

Minnesota Area Association of Physics Teachers  
Fall 2008 Meeting: Gustavus Adolphus College  
Saturday October 25 2008

- 7:45 AM      **Registration and refreshments**, first floor lobby F.W. Olin Hall
- 0830 – 1035      **Contributed talks**: Room 103 F.W. Olin Hall
- 0830 – 0842      Bradley Abell and Daniel Mellema, Gustavus Adolphus College (sponsored by Thomas Huber, Gustavus Adolphus College)      **Non-Contact Modal Excitation of Micro-Cantilevers Using Ultrasonic Radiation Forces**  
Mass sensing and scanning probe microscopy utilizes modal excitation of nano- and micro-structures. Typically, these structures are observed using a mechanical shaking device to excite the structure. In order to prevent false resonances from the mounting apparatus, a non-contact technique must be used for observing modal excitation. We will present an ultrasonic excitation technique that eliminates false resonance peaks and allows for selective excitation of the symmetric or anti-symmetric resonance mode of coupled micro-cantilevers.
- 0842 – 0854      Ananda Shastri, Minnesota State University Moorhead      **Presenting the Physics of Nuclear Weapons to Non-science Majors**  
Understanding the physics of nuclear weapons is highly relevant for many reasons. The Department of Physics and Astronomy at Minnesota State University Moorhead offers two courses in which the physics of nuclear weapons is presented to non-science majors. Both courses make use of a slide rule computer, which may be easily built by students, to explore open-ended questions about nuclear weapons effects. A description of the computer will be given, and examples of its use will be discussed.
- 0854 – 0906      Keith R. Stein, Richard W. Peterson, Jack Houlton, Justin Knapp, Brandon Peplinski, Christopher Scheevel, and David Swenson, Bethel University      **Applied Physics in the Advanced Lab: Studies on Acoustic Vibrations**  
Acoustic vibrations are studied for several objects through computational and optical diagnostic techniques. Eigenfrequency analyses are carried out with COMSOL, whereas experimental optical studies utilize real-time stroboscopic holography. Comparative studies are presented for the vibrational modes and frequencies of a handbell, coffee cup and tuning fork. The combination of computational modeling and optical diagnostics provides a powerful blending that can provide students of applied physics, optics, and engineering with an enhanced upper level lab experience.
- 0906 – 0926      Bruce R. Thomas, Carleton College      **Quantum Mechanics of Classical Isochronous Oscillators**  
I always thought that there was a close connection between the amplitude independence of the frequency of a classical harmonic oscillator and the equal spacing of the energy levels of the quantum mechanical version. A recent paper (“Isochronous oscillations: Potentials derived from a parabola by shearing”, C. Anton and J. L. Brun, Am. J. Phys. 76, 537-

540 (June 2008)) shows that there are limitless possibilities for distorting the harmonic oscillator potential without destroying the classical isochronous property. What about the quantum mechanics of the distorted potentials? Are the energy levels still equally spaced? The answer seems to be “sometimes”.

0926 – 0931     **BREAK**

0931 – 0943     Nathan Moore, Winona State University

**Bread Oven Heat Flow**

This talk describes a thermodynamics problem used in a University Physics 2 class. The problem solved by students was to model the flow of heat through a block of material by simulating the "motion" of energy quanta through a solid. Students tested the qualitative validity of their simulations by comparing energy density profiles from their simulations to an experimental data set taken in the departmental bread oven (which was built by a previous Thermodynamics class).

0943 – 1003     Ken Heller and Jennifer Docktor, University of Minnesota

**Predicting Student Performance in University Introductory Physics: The Role of Physics Concepts and Math Skills.**

This talk presents the analysis of a decade of data representing thousands of students to determine the extent that high school preparation in physics concepts (as measured by the FCI) and math skills (as measured by an algorithmic math test) can predict their performance in the University of Minnesota Introductory Physics course for engineering and physical science students. Gender differences in preparation and its effect on success will also be reported.

1003 – 1023     Jennifer Docktor and Ken Heller, University of Minnesota

**Developing a Useful Instrument to Assess Student Problem Solving**

Problem solving is a complex skill that is important for learning physics. Unfortunately, there is no standard way to evaluate problem solving. A common assessment tool for such processes is a rubric, which divides a skill into multiple categories and defines criteria met to attain a score in each. We will report progress on the development of a physics problem solving rubric that is easy to use yet remains reasonably valid and reliable.

1023 – 1035     Gordon McIntosh, University of Minnesota, Morris, and Ben Rislow, College of William and Mary

**The  $v=0, J=1-0$  Silicon Monoxide Maser Emission from VY Canis Majoris**

The maser emission from VY CMa was observed from UMM using the Haystack Radio Telescope, Westford, MA, between 2003 and 2006. The polarization characteristics and temporal variations of the emission have been analyzed. The  $v=0, J=1-0$  emission exhibits an unusually long characteristic time and stable linear polarization properties. This curious behavior may indicate the origin of the emission in a stable outflow from the star.

