.

Nonlinear Optical Molecules in Capillary Waveguides

Researcher: Associate Professor Steven R. Montgomery
Sponsor: Dr. Jim Shirk, Optical Sciences Division, Code 5613, Naval Research Laboratory (NRL)

Myriad applications for nonlinear optical materials fuel their study. This ongoing study examines the nonlinear optical interaction of large organic molecules dissolved in liquid organic solvents and polymers with laser light. The measurements are carried out in small waveguides a few microns in diameter, since light in a waveguide stays focused at high intensity over long distances, allowing a much longer interaction length than can be obtained by focusing into a large sample over the Rayleigh range of the focused spot. Measurements are done at visible and infrared wavelengths. Molecules have been designed and fabricated to produce nonlinear optical properties and measured to check performance. This information is used to guide the development of new molecules for enhanced nonlinear optical response at new wavelengths.

Solid-State Laser Cooling of Organic Dyes in Modified Polymers

Researcher: Assistant Professor Carl E. Mungan
Sponsor: Research Corporation

Fundamental thermodynamic principles for laser cooling and other applications were analyzed this year. A detailed statistical mechanics approach to optical refrigeration and lasing was undertaken. Significant errors in previously published work on this subject were uncovered while developing a consistent treatment of the entropy and temperature of radiation. This is significant because non-thermal radiative energy transfers are central to the operation of both luminescent coolers and optically pumped lasers. The plan is to build a 3-cubic-centimeter antenna-coupled high-temperature-superconducting bolometer operating in the terahertz regime that is laser cooled to 90 K.

Prediction of Ship Magnetic Signatures with the Cooperative Theory of Ferromagnetic Hysteresis

Researcher: Professor Carl S. Schneider
Sponsors: Office of Naval Research (ONR) and Naval Surface Warfare Center, Carderock Division (NSWC-CD)

Samples used in the experiments are long hollow cylinders with end fittings for both axial force and pressure, causing biaxial stress. The stress apparatus includes both an axial force mechanism and a pressure system which create biaxial wall stresses up to 150 MPa. The effects of both positive and negative stress have been observed axially and the axial equivalent of biaxial stress observed. Explicit external pressure tests have been made and are being interpreted. Stresses are monitored using an array of strain gages at various points on the sample to ensure that stress is well defined in the region of measured flux. Precision voltmeters and computer controlling and analyzing software are being upgraded to LabView with PCMCIA to GPIB connectors to enhance data rate and precision as well as more complete automation. The applied field and resulting magnetic flux are axial to avoid penetrating the pressurized sample, and gives uniform field and flux. Experimental measurement of effective stress show both Brown and Bozorth stress fields predicted by theory. Computed magnetization due to stress is in excellent agreement with experimental observations.

ANDES, An Intelligent Tutor for Basic Physics

Researchers: Professor Donald J. Treacy and Professor Mary C. Wintersgill
Sponsor: Office of Naval Research (ONR) Cognitive Science Division

ANDES is an intelligent tutor for Basic Physics. It is designed to tutor midshipmen through their assigned Physics homework. This has 3 purposes: 1) remove "Physics frustration", 2) give "just in time help" to the midshipmen doing the assignments, 3) raise the level of classroom interaction because there is no need to discuss how to solve Physics problems assigned for homework. The tutor will immediately give the students feedback as to whether the action they took toward solving an assigned problem was correct of incorrect. If the action was incorrect the student may ask the tutor "What's wrong" and receive an answer to point them in the direction of a correct solution. If a student is at an impasse the student can ask the tutor to "Give me a hint". These features combine to make a type of mastery tutor that will allow a student to obtain a correct solution for every problem assigned. The results of using this tutor show that the students do substantially better on problem solving tests and somewhat better on multiple choice tests. As far as ONR is concerned the project is complete. ANDES is still being developed both at the Naval Academy and the University of Pittsburgh and has been placed on a server at the "On Line Institute" (OLI) at CMU.

Independent Research

Compositional Analysis of Metal Fittings from 18th Century Wooden Ships

Researcher: Professor Francis D. Correll

The goal of this ongoing project is to provide new information about 18th-century naval production methods and metallurgy using Particle Induced X-Ray Emission (PIXE), a modern ion-beam analysis technique. HMB *DeBraak* was a 16-gun brig-sloop that sank in a squall on May 25 1798, off Cape Henlopen Delaware. The hull became covered with silt shortly after it sank, largely preserving it and its contents from decay. *DeBraak* was finally found and salvaged in 1984. Among the items recovered from the hull are copper-alloy bolts and fasteners as well as copper sheathing and sheathing nails. They constitute a valuable record of the materials and techniques used in the construction of naval vessels in the late 18th century. We have begun a program to measure the elemental compositions of hull bolts from HMB *DeBraak* using PIXE. We have completed preliminary measurements on 18 bolts borrowed from the Delaware State Museums and are about to begin measurements on another 26 bolts. So far, we have developed techniques for cleaning the bolts, have determined which x-ray absorbers can be used to efficiently obtain useful and reliable spectra, and have measured and fit several spectra for each bolt. In addition,

we have deduced the elemental compositions of these bolts, including quantization of some minor and trace elements. We will continue to refine and extend these measurements and expect to publish the results.

Proton Conduction in Manganese Oxide Ambigel

Researchers: Associate Professor Charles A. Edmondson
and Michael S. Doescher, Jeremy Pietron, Brett M. Dening,
Jeffrey W. Long, Christopher P. Rhodes, and Debra R. Rolison, Naval Research Laboratory (NRL)

This work is a small-scale collaboration with researchers at the Naval Research Laboratory. Ambigels and Aerogels hold the promise of providing high power density batteries and fuel cells as well as efficient sensors and electrocatalysts. The focus of the project is to understand the transport of protons through surface water layers adhered to the manganese oxide ambigel. Details of the transport path in monolithic and dense powders formed from macroscopic particles of the ambigel are being studied using complex impedance techniques in variable humidity environments.

Survey of Shallow Benthic Hydrography and Habitats in the Spratly Islands, South China Sea

Researchers: Professor Douglas W. Edsall, John Brock, U. S. Geological Survey Center for Coastal & Watershed Studies, Jack Medlin, International Program U. S. Geological Survey National Center, Sam Purkis, National Coral Reef Institute Oceanographic Center, Bernhard Riegl, National Coral Reef Institute Oceanographic Center, John McManus National Center for Caribbean Reef Research
Sponsor: National Geospatial-Intelligence Agency (NGA)

The proposed work will test the feasibility of using Quickbird commercial satellite imagery to map in detail the bathymetry and benthic habitats around selected atolls, islets and carbonate shoals within the biodiversity core of the Spratly Islands. The initial phase is the field investigation, defined as a pilot activity to prepare for the full project. The objective of the pilot project (Phase 1) is to collect high resolution hydrographic and along-track substrate imaging data sets to be made available to the National Geospatial-Intelligence Agency (NGA) for use in the revision of existing bathymetric charts and to be used as "ground truth" knowledge within Phase 2 of the proposed full project.

This project is an outgrowth of efforts undertaken while working at ONRIFO in Tokyo in 2001. The identification of a funding source for the study has been the major problem. There will be an international scientific component for this study arranged through the auspices of the USGS's International Geology Office.

