

**MINNESOTA AREA ASSOCIATION OF PHYSICS TEACHERS  
SPRING 2010 MEETING: SAINT JOHN'S UNIVERSITY, COLLEGEVILLE  
SATURDAY APRIL 24 2010**

**Registration and coffee: 0745 – 0815**  
**Peter Engel Science Center**

————— **CONTRIBUTED TALKS SESSION I: 173 Peter Engel Science Center** —————

**0815 – 0835**

**Fritz Reiche's 1921 quantum theory textbook**

Clayton Gearhart, *St. John's University, Collegeville*

Who reads physics textbooks? Students, of course, as well as their professors and other physicists. But textbooks also give us a snapshot of a discipline, in a particular time and place, and from a particular point of view. I will introduce a widely read 1921 introductory book on quantum theory by the German theoretical physicist Fritz Reiche, a student of Max Planck and an important early contributor to quantum theory.

**0835 – 0855**

**The physical basis of natural units**

Leon Hsu, *University of Minnesota, Minneapolis*

The natural unit system, in which the value of fundamental constants such as  $c$  and  $h$  are set equal to one and all quantities are expressed in terms of a single unit, is usually introduced as a calculational convenience to students studying atomic or particle physics. However, I believe there is a physical justification as well. In this talk, I discuss the physical basis underlying the natural unit system.

**0855 – 0915**

**Point Charge Dynamics Near a Grounded Conducting Plane**

Kevin Haglin, *Saint Cloud State University, Saint Cloud*

The classic image problem in electromagnetism involves a grounded infinite conducting plane and a point charge. The force of attraction between the point charge and the plane is identified using an equivalent-field picture of an image charge with opposite sign equidistant behind the plane resulting in an inverse-squared force of attraction between the original charge and the plane. If the point charge is released from rest it will reach the plane in a time  $\tau$ . This time  $\tau$  has not been calculated correctly up to now. Clarification of the inconsistency is presented along with a correct solution to the classic image problem.

**0915 – 0930**

**Hydrophobic Surface on a Polypropylene Substrate (\*\* student talk \*\*)**

N. L. Pettit, R. Kane, C. Kahlstorf, B.L. Stottrup, *Augsburg College, Minneapolis*

We investigate a novel method to fabricate hydrophobic surfaces by heating Millipore™ Isopore filters (of different pore sizes) on a polypropylene substrate (Hsu, et al. Langmuir 2010). The surfaces are then characterized by using a scanning electron microscope and an atomic force microscope (both through the University of Minnesota's Characterization Facility) to look at the topography. We also characterize the surfaces by measuring the contact angle of the water droplet on the surface.

**0930 – 0945**

**Selective Excitation of Cantilevers using Ultrasound (\*\* student talk \*\*)**

Bryce Bjork, Dan Mellema, CJ Hunt, Thomas Huber, *Gustavus Adolphus College, Saint Peter*  
Most conventional excitation techniques require physical contact with a mechanical shaker. We discuss a non-contact technique using the ultrasound radiation force. An audio-range modulation signal is combined with a 440-kHz carrier and emitted from two ultrasound transducers. The audio frequency range encompassed nearly overlapping transverse and torsional vibrational modes of a cantilever. A phase difference was introduced between the two transducers and allowed for the resolution of the two modes, which is not possible using conventional mechanical excitation.

————— **0945 – 1030 POSTERS, DISCUSSION, REFRESHMENTS: *Location TBA*** —————

**Skylight Polarization during a Balloon Ascent**

Jeff Lind and Gordon C. McIntosh, *University of Minnesota, Morris*

This experiment attempted to measure the polarization of skylight as a function of altitude. The polarimeter used six light sensors and rotating linear polarizers and was flown on a balloon launch to an altitude of approximately 80,000 ft. The experimental procedure used to measure the polarization of skylight was determined to be inappropriate because of the instability of the apparatus during the balloon flight.

**The Lifetime of R Cassiopeia's SiO Maser Features**

Rémi Patriat and Gordon C. McIntosh, *University of Minnesota, Morris*

Maser spectra of the long period variable star R Cassiopeia have been observed over approximately four stellar periods in the silicon monoxide  $v = 1, J = 1 - 0$  transition. The linear polarization characteristics of the spectra have been determined. The lifetimes and beginning and ending phases of nineteen maser features have been extracted from Gaussian fits to the polarized spectra. This research has been supported by NSF Grant AST-0606764.