1035 – 1100 **Poster Session:** second floor lobby F.W. Olin Hall (refreshments available)

Chenyu Yang, (adviser Dr. Steve Mellema), Gustavus Adolphus College

#### **Construction of a Low-Coherence Optical Reflectometer**

Our intent is to produce an optical heterodyning circuit for imaging reflective sample objects embedded in a highly-scattering medium. One beam of an interferometer is reflected from the sample object, and the other beam is frequency shifted by 80 MHz using an acousto-optic modulator. When the path lengths of the two beams are perfectly matched, the instrument produces a beating interference pattern. A high-speed detector coupled to a lock-in amplifier measures the intensity of the reflected light and, by scanning across the illuminated region, the sample object is imaged.

Benjamin Wolf, Daniel Mellema, and Jing Han Soh (adviser Dr. Steve Mellema), Gustavus Adolphus College

#### **Characterization of Speech Intelligibility in Christ Chapel**

At Gustavus Adolphus College, the acoustical response of both the new and old Christ Chapel sound systems was characterized by Speech Transmission Index (STI) and Clarity Index (C50) to determine the clarity of spoken voice through signal-to-noise measurements. Electronic and Acoustic System Evaluation and Response Analysis (EASERA) speech software was used to project and analyze a sound wave sent through each sound system in Christ Chapel. The overall intelligibility metrics for the new sound system were found to have improved compared to the old system. Improved speech intelligibility was seen especially in the front rows of the main floor.

Heather Cegla, Minnesota State University Moorhead; Tim Young, Tricia Johnson, and Dean Smith (University of North Dakota) (sponsored by Ananda Shastri, Minnesota State University Moorhead)

#### **Searching for Transiting Extrasolar Planets**

An optical transit method is used to try and detect extrasolar planets (exoplanets) using small telescopes. Five candidate stars with known exoplanets from radial velocity data were observed to determine whether the exoplanet was transiting within the expected time frame window. A test on a variable star showed that it is possible to detect the small change in magnitude expected with a transiting exoplanet, about 2%. Photometric methods with two different telescopes and CCD cameras were used to take photometric data for over two months. The observations confirm that two of the candidates show transits. These are known to transit and validate the procedure used here if careful photometric procedures are followed. Three other candidates were observed and did not show a definite transit. This could be due to several reasons: insufficient data of the transit, poor weather conditions, or poor telescope tracking.

Devin Kasper, Jordan Schmidt, Ananda Shastri, Minnesota State University Moorhead

#### **Nuclear Magnetic Resonance of Solid State Hydrides**

Hydrogen storage systems are very important for the development of hydrogen powered vehicles. As a result, understanding metal hydrides--metal alloys into which hydrogen may be infused, stored, and retrieved—is an important scientific problem. One such metal hydride is examined in this study using nuclear magnetic resonance (NMR). In NMR, the sample is placed in a magnetic field. The nuclei of the atoms, which have a nuclear spin, align with the external magnetic field. The relaxation time, T1, is the time required for the nuclear spins to realign with the external field after disruption, and gives information about the interactions between the nucleus and the environment. In particular, the height of the energy barrier—the barrier over which the hydrogen must jump to diffuse through the metal hydride—may be determined from an analysis of the data if T1 is measured as a function of magnetic field and temperature. T1 measurements and their analysis will be presented, with the intent of finding the barrier height for hydrogen diffusion in the hydride.

Jason Bonde and Gordon McIntosh, University of Minnesota, Morris

**The Characteristic Lifetime of Mira's SiO Maser Features**

Silicon monoxide (SiO) maser spectra of the long period variable star Mira have been observed for over five stellar periods in the  $v = 1, J = 1 - 0$  transition and a characteristic maser lifetime has been extracted. It has been suggested that the maser emissions of long period variables are reset at a certain phase of the star by the passage of a shock wave through the circumstellar region (Humphreys et al. 2002). To test this suggestion the linear polarization parameters of the SiO emission were extracted and a time series cross correlation of the polarized spectra was performed. A characteristic lifetime of 470 days was determined. This lifetime is considerably longer than Mira's optical variation period of 332 days and suggests that the masers are not reset by the passage of a shock at a particular stellar phase.

**INVITED TALKS**

**Room 103 F.W. Olin Hall**

1100 – 1145 Leon Lederman, Nobel Laureate in Physics,  
Pritzker Professor of Physics, Illinois Institute of Technology  
**Physics First: A Revolution in Science Education**

1145 – 1215 Steve Ethen, 2006 Recipient of the 2006 AAPT Excellence in Pre-College Teaching  
Award.

1230 Lunch and Business Meeting