Refinement of Global Planetary Magnetosphere Models

Researcher: Professor Irene M. Engle

To effect further improvement into the full range of global magnetospheric models of the Saturnian magnetosphere, in preparation for the Cassini spacecraft entry into polar orbits about Saturn. Jeremy Bruch (Naval Academy Trident Scholar 1999) worked on a problem of incorporating a modified magnetotail model based upon an into two of the incident solar-wind direction versions of the Saturnian magnetosphere model during his 1998-99 Trident Scholar year. That initial work has been expanded upon, to produce a full range of models for the total range of possible incident solar wind directions. A crucial next step was to modify the magnetotail models in such a way that their outer boundaries would meld with the boundaries computed from applying the magnetohydrodynamic principle of balancing the incident solar wind pressure on the boundary with the combined internal magnetic field pressure (plus some plasma pressure) inside the boundary. Thomas P. Armstrong and Jerry W. Manweiler, of Lawrence, Kansas have been assisting in adapting the Saturnian magnetosheric models for application to analysis of low-energy charged particle data obtained by the Cassini orbiter in situ at Saturn

Global Planetary Magnetosphere Boundary Representations

Researcher: Professor Irene M. Engle

An ongoing difficulty of making sophisticated magnetospheric models optimally useful in applications is adequately specifying the region of applicability. A well-developed mathematical model essentially constructs its own domain if a sufficient number of magnetic field lines which are "footed" on the planet surface are traced. None of the lines will go beyond what is known as the magnetopause, the boundary to the local magnetosphere. Unfortunately, in general, a mathematical model will also readily permit the tracing of field lines started points outside the model, but these lines, and the magnitudes and directions of the magnetic fields at locations along them are entirely irrelevant. When a position r(□,□) or, alternatively (x,y,z) is specified, it is helpful to know whether that spatial location is inside or outside the magnetopause boundary. The goal is to be able to specify an R(□,□) representing maximum distance r from the planet center along a particular spatial direction (□,□). Since the original calculation of the magnetopause is generally done via an angular grid and the shapes, especially where magnetotails are incorporated, are not at all simple (e.g. R = Ro would represent a sphere). Although the near-planet magnetosphere can be in some cases considered to be a misshapen sphere with dimples on the side facing the solar wind, the extended magnetotail on the side away from the solar wind is more closely approximated by a elliptical cone which expands as one is further away from the planet. Sufficiently accurately representing the boundaries is an ongoing challenge for assorted magnetospheric models of three planets, i.e., Mercury, Jupiter, and Saturn. Engle and former Naval Academy physics majors Jacob Scott and Robert Carnell are attempting to fit a very compact representation to previously developed (in 3-D matrix form) representations of the magnetosphere of Mercury under 2 extreme solar wind conditions.

Physical Properties of Ionic Liquid-Lithium Salt Electrolyte Mixtures

Researchers: Associate Professor Charles Edmondson,
Assistant Research Professor Wesley A. Henderson (USNA Chemistry Department),
Assistant Professor Paul C. Trulove, (USNA Chemistry Department),
Hugh C. De Long, Air Force Office of Scientific Research, Joon-Ho Shin, Casaccia Research Center, Rome, Italy,
and Stefano Passerini, Casaccia Research Center, Rome, Italy

This project is a small-scale collaboration with colleagues in the Naval Academy Chemistry Department. Ionic liquids (ILs) are a rapidly developing field of research, which has gained increasing notoriety in the last few years for electrolyte applications - especially for advanced lithium batteries. Reasons for this include the high electrochemical stability, nonvolatility and nonflammability of the ILs, in sharp contrast with the properties of conventional solvents now used in lithium battery electrolytes. The physical properties of ILs, however, remain relatively poorly understood such as what factors govern melting points, viscosity, ionic conductivity and hydrophobicity. For a lithium battery to operate, electroactive Li^+ cations must be present in the electrolyte. Thus, IL mixtures with lithium salts are utilized. However, early workers on this topic have often reported the formation of unidentified crystalline materials in the mixtures which hinder or prevent the batteries from operating. Thus, it is imperative that a greater understanding of the phase behavior and physical properties of IL-LiX mixtures be developed. With this in mind, we have undertaken a detailed investigation of IL-LiX mixtures including synthesis, electrochemical characterization (ionic conductivity, electrochemical stability), thermal behavior (DSC) and powder XRD (the latter two for the preparation of phase diagrams). The phase behavior of IL-LiX mixtures can be quite complex with multiple mixed-salt crystalline phases forming which differ dramatically in their crystallization kinetics and thermal stability. This work should prove to be a great practical aid to those involved in lithium battery development and several manuscripts are currently in preparation.

Beating the Black Drop

Researcher: Associate Professor James R. Huddle

On 8 June 2004, Venus transited the sun for the first time since 6 December 1882. Only five other transits of Venus have been observed since Kepler discovered in 1631 that the phenomenon was possible. Although transits of Venus are exceedingly rare, they have a rich history, and played important roles in the determination of the size of the solar system and in the history of international cooperation in science. The purpose of this work is to recreate an experiment proposed in 1716 by Edmond Halley. That experiment was to use measurements during a transit of Venus to measure the astronomical unit, or au. Since it involved precise timings of the contacts of Venus with the limb of the sun, Halley's method suffered from the Black Drop effect, which was unknown at that time, and was only explained in the present (21st) century. It may be possible to modify Halley's method to avoid problems caused by the Black Drop effect: If one make a series of photographs of Venus as it transits the Sun, one may measure the distance between the silhouette of Venus and the center of the Sun as a function of time. Then one may obtain the contact times from a plot of these data. This researcher led an expedition to Luxor, Egypt to observe last June's transit, during which he obtained a suitable series of photographs. The data are still being analyzed at the time of this report.

Experiments for Students during a Total Solar Eclipse

Researcher: Associate Professor James R. Huddle

A total solar eclipse presents an exciting opportunity to teach science to young people. A suite of experiments for this purpose has been under development since the 26 February 1998 eclipse in Aruba. In the past year, Dallas Semiconductor introduced the Hygrochron, a device that may be useful in the study of eclipse meteorology. The device is about the size of a stack of six dimes, and contains sensors for temperature and for relative humidity, a microprocessor to collect data from the sensors, and enough memory to hold 2048 temperature and humidity readings. It is powered by an internal battery, and can be connected to a computer for programming and for data retrieval. Since the Hygrochron can be programmed weeks before a data run is to begin, it is not necessary to carry a computer into the field; this feature makes the Hygrochron very attractive for eclipse meteorology experiments, which often take researchers into remote locations that are accessible only with difficulty. Hygrochron's performance is currently being evaluated, and it is planned to use them to monitor temperature and humidity at various points along the path of the total solar eclipse of 29 March 2006.

Molecular Dynamics Simulations of the Friction and Wear of Self-Assembled Monolayers and Amorphous Carbon Films

Researchers: Assistant Professor Paul T. Mikulski,
and Professor Judith A. Harrison, Assistant Research Professor Guangtu Gao
and Assistant Research Professor Ginger Chateauneuf (all of USNA Chemistry Department)

The overall goal of this research is to use molecular dynamics simulations to study atomic-scale systems in sliding contact in an effort to better understand the physics of atomic-scale friction. An empirical classical hydrocarbon potential that models both chemical reactions (the breaking and forming of bonds) as well as long-range non-bonded interactions was employed. Computationally feasible systems are typically composed of tens of thousands of atoms simulated over hundred of picoseconds with time steps of a few tenths of a femptosecond. My primary project has focused on computer simulations of an amorphous carbon tip across a self-assembled monolayer (SAM). Methods of analysis, that allow one to see how friction and load is distributed across individual atoms in the SAM, have been developed and refined. These methods allow for a clear connection between low friction in certain types of systems and specific structural features of the monolayer. Collaborative work with colleagues at the Beckman Institute at Cal Tech who have developed a potential similar to that employed by our group (except that it allows many more types of atoms) will further expand this research. With this potential, we hope to explore systems containing fluorinated SAMs and/or silicon-nitride tips.

Hysteresis in Conducting Ferromagnets

Researcher: Professor Carl S. Schneider

Maxwell's magnetic diffusion equation is solved for conducting ferromagnetic cylinders to predict a magnetic wave velocity, a time delay for flux penetration and an eddy current field, one of five fields in our linear unified field model of hysteresis. Measured Faraday voltages for a thin steel toroid are shown to be proportional to magnetic field step amplitude and decrease exponentially in time due to maximum rather than average permeability. Dynamic susceptibilities are a convolution over field of the quasistatic susceptibility from our cooperative anistropic model of hysteresis with a nonlinear delay function of frequency, normalized to the square root of the classical eddy current field and invariant in shape.

Optical Debris Analysis Techniques for Mechanical Systems in Military Environments

Researchers: Professor Lawrence L. Tankersley,
and Dr. J. Reintjes and Dr. John Tucker (Naval Research Laboratory)

This project is a program to develop real time, full flow optical analysis for turbine engine and gearbox lubricants and for hydraulic fluids as its ultimate goal. Detected debris particles are to be characterized to provide failure projection. Less capable versions of the system are to be used to monitor drawn fluid samples off-line and to provide sampling of fluids in active on-line systems. In addition to hardware, image analysis algorithms must be developed and implemented to classify debris candidates. A Portable Fluid Analysis (PFA) System consisting of the suspended particle monitor (the NRL LaserNet FINES system), an IR spectral analyzer and a viscometer was assembled and integrated under the control of a single program. Two copies of the analyzer were provided to the Fleet Technical Support Centers (FTSCLANT and FTSCPAC) for evaluation. The next stage of the PFA program has been awarded funding for the next two years. The system is being specialized to meet the requirements of the USMC Expeditionary Fighting Vehicle. The capabilities of the PFA to detect fuel contaminants including those related to the catalytic conversion of petroleum (CatFINES) are being evaluated. The system appears to be suited to the task, and program requirements are being discussed with the Army Petroleum Center.

Learn Lab

Researcher: Professor Donald J. Treacy

The purpose of "Learn Lab" is to try various strategies to improve student learning. This is a series of mini projects that a good teacher would use in the course to motivate and improve student learning. The important aspect is that the experiments are driven by previous cognitive research on how students learn. These experiments use an extension of Andes, giving it more power in generating hints for students. When a particular strategy is successful it is implemented. The first in this series of experiments was performed this spring. It consisted of showing the students a worked-out example of a problem similar to the problem assigned for homework when they asked for a hint. This is an ongoing experiment. The results from the first portion, on inductive resistive circuits and on inductive capacitive circuits, this spring have not yet been evaluated. This evaluation will be done this summer. This research is being conducted in conjunction with the Learning Research and Development Center at the University of Pittsburgh.

Midshipman Research Course Projects

Measurement of the Neutron (GnE) from the Scattering of Polarized Electrons from Polarized Deuterium

Researcher: Midshipman 2/C Matthew Baker, USN
Adviser: Assistant Professor Kevin L. McIlhany

Midshipman 2/C Baker studied nuclear physics, in an effort to grasp the difficult concepts behind nuclear scattering theory. He traveled to the MIT-Bates laboratory in the Spring of 2005 to participate in the data taking of BLAST. In this project, a measurement of the electric form factor (G^n_E) of the neutron was extracted from scattering data of polarized electrons from polarized deuterium. The proposed error bars on G^n_E will be better than 5% statistical plus 5% systematic, once the entire data set from the 2003-2004 run has been analyzed.

Analysis of Metal Fittings from HMB *de Braak*

Researcher: Midshipman 1/C Lord K. Cole, USN
Advisers: Professor Francis D. Correll and Professor Jeffrey R. Vanhoy
Sponsor: Delaware State Museums

For thousands of years, ships were made of wooden beams and planks that were usually held together by metal fasteners of various types. Wrecked ships dating from the 4th and 5th centuries BCE contain copper fasteners in the form of clenched nails. By Roman times, iron fasteners had largely replaced copper ones because they were cheaper and stronger. Iron fasteners remained the standard until the last quarter of the 18th century, when the British Navy began to cover ship hulls with thin copper plates to protect them from marine growth. The Admiralty quickly discovered that copper sheathing and iron fasteners experienced vigorous galvanic reactions when exposed to seawater. The result was rapid corrosion of the iron fasteners, which severely weakened the ships.

Toward the end of the 18th century, the Admiralty began using different copper alloys for ship fasteners, but little is actually known about the development of these alloys. Naval historians and marine archaeologists hope to learn more about their development by studying fasteners that have been recovered from various ships from that time period.

We used Proton Induced X-ray Emission (PIXE) to determine the elemental composition of 18 hull bolts from the 18th century warship *HMB de Braak*, which sank off the coast of Delaware in 1798, was raised in 1984, and is the subject of ongoing investigations by archaeologists at the Delaware State Museums. The procedure we employed includes thorough cleaning of the sample surfaces, choice of x-ray filters to reduce unwanted spectral distortions, and thick-target fitting of the spectral data. We found that most of the bolts are nearly pure copper, but also observed some differences in the compositions that may provide significant information about the origin of the material used to fabricate the bolts.

Determining the Polarization of Gamma Rays using Compton Scattering

Researcher: Midshipman 2/C Timothy Fitzgerald, USN
Adviser: Assistant Professor Daryl J. Hartley
Sponsor: National Science Foundation (NSF)

Midshipman 2/C Fitzgerald continued the work started by Midshipman Hathaway `04 with the Naval Academy's clover detector. Midshipman Hathaway developed a code that allowed for the full energy of Compton scattered gamma rays to be determined in the clover detector. A Compton scattered gamma ray deposited only a part of its energy in two crystals, therefore, neither crystal has the correct energy of the gamma. However, by summing the energy observed in the crystals, the correct energy can be determined. In addition, by determining the direction of scatter, one can determine whether the gamma ray has an electric or magnetic nature. If the gamma ray

scatters perpendicular to the reaction plane (defined by the plane composed of the beam direction and the direction of the detector with respect to the target), it is electric, but if it scatters parallel to the reaction plane, the gamma is magnetic. Midshipman 2/C Fitzgerald made a new end station and target holder for the tandem accelerator lab such that the clover can be placed near the target. He then ran a experiment in which a magnesium foil was bombarded by 2.5 MeV protons. Three prominent gamma rays were produced (one from ^{24}Mg and two from ^{25}Mg). Midshipman 2/C Fitzgerald then edited the existing code to produce spectra of when perpendicular and parallel scattering events occurred. An asymmetry ratio was then determined from the gamma ray intensities that allowed for the assignment of the transitions as electric or magnetic. The results compared favorably to the know values, thus confirming the experiment as a success.

Spectroscopy of Ta-171

Researcher: Midshipman 2/C William Mohr, USN
Adviser: Assistant Professor Daryl J. Hartley
Sponsor: National Science Foundation (NSF)

Finding nuclei with no symmetry is extremely difficult. A predict gap at neutron number N = 100 suggested that nuclei with N ~ 100 may be good candidates to see this shape. Since this shape could not be proven in ^{174}Hf, it was decided to search for this shape in ^{171}Ta, which is more similar to ^{163}Lu (the only known case of triaxial deformation). Therefore, Midshipman Mohr assisted in running the experiment at Argonne National Lab using Gammasphere to detect gamma rays de-exciting ^{171}Ta following the ^{51}V + ^{124}Sn reaction. The data was written on 8 mm tape and processed by Midshipman Mohr at the Naval Academy. Mr. Mohr was responsible for determining the calibration and efficiency of Gammasphere using known sources. In addition, the velocity of the recoiling nuclei was determined experimentally by Midshipman Mohr such that corrections for Doppler shifts could be applied to the data. A coincidence matrix was then created and inspected by Mr. Mohr such that he could greatly extend the level scheme. Although no evidence of triaxial shapes could be observed, Mr. Mohr learned a great deal about basic nuclear structure and high-spin behavior. In particular, he examined the alignment of rotational bands and observed the backbending feature when the nucleus can increase its angular momentum without spinning faster.

Search for a Tenth Planet

Researcher: Midshipman 2/C Eric A. Roe, USN
Adviser: Assistant Professor Jeffrey Larsen

In this project, we discussed the physical motivations that led to the belief that a tenth planet exists, the observables that could be used to infer whether or not such a planet exists, the basics of CCD observations and star finding/motion detection algorithms, and the logistics required to carry out this project.

Characterizations and Measurements of Acoustical Signatures of Musical Instruments

Researcher: Midshipman 2/C Andrea Wernecke, USN
Adviser: Assistant Professor Kevin L. McIlhany

Characterization and measurements of various instruments have been made with a parallel study in acoustic modeling of similar structures. A literature search found that the effect of using shoulder rests on violins has not been extensively studied. It was shown through the data set that the shoulder rest indeed affects the Chladni patterns, which in turn change the audible characteristics of the violin.

Developing and Verifying the Dynamic Cooperative Anisotropic Theory of Ferromagnetic Hysteresis

Researcher: Midshipman 1/C Stephen D. Winchell, USN
Adviser: Professor Carl S. Schneider
Sponsor: Naval Surface Warfare Center, Carderock, MD code 85

The United States Navy is currently working to reduce magnetic signatures of surface ships due to roll, yaw and pitch in heavy weather. These signatures arise from changes in the Earth's magnetic field experienced by the conducting ferromagnetic hull. Maxwell's equations can be used to solve this problem only if a description of time dependent ferromagnetic hysteresis is available. The domain interaction has been described within a polycrystalline ferromagnetic material with a piecewise analytic anisotropic cooperative model of domain cooperation which does not account for time dependent or dynamic effects. This project's objective is to develop a dynamic cooperative anisotropic theory of ferromagnetic hysteresis and then use experimental data to verify its accuracy. In order to carry out measurements of the dynamic effects on the sample we had to find and build a sample of the proper geometry and specifications. After design and fabrication was completed, the sample was put into a circuit which included a variable current source to create an applied field and a flux integrator to measure the sample's response to the applied field. The reduction of errors and noise was a major consideration for the sample and circuit construction thermal fluctuation problems, and since sample is thicker it has large eddy current effects. Temperature variations create noise which becomes a major consideration; multiple sources of inaccuracy and noise were detected and repaired in order to achieve data whose accuracy was better than one part in one hundred. The data acquisition software was programmed and the hardware assembled in order to begin recording data for the experiment. Once a functional input system was wired and created, the computer was used as a function generator as well, because of its accuracy. An output system was programmed and wired so that the power supplies were directly controlled by the computer.

Publications

Journal (Refereed) Manuscript

BENDLER, John T., Professor, FONTANELLA, John J., Professor, Shlesinger, M. F., Bartos, J., Sausa, O., and Kristiak, J., "Free Volume Dynamics in Glasses and Supercooled Liquids," *Physical Review E*, Vol. 71, pp. 031508-1-031508-10, 2005.

> A new free volume theory is developed based on the defect diffusion model (DDM). In addition, new positronium annihilation lifetime spectroscopy (PALS) ortho-positronium (o-PS) free volume and intensity data are presented for polypropylene glycol with a molecular weight of 4000 (PPG 4000) in both the glassy and liquid states and new dielectric relaxation and electrical conductivity data are reported for PPG 4000 in the liquid state. The DDM is used to interpret all of the new data for PPG 4000 and previously reported PALS and dielectric relaxation data for glycerol. It is shown that while the PPG 4000 data exhibit a preference for the three halves power law, the data for glycerol favor the first power (standard VTF) law. Good agreement between the DDM and the experimental results is found for all of the electrical data and the PALS free volume data. While reasonable agreement is also found for the PALS intensity data for PPG 4000, a discrepancy exists between the experimental PALS intensity data and theory for glycerol. For the electrical conductivity for PPG 4000, a transition is observed at the same temperature (about 1.4 T_g where T_g is the glass transition temperature) where the PALS free volume changes from steeply rising with temperature to approximately independent of temperature. The same behavior is observed at about 1.5 T_g for previously reported dielectric relaxation and PALS data for glycerol. Model parameters are presented that show the dominance of MSDs above 1.4-1.5 T_g and the dominance of ICSDs below T_g. Finally, a coherent picture of glasses and glass-forming liquids is presented based on the theory and results of the experiments.

BENDLER, John T., Professor, "Synthesis of High Aspect Ratio Bisphenols and Polycarbonates Incorporating Bisaryl Units," Macromolecules, Vol. 38, pp. 3622-3629.2005

Theoretical arguments linking monomer geometries to polymer fracture strengths and melt flow properties provide the rationale for design of a series of isomeric, high-aspect ratio bisphenols and new polycarbonates. An efficient synthesis of these monomers in addition to an optimal triphosgenation-based method for the synthesis of high molecular weight polycarbonates is presented. Preparation and polymerization of *ortho*, *meta* and *para* tetraaryl bisphenol-A are reported, in addition to glass transition temperatures of the new polycarbonates. As expected, both the *p*- and *m*- isomers form ductile, amorphous high-heat films, while the *o*-isomer produces a relatively low-T_g brittle glass.

BENDLER, John T., Professor, FONTANELLA, John J., Professor, and Shlesinger, M. F., "Sources of Exponents," *Physica D*, Vol. 193, pp. 67-72, 2004.

Examples are given of scaling relationships governed by fractional exponents. Additional examples are presented with heavy tail probability distributions governed by a fractional exponent. This includes the analysis of the Boltzmann-Gibbs entropy, subject to an appropriate constraint, to generate long-tailed probability distributions. The stretched exponential distribution is employed to derive a time scale for the glass transition that contains an essential singularity at a critical temperature. These examples demonstrate that there are many routes to producing fractional exponents in physical systems.

BENDLER, John T., Professor, FONTANELLA, John J., Professor, and Shlesinger, M. F., and WINTERSGILL, Mary C., Professor, "Reply to Comments on the need to reconsider traditional free volume theory for polymer electrolytes," *Electrochimica Acta*, Vol. 49, pp. 5249-5252, 2004.

New aspects of the defect diffusion model (DDM) are presented. First, it is shown that if the correlation volume exhibits two dimensional scaling e.g. grows in two dimensions more rapidly than in a third orthogonal direction, the standard Vogel relation is obtained. Second, it is pointed out that, independent of the dimensionality, $\partial \ln\sigma/\partial P$ should be proportional to $\partial \ln\sigma/\partial \ln T$ where the proportionality constant is $-\partial \ln T_c/\partial P$. It is shown that both of these results are consistent with the temperature and pressure variation of the electrical conductivity for 20:1 PPG:$LiCF_3SO_3$ below about 1.3 times the glass transition temperature, T_g. Finally, the DDM is compared with the free volume theory (FVT) of Dlubek et al. who have reconsidered "traditional" FVT and presented a formalism where the free volume is not proportional to the macroscopic volume. One aspect of the new FVT which is difficult to understand is that the compressibility of the occupied volume is larger than the compressibility of the free volume.

FONTANELLA, John J., Professor, (co-author), "Nanoscale Polymer Electrolytes: Ultrathin Electrodeposited Poly(Phenylene Oxide) with Solid-State Ionic Conductivity," *Journal of Physical Chemistry B*, Vol. 108, pp.13079-13087, 2004.

Incorporating ions within electrodeposited polymer dielectric films creates Ultrathin (<50 nm) solid electrolytes of potential use in other solid-state ionic devices and for fundamental studies of charge transport on length scales that bridge molecular electronics and conventional electrochemical devices. Electro-oxidation of phenol in basic acetonitrile generates electrodeposited nanoscale (21 ± 2 nm), pinhole-free poly(phenylene oxide), PPO, films on indium-tin-oxide substrates. Solid-state electrical measurements using top electrode contacts (vapor-deposited Au, liquid Hg, or liquid Ga-In eutectic) confirm that these PPO films are electronically insulating ($7 \pm 2 \times 10^{-12}$ S cm^{-1}) with a high dielectric strength ($1.7 \pm 0.1 \times 10^6$ V cm^{-1}). The insulating film is converted to an ultrathin solid polymer electrolyte by soaking in a solution of $LiClO_4$–propylene carbonate and then heating under vacuum to remove solvent. Atomic force microscopy establishes that the ion-modified film is thicker (43 ± 10 nm) than the as-prepared PPO film. The X-ray photoelectron spectroscopic measurements suggest minimal retention of

solvent in the film. Electrochemical impedance measurements demonstrate that the incorporated ions are mobile in the solid state with an ionic conductivity of $7 \pm 8 \times 10^{-10}$ S cm^{-1}.

HARTLEY, Daryl J., Assistant Professor, (co-author), "Possible Assignment of Chiral Twin Bands in ^{188}Ir," *Physical Review C*, Vol. 70, pp. 044305-1 – 044305-8, 2004.

High-spin states in the doubly-odd Z = 77 nucleus ^{188}Ir were populated in the ^{186}W(^{7}Li,5n) reaction at 52 MeV. Two nearly degenerate $\Delta I = 1$ sequences with the same parity were established. Both bands have been assigned the $\pi h_{9/2} \otimes \nu i_{13/2}$ configuration, based on the systematic behavior of these excitations in the Ir nuclei and on the measured values for the $B(M1)/B(E2)$ ratios, and they are suggested as candidates for a chiral doublet.

HARTLEY, Daryl J. Assistant Professor, (co-author), "Shape Coexistence and Band Crossings in ^{174}Pt," *Physical Review C*, Vol. 70, pp. 014309-1 – 014309-6, 2004.

High-spin states in ^{174}Pt were populated via the ^{92}Mo(^{84}Sr,2p) and ^{92}Mo(^{84}Sr,2p2n) reactions. The ground-state band has been extended from I = 14 to 24 (tentatively 26) and a new side band is observed up to a spin of 21 (tentatively 23). A low-frequency crossing is observed in the latter band at a rotational frequency that is similar to that seen in the ground-state band. The first and second $i_{13/2}$ neutron alignments are also observed in ^{174}Pt. Surprisingly, these crossings occur at approximately the same frequency. Total Routhian surface and cranked shell model calculations are used in an attempt to understand this behavior.

HARTLEY, Daryl J. Assistant Professor, (co-author), "Wobbling Excitations in Strongly Deformed Hf Nuclei?" *Physics Letters B*, Vol. 608, pp. 31-38, 2005

Two Gammasphere experiments have been performed in order to establish the possible triaxial nature of strongly deformed (SD) bands in ^{174}Hf. A lifetime measurement, using the Doppler-shift attenuation method, confirmed the large deformation of the four previously observed bands in this nucleus with transition quadrupole moments ranging from 12.6 to 13.8 b. These values are significantly larger than those predicted for triaxial minima by ultimate cranker (UC) calculations. A thin-target, high-statistics experiment was also carried out to search for linking transitions between the SD bands. No such transitions, which represent an experimental signature for wobbling modes, were observed. Four additional SD bands were found in ^{174}Hf together with a single SD band in 173Hf. These results indicate that the strongly deformed sequences of N ~ 102 Hf isotopes behave differently than the triaxial strongly deformed bands found in Lu nuclei near N = 92. The interpretation of these bands in terms of possible stable triaxial deformation is confronted with the experimental findings and UC predictions.

HARTLEY, Daryl J. Assistant Professor, (co-author), "High-spin States in ^{179}Au: Spectroscopy of Shape-driving Orbitals Beyond the Neutron Midshell," *Physical Review C*, Vol. 69, pp. 064315-1 – 064315-6, 2004.

Multiple band structures in ^{179}Au are established from γ-ray spectroscopic measurements with Gammasphere at the Argonne Fragment Mass Analyzer. The yrast band, based on the $13/2^{+}$ proton, confirms the predicted drop in excitation energy of the prolate deformed band head as compared to the heavier isotopes. The implications for the prolate energy minimum in odd-mass Au nuclei beyond the neutron $i_{13/2}$ midshell (N<102) are discussed.

HARTLEY, Daryl J. Assistant Professor, (co-author), "Highly Deformed Bands in ^{175}Hf," *Physical Review C*, Vol. 70, pp. 054314-1 – 054314-8, 2004.

Two high-spin regularly spaced rotational bands with large dynamical moments of inertia have been identified in ^{175}Hf with the Gammasphere spectrometer. These new bands are very similar to the previously identified triaxial superdeformed bands in the hafnium nuclei. However, the new bands in ^{175}Hf have been linked into the known level scheme and thereby provide the first firm spin assignments for these structures in this region. In order to understand the new bands, theoretical calculations have been performed based on the Ultimate Cranker (UC) code. The new bands in ^{175}Hf are deduced to be built upon highly deformed structures. No experimental evidence for triaxiality was established and this work suggests that the structure of the so-called "triaxial" superdeformed bands in the Hf nuclei may be quite different from those identified in the lighter mass Lu nuclei. Since the two highly deformed bands in ^{175}Hf are associated with different deformations, this work also identifies the role of the intruder orbits in polarizing the nuclear shape.

HARTLEY, Daryl J. Assistant Professor, (co-author), "Coulomb Excitation and Transfer Reactions with Rare Neutron-rich Isotopes," *Nuclear Physics A*, Vol. 752, pp. 264c-272c, 2004.

Neutron-rich radioactive ion beams available from the HRIBF allow a variety of measurements around the ^{132}Sn region, including Coulomb excitation, fusion-evaporation, and neutron transfer. The B(E2; $0^+ \rightarrow 2^+$) value for first 2^+ excited states of even-even neutron-rich $^{132\text{-}136}$Te and $^{126\text{-}134}$Sn have been measured by Coulomb excitation in inverse kinematics. The results are discussed in terms of the shell model and the quasiparticle random phase approximation. Neutron transfer onto a ^{134}Te beam, from ^{9}Be and ^{13}C targets to populate single-particle states in ^{135}Te, has also been studied. Gamma rays from the ^{13}C(^{134}Te, ^{12}C) reaction were used to identify the $\nu i_{13/2}$ state in ^{135}Te, at an energy of 2109 keV. These and other results, and plans for future experiments with these neutron-rich beams, are presented.

KATZ, D., Associate Professor, (co-author), "Canonical Particle Acceleration in FRI Radio Galaxies", The Astrophysical Journal, Vol. 626, pp. 748-766, 2005

Matched resolution multi-frequency VLA observations of four radio galaxies are used to derive the asymptotic low energy slope of the relativistic electron distribution. Where available, low energy slopes are also determined for other sources in the literature. They provide information on the acceleration physics independent of radiative and other losses, which confuse measurements of the synchrotron spectra in most radio, optical and X-ray studies. We find a narrow range of inferred low energy electron energy slopes n(E) □ E−2.1 for the currently small sample of lower luminosity sources classified as FRI (not classical doubles). This distribution is close to, but apparently inconsistent with, the test particle limit of n(E) □ E−2.0 expected from strong diffusive shock acceleration in the non-relativistic limit. Relativistic shocks or those modified by the back-pressure of efficiently accelerated cosmic rays are two alternatives to produce somewhat steeper spectra. We note for further study the possibility of acceleration through shocks, turbulence or shear in the flaring/brightening regions in FRI jets as they move away from the nucleus. Jets on pc scales and the collimated jets and hot spots of FRII (classical double) sources would be governed by different acceleration sites and mechanisms; they appear to show a much wider range of spectra than for FRI sources.

LARSEN, Jeffrey A., Assistant Professor, (co-author), "Matched Filter Processing for Asteroid Detection," *Astronomical Journal*, May 2005, accepted for publication. .

Matched filter processing has been shown to provide significant performance gains in when processing compared to the commonly used moving target indicator algorithms. These gains include extending detection capability to fainter objects and cluttered fields. The matched filter software described in this paper has been shown to recover up to 40% more asteroids in good quality Spacewatch imagery compared to the original version of its detection software mostly due to its ability to pick up fainter objects. The technique has some drawbacks, mostly in the form of slow execution and a large false positive ratio.

However, this algorithm is incredibly useful for so-called "recovery" observations where the expected motion of the asteroid can be determined in advance. In this case the algorithm runs quickly and with a very small number of false positives. This paper describes Gural's technique, which was implemented and tested by Larsen and student researcher Gleason on Spacewatch imagery. Larsen's role was to adapt the software to run on Spacewatch images, to create the testing routines for a wide variety of observational conditions, to provide feedback on failure modes to Gural, and to assist in writing those portions of the paper.

McILHANY, Kevin L., Assistant Professor, (co-author), "*Measurement of R = sigma_L / sigma_T and the Separated Longitudinal and Transverse Structure Functions in the Nucleon Resonance Region"*, October 2004. JLAB-PHY-04-45, 5pp. e-Print Archive: nucl-ex/0410027.

We report on a detailed study of longitudinal strength in the nucleon resonance region, presenting new results from inclusive electron-proton cross sections measured at Jefferson Lab Hall C in the four-momentum transfer range $0.2 < Q^2 < 5.5(\mathrm{GeV/c})^2$. The data have been used to accurately perform over 170 Rosenbluth-type longitudinal / transverse separations. The precision R = sigma_L / sigma_T data are presented here, along with the first separate values of the inelastic structure functions F_1 and F_L in this regime. The resonance longitudinal component is found to be significant. With the new data, quark-hadron duality is observed above $Q^2 = 1(\mathrm{GeV/c})^2$ in the separated structure functions independently.

MIKULSKI, Paul T., Assistant Professor, "Contact Forces at the Sliding Interface", *Journal of Chem. Phys.*, 122, pp. 024701-1 through 024701-9 (2005).

Classical molecular dynamics simulations of an amorphous carbon tip sliding against monolayers of *n*-alkane chains are presented. The tribological behavior of tightly packed, pure monolayers composed of chains containing 14 carbon atoms is compared to mixed monolayers that randomly combine equal amounts of 12- and 16-carbon-atom chains. When sliding in the direction of chain cant under repulsive (positive) loads, pure monolayers consistently show lower friction than mixed monolayers. The distribution of contact forces between individual monolayer chain groups and the tip shows pure and mixed monolayers resist tip motion similarly. In contrast, the contact forces "pushing" the tip along differ in the two monolayers. The pure monolayers exhibit a high level of symmetry between resisting and pushing forces which results in a lower net friction. Both systems exhibit a marked friction anisotropy. The contact force distribution changes dramatically as a result of the change in sliding direction, resulting in an increase in friction. Upon continued sliding in the direction perpendicular to chain cant, both types of monolayers are often capable of transitioning to a state where the chains are primarily oriented with the cant along the sliding direction. A large change in the distribution of contact forces and a reduction in friction was observed.

MIKULSKI, Paul T., Assistant Professor, "Effect of Filling on the Compressibility of Carbon Nanotubes: Predictions from Molecular Dynamics Simulations", *Journal of Nanoscience and Nanotechnology*, 5 (2005) 536-541.

The compressibility of filled and empty (10, 10) carbon nanotubes (CNTs) is examined using classical molecular dynamics simulations. The filled nanotubes contain C60, CH4, Ne, n-C4H10, and n-C4H7 molecules that are covalently cross-linked to the inner CNT walls. In addition, nanotubes filled with either a hydrogen-terminated carbon nanowire or a carbon nanotube of comparable diameter is also considered. The forces on the atoms are calculated using a many-body reactive empirical bond-order potential and the adaptive intermolecular reactive empirical bond-order potential for hydrocarbons. The butane-filled system shows a unique yielding behavior prior to buckling that has not been observed previously. Cross-linking the molecules to the inner CNT walls is not predicted to affect the stiffness of the filled nanotube systems and removes the yielding response. The mechanical response of the nanowire filled CNT is remarkably similar to the response of the similarly sized multiwalled CNT.

MIKULSKI, Paul T., Assistant Professor, "Compression and Shear-Induced Polymerization in Model Diacetylene Containing Monolayers", *J.Phys. Chem. B*, 108 (2004), pp. 16626 - 16635.

Molecular dynamics simulations have been used to examine the response of monolayers composed of alkyne chains, which contain diacetylene moieties, to compression and shear. The simulations show that both compression and shear result in cross-linking, or polymerization, between chains. Irregular polymerization patterns appear among the carbon backbones. The vertical positioning of the diacetylene moieties within the alkyne chains (spacer length) and the sliding direction have an influence on the pattern of cross-linking and friction. In addition, chemical reactions between the chains of the monolayer and the amorphous carbon tip occur when diacetylene moieties are located at the ends of the chains closest to the tip. These adhesive interactions increase friction.

MUNGAN, Carl E., Assistant Professor, "Radiation Thermodynamics with Applications to Lasing and Fluorescent Cooling," *American Journal of Physics*, Vol. 73, pp. 315–322, April 2005.

Laser cooling of bulk matter uses thermally assisted fluorescence to convert heat into light and can be interpreted as an optically pumped laser running in reverse. Optical pumping in such devices drives the level populations out of equilibrium. Nonthermal radiative energy transfers are thereby central to the operation of both lasers and luminescent coolers. A thermodynamic treatment of their limiting efficiencies requires a careful development of the entropy and effective temperatures of radiation, valid for the entire range of light from the blackbody to the ideal laser limiting cases. In particular, the distinct meaning and utility of the brightness and flux temperatures should be borne in mind. Numerical examples help illustrate these concepts at a level suitable for undergraduate physics majors.

MUNGAN, Carl E., Assistant Professor, "A Primer on Work-energy Relationships for Introductory Physics," *The Physics Teacher*, Vol. 43, pp. 10–16, January 2005.

There has been and continues to be considerable discussion in the educational community about different ways of relating the concepts of work and energy in introductory physics. The present article reviews a consistent and streamlined treatment of the subject, drawing particular attention to aspects seldom covered in textbooks. The paper is intended to clarify the central equations for introductory courses and to put the wider literature in context. It is specifically designed to tie closely in terminology and order of presentation to standard texts, so that it complements rather than supplants them. In brief, the key point is that there are two major categories of work, center-of-mass work and particle work. After an overview of these two approaches, a few instructive examples (that can be used in group problem-solving sessions in class) are introduced.

SCHNEIDER, Carl S., Professor, "Effect of Stress on the Shape of Ferromagnetic Hysteresis Loops," *J.Appl. Phys*., 97, 1 (2005)

The shape of ferromagnetic hysteresis loops is described in terms of symmetric Brown and antisymmetric Bozorth stress fields. The magnetization and nonlinear stress dependence of stress fields are measured and plotted. The brown field is found to exist in every magnetoelastic process and is manifested when hysteresis of 90^0 domain walls is asymmetric. Stress fields are derived from magnetoelastic energy density both within a ferromagnetic domain and throughout the sample and are a measure of domain structure. The common stress crossover of saturate curves is modeled in terms of fraction of 900 domain walls. The Brown stress field changes the coercive field and the Bozorth stress field changes remanence.

Conference Proceedings

HARTLEY, Daryl J. Assistant Professor, (co-author), "Search for Wobbling Excitations in Hf Nuclei: Are the SD Bands Triaxial?" *Nuclei at the Limits: Proceedings of the AIP Conference*, Vol. 764, pp. 15-20, 2005.

> Two Gammasphere experiments have been performed in order to establish the possible triaxial nature of strongly deformed (SD) bands in ^{174}Hf. A lifetime measurement confirmed the large deformation of the four previously observed bands in this nucleus. In addition, a thin-target, high-statistics experiment was also carried out to search for linking transitions, which represent an experimental signature for wobbling modes, were observed. Four new bands were found in ^{174}Hf together with a single SD band in ^{173}Hf. These results indicate that the strongly deformed sequences of N ~ 102 Hf isotopes behave differently than the triaxial strongly deformed bands found in Lu nuclei near N = 92. The interpretation of these bands in terms of possible stable triaxial deformation is confronted with the experimental findings and UC predictions.

MOHR, William H, Midshipman, USN, and HARTLEY, Daryl J., Assistant Professor, "Spectroscopy of ^{171}Ta," *Proceedings of the National Conference for Undergraduate Research (NCUR),*" in press.

> Current nuclear theory suggests that the isotope ^{171}Ta may have triaxial deformation. An experiment involving Gammasphere, used a heavy-ion fusion evaporation reaction to create ^{171}Ta. By using the germanium detectors of Gammasphere to measure the energies of the emitted gamma rays, conclusions can be made as to the shape and behavior of ^{171}Ta in its high-spin states. In order to accurately measure the gamma-ray energies, it was necessary to calibrate and determine the efficiency of the detectors using different known sources. Coincidence relationships between gamma rays were used to construct an energy level scheme. New decay paths and linking transitions were discovered, however, no evidence of triaxiality has been found. Other behaviors, such as backbending, were examined by inspecting the angular momentum of the decay sequences.

VanLehn, K., Bhembe, D., Chi, M., Lynch, C., SCHULZE, Kay G., Professor, SHELBY, Robert N. Professor Emeritus , Tayor, L., TREACY, Donald J., Professor, Weinstein, A., & WINTERSGILL, Mary C., Professor "Implicit Versus Explicit Learning of Strategies in a Non-Procedural Cognitive Skill." 7th Conference on Intelligent Tutoring Systems, Lester, J.C., Vicari, R.M., Paraguacu, F. (Eds.), Springer-Verlag:Berlin Heidelberg, (2004), pp. 521-530.

> University physics is typical of many cognitive skills in that there is no standard procedure for solving problems, and yet a few students still master the skill. This suggest that their learning of problem solving strategies is implicit, and that an effective tutoring system need not teach problem solving strategies as explicitly as model-tracing tutors do. In order to compare implicit vs. explicit learning of problem solving strategies, we developed two physics tutoring systems, Andes and Pyrenees. Pyrenees is a model-tracing tutor that teaches a problem solving strategy explicitly, whereas Andes uses a novel pedagogy, developed over many years of use in the field, that provides virtually no explicit strategic instruction. Preliminary results from an experiment comparing the two systems are reported

Book Chapters

ALBERT, C. Elise, Professor, and Danly, Laura, "Intermediate-Velocity Clouds", in High-Velocity Clouds, VanWoerden, Wakker, Schwarz and DeBoer, ed., Kluwer Academic Publishers, 2004, pp. 73-100.

> Interstellar gas is widely detected at intermediate velocities, both in HI emission at 21 cm and in optical and ultraviolet observations of trace elements seen in absorption toward distant stars. In the northern hemisphere, the distribution of intermediate-velocity clouds is dominated by several large complexes, and two weaker complexes have been identified recently in the southern hemisphere. Intermediate-velocity clouds are located in the lower Galactic halo and most of them appear to be falling toward the galactic plane. They display a variety of physical conditions, but abundances consistently indicate grain disruption and a gas composition that is nearly solar. A range of models has been proposed to explain these basic characteristics but, at this time, no single scenario offers a compelling description of the intermediate-velocity cloud observations. Overall, evidence appears to be mounting in favor of identifying at least some of the intermediate-velocity clouds with the return flow of a Galactic Fountain. However, in individual cases, several different processes could also be at work and the relationship, if any, between high- and intermediate- velocity clouds is unclear. Intermediate-velocity clouds are a widespread phenomenon which may well play an important role in the dynamics and evolution of the gaseous component of our Galaxy.

BENDLER, John T., Professor, and SCHROEDER, Maria J., Associate Professor (USNA Chemistry Department), "Synthesis of 1,1-dichloro-2,2-bis[4-(4'-Hydroxyphenyl)phenyl]ethene and its Incorporation into Homo- and Heteropolycarbonates," Advances in Polycarbonates, Chapter 11, pp. 133-146. (2005)

> Polycarbonates from 1,1-dichloro-2,2-bis[4-(4'-Hydroxyphenyl)phenyl]ethene (BPC) constitute a highly-flame resistant family of engineering thermoplastics. The preparation of polycarbonates from BPC was first reported in 1964 as a copolymer with bisphenol A (BPA). A new monomer analogue of BPC, TABPC, has been synthesized which has a higher aspect ratio than BPC. This monomer has been polymerized to polycarbonates with the goal of improved ductility and heat resistance. An efficient synthesis of the monomer is reported as are the molecular weights and glass transition temperatures of homo- and heteropolycarbonates of TABPC.

BENDLER, John T., Professor, "Ductile Polycarbonates Containing Bisaryl Units: Theory and Modeling," Advances in Polycarbonates. Chapter 10, pp. 122-132. (2005)

> Theoretical arguments suggest that polymer segment geometries, and in particular, molecular aspect ratios play an important role in controlling bulk polymer ductility. Under tensile loading, competition between crazing and shear flow determines the ultimate failure mechanism of a glassy polymer. Shear yielding stresses are less variable from polymer to polymer than are craze initiation stresses and craze strengths.

SCHNEIDER, Carl S., Professor, "Cooperative Anisotropic Theory of Ferromagnetic Hysteresis," in Progress in Solid State Physics, Nova Press, June 2005

> Measurement of B(H) curves of mild steel, nickel, cobalt, Terfenol and Othonol have lead to analytic macromagnetic model in precise agreement and deeper understanding of ferromagnetic hysteresis in terms of saturation magnetization, coercive field, reversible susceptibility and domain cooperation. Sample design, experimental control and analysis are described including details of homogeneous field, stress and magnetization, shape demagnetization, eddy currents, coercive smearing, magnetoelastic vibrations and strain gage use and interpretation for both magnetostriction and stress measurement. The theory is observed from virgin and reversal hysteresis curves and reversible susceptibility. Approximations are made to describe minor loops which further reduce to the Rayleigh laws. The effects of stress before and after magnetic field change are derived from magnetoelastic energy and coherent action of Brown's micromagnetic stress field and Bozorth's global magnetostrictive stress field, with excellent agreement with

experiments. Verified predictions include stress variation of coercivity, remanence and maximum susceptibility as well as a stress crossover on the saturate hysteresis curve due to domain structure. Brown's and Bozorth's stress fields are found to act in all stress processes and are found to be nonlinear for large stress and magnetization due to their effect on domain structure. Bozorth's stress field is predicted and observed to cause creeping of stress loops and the stress demagnetization effect up to remanence where the Villari reversal occurs. Vector fields and stresses have been applied and vector magnetizations measured to extend this model to three dimensions. Rate dependent eddy current and temperature effects are described theoretically using effective fields and material anisotropy effects. The change in elastic modulus of ferromagnetic transducers can be derived from this theory so that robotic actuators can be smoothly controlled and nonlinear transducers accurately interpreted. The behavior of ferroelectric transducers can also be described by changing the variables of this theory. Application of this model beyond the physics of materials is possible.

Technical Reports

LARSEN, Jeffrey A., Assistant Professor, Read, M. T., Blythe, M., Shelly, F., Bezpalko, M., Huber, R., Manguso, L., Torres, D., Kracke, R., McCleary, M., Stange, H., Milner, A., Stuart, J., Sayer, R., Evans, J., Kommers, J., Birtwhistle, P., Spahr, T. B., "2005 BY1," Minor Planet Electronic Circular, 2005-B27, 2005.

LARSEN, Jeffrey A., Assistant Professor, (co-author), "2004 MN4", Minor Planet Electronic Circular, 2004-Y70, 2004.

LARSEN, Jeffrey A., Assistant Professor, (co-author), "2004 YD5", Minor Planet Electronic Circular, 2004-Y70, 2004.

LARSEN Jeffrey A., Assistant Professor, (co-author), "Observations of Comets", Minor Planet Electronic Circulars, 2004-Y58, 2004.

Trident Scholar Project

Normal Mode Analysis of the Chesapeake Bay

Researcher: Midshipman 1/C Grant Gillary, USN
Advisers: Professor Reza Malek-Madani (USNA Mathematics Department)
and Assistant Professor Kevin L. McIlhany,
Sponsor: Office of Naval Research (ONR)

The purpose of this project was to find the normal modes for a mathematical model of the Chesapeake Bay geometry. The method used, Normal Mode Analysis, was similar to that of Eremeev et al. [1992a] and Lipphardt et al. [2000]. Normal Mode Analysis uses a truncated basis set of velocity fields to approximate the flow for a specific body of water. The approach taken in this project uses the three modes described by Lipphardt et al. [2000] for application to Monterey Bay with one mode corresponding to flows with streamline potentials, one mode to flows with velocity potentials and an inhomogeneous mode which takes into account forcing functions at the boundaries. Linear combinations of these three normal modes are used to provide a complete picture of the flows in a specific body of water. This complete picture fills in spots in a surface current velocity field where sampling devices cannot reach. The ability to accurately extrapolate empirical surface current velocity fields can be used to provide the military with current data in coastal waters for mission planning or navigation. It is also useful for studying the spread of wet life in a body of water such as predicting the spread of oysters from man made reefs.

There is no analytical solution for the normal mode equations with a boundary as complicated as the Chesapeake Bay which has 11,684 miles of shoreline but is only 189 miles long and 30 miles wide. Therefore, the normal modes have been calculated using a finite differencing method in MATLAB® alongside the finite element based program, FEMLAB®. Convergence and accuracy of the solutions was first tested on the square, the circle and the equilateral triangle, then the normal modes were solved for the Chesapeake Bay. A representation of the bay with Universal Transverse Mercator (UTM) grid points for the coastline provided by the National Oceanic and Atmospheric Association (NOAA) was used for the calculations. This project has produced two useful products: (1) the normal modes of the Chesapeake Bay and (2) the open source MATLAB® code that uses the finite differencing method to solve boundary condition problems in complex geometries.

Presentations at Professional Meetings and Conferences

BENDLER, J. T., Professor, FONTANELLA, J. J., Professor, Shlesinger, M. F., Bartos, J., Sausa, O., and Kristiak, J., "Defect Diffusion, Free Volume and Positron Annihilation Lifetime Spectroscopy," 2005 March Meeting of the American Physical Society, Los Angeles, CA, 21-25 March 2005.

BENDLER, J. T., Professor, FONTANELLA, J. J., Professor, Shlesinger, M. F., Bartos, J., Sausa, O., and Kristiak, J., "Defect Diffusion, Free Volume and Positron Annihilation Lifetime Spectroscopy," 2005 March Meeting of the American Physical Society, Los Angeles, CA 21-25 March 2005.

BENDLER, J.T., Professor, "Highly Entangled Polycarbonates Incorporating Bisaryl Units," General Electric Global Research Invited Seminar, Schenectady, NY, 14 October 2004.

EDSALL, Douglas W., Professor and Collen, J.D., "Medical Geology and the Health of SOPAC Member Nation Populations: Is such an Investigation of Interest?" 33rd Annual SOPAC/STAR Session, Fiji, 19-24 September 2004.

FONTANELLA, John J., Professor, and EDMONDSON, C. A., Associate Professor, "Properties of Fuel Cell and Battery Materials," Office of Naval Research Capacitor Program Review, Washington, DC, 9-10 June 2005.

FONTANELLA, John J., Professor, Cox, L. A., Wathen, M., and WINTERSGILL, M. C., Professor, "A Paperless Laboratory for Introductory Physics," 129th National Meeting of the American Association of Physics Teachers, Sacramento, CA, 31 July – 4 August 2004.

HARTLEY, Daryl J., Assistant Professor (co-presenter), "Quadrupole Moments of Wobbling Bands in ^{167}Lu", Division of Nuclear Physics Meeting, Chicago, IL, 27-30 October 2004.

HARTLEY, Daryl J., Assistant Professor (co-presenter), "Two-quasiparticle Bands in ^{174}Hf Studied with Gammasphere", Division of Nuclear Physics Meeting, Chicago, IL, 27-30 October 2004.

HARTLEY, Daryl J., Assistant Professor, (co-presenter), "Search for Wobbling Excitations in Hf Nuclei: Are the SD Bands Triaxial?" Nuclei at the Limits, Argonne National Laboratory, Argonne, IL, 26-30 July 2004.

HARTLEY, Daryl J., Assistant Professor, (co-presenter), "Search for Wobbling Excitations in Superdeformed Hf Nuclei," Division of Nuclear Physics Meeting, Chicago, IL, 27-30 October 2004.

HARTLEY, Daryl J., Assistant Professor, (co-presenter), "Coulomb Excitation and Transfer reactions with Rare Neutron-rich Isotopes", International Nuclear Physics Conference, Göteborg, Sweden, 27 June – 2 July 2004.

HARTLEY, Daryl J., Assistant Professor, (co-presenter), "Beyond Band Termination in ^{157}Er and the Search for Wobbling Excitations in Strongly Deformed ^{174}Hf", Surrey, England, 5-8 January 2005.

HARTLEY, Daryl J., Assistant Professor, (co-presenter), "Search for Triaxial Superdeformation and Wobbling Mode in ^{172,171}Hf," Division of Nuclear Physics Meeting, Chicago, IL, 27-30 October 2004.

LARSEN, J. A., Assistant Professor (co-presenter), "An Observational Limit on the Number-Density of Interstellar Comets," American Astronomical Society, Division of Planetary Sciences Meeting #36, Poster 40.08.

LARSEN, J., Assistant Professor (co-presenter), "A Survey for TNOs using the APS POSS I Database," American Astronomical Society Meeting 205, Poster 56.20.

MIKULSKI, Paul T., Assistant Professor, "Atomic-Scale Tribology of Solid Lubricants", Fall **M**eeting of The Materials Research Society, 29 November – 3 December 2004.

MIKULSKI, Paul T., Assistant Professor, "Carbon, Hydrogen, and Silicon-containing Solid Lubricants", American Physical Society Meeting, 21-25 March 2005.

MUNGAN, Carl E., Assistant Professor, "Asteroid Collision with Earth: An Instructive Application of Conservation Laws," 129th American Association of Physics Teachers National Meeting, Sacramento, CA, 31 July – 4 August 2004.

Rieser, U. and EDSALL, Douglas W., Professor, "OSL Dating of Diatoms: A Potential Application of an Established Chronometric Method", 2004 Annual Fall Meeting of The American Geophysical Union, San Francisco, CA, 13-17 December 2004.

SCHNEIDER, Carl S., Professor, "Effect of Stress on the Shape of Ferromagnetic Hysteresis Loops," MMM Conference, Jacksonville, FL, 10 November 2004

VanLehn, Kurt, Shapiro, Joel, Lynch, Collin, SCHULZE, Kay G., Professor (USNA Computer Science Department), SHELBY, Robert N., Professor Emeritus, Taylor, Linwood, TREACY, Donald J., Professor, Weinstein, Anders, and WINTERSGILL, Mary C., Professor, "The Andes Physics Tutoring System: Five Years of Evaluations," AIED 2005, Amsterdam, Netherlands, Summer 2005.

TANKERSLEY, L.L. Professor (co-presenter), "Comprehensive, Field-Deployable Portable Fluid Analyzer for USMC Expeditionary Fighting Vehicle", Machinery Failure Prevention Technology Conference #59, Virginia Beach, VA, 18-21 April 2005.

TUCHOLSKI, Edward J., Commander, USN, "Nondestructive Evaluation of Aromatic Polyimide Insulated Aircraft and Spacecraft Wiring", Materials Characterization Session, 16th World Congress on Nondestructive Testing, Montreal, Canada, 30 August 2004.

WINTERSGILL, Mary C., Professor, TREACY, Donald J., Professor, SHELBY, Robert N., Professor Emeritus, SCHULZE, Kay G., Professor (USNA Computer Science Department), and Kurt VanLehn, "Andes, an Intelligent Tutor for a Two Semester General Physics Course," American Association of Physics Teachers – 129th National Meeting, Sacramento, CA, 31 July - 4 August 2004.