**Exploring the Magnetopause in an Undergraduate Lab**

Jim P. Crumley, Ari D. Palczewski, Stephen A. Kaster, *College of St. Benedict/St. John's University, Saint Joseph*

The standoff distance of the magnetopause is an ideal topic to use to introduce to space physics since it can be modeled as a pressure balance between the solar wind and Earth's magnetic field. We use the standoff distance as the basis of a lab for physics majors. In the lab students examine the standoff distance using an online NASA MHD simulation. They also analyze data from several spacecraft to find magnetopause crossings.

**A Magnetic Needle Viscometer for Measuring Surface Viscosity**

T.D. Lopez and B.L. Stottrup, *Augsburg College, Minneapolis*

Rheologists and biophysicists have used viscometers to measure viscosities of bulk films and their complimentary two dimensional films. We describe the construction of a surface viscometer based on the designs of the research groups of Fuller and Zasadzinski. The intension of this research is to complete an apparatus that is fully automated. Results on the canonical DPPC system will be presented illustrating the value of this device.

### **Lipid Monolayer Line Tension Measurements and Model Convolution**

A. H. Nguyen, E. Tuzel, B.L. Stottrup, *Augsburg College, Minneapolis*

Research into the phase separation of coexisting liquid phases in mixed phospholipid/sterol monolayer systems is an important experimental approach to understand the lateral inhomogeneities or “lipid rafts” within lipid membranes. We present measurements of line tensions between immiscible phases in mixed monolayer systems of phospholipids and the cholesterol analog 25-hydroxycholesterol. We will also present results obtained using Model Convolution Microscopy to study the importance and necessity of the incompressibility constraint in the Fourier analysis of lipid domains.

### **Bulk Viscosity of Subatomic (Hadronic) Matter**

Brendon Pikus, *Saint Cloud State University, Saint Cloud*

Heated and compressed subatomic matter expands unexpectedly rapidly in particle accelerator experiments. Viscosity is expected to slow the expansion but is evidently not particularly effective. We seek an answer to the question why is viscosity ineffective? We estimate the bulk viscosity of an interacting gas of light hadrons using analysis from kinetic theory. We find that the viscosity is proportional to the relativistic momentum, the particle density, and to the mean free path.

## ———— CONTRIBUTED TALKS SESSION II: 173 Peter Engel Science Center ————

### **1030 – 1050**

#### **Physics meets rock: Understanding electric guitar pickups**

Thomas Huber, *Gustavus Adolphus College, Saint Peter*

While most physics textbooks have discussions of wind and string instruments, there is generally not a discussion of how the pickups in electric guitars work. This is a topic that is of interest to students, and can be easily understood in the context of Faraday’s Law of Induction. I will discuss the basic operation of electromagnetic pickups, followed by demonstrations that illustrate how they work, and the “humbucking” method that is commonly used to reject 60 Hz pickup noise.

### **1050 – 1110**

#### **How high can you sing “la”?**

Ananda Shastri, *Minnesota State University, Moorhead*

Introductory college science courses for non-science majors strive to demonstrate how interesting questions may be addressed by applying logic and physical principles. In a recent physics of music lab for just such a course, students were asked to predict the highest “la” they might be able to sing based upon the sound spectrum of “la” spoken in a normal tone of voice. This challenge illustrates a number of interesting points in physics and scientific methodology.

### **1110 – 1125**

#### **Helium neon laser linewidth measurements (\*\* student talk \*\*)**

P. Larson and C. W. Hoyt, *Bethel University, St. Paul, MN*

We present measurements of laser linewidth for a common laboratory frequency-stabilized helium neon (HeNe) laser. The beat frequencies between the modes in two identical HeNe lasers are characterized using a high resolution (1 kHz - 1.5 GHz) spectrum analyzer. Assuming they have identical noise properties, the linewidths of the two helium-neon lasers involved in the experiment are less than 230 kHz. The measurement is limited by low frequency, high amplitude technical noise such as acoustic coupling to the environment that is not common-mode. This system can be used to directly measure the linewidth of other lasers such as external cavity diode lasers.

**1125 – 1225**

**Computer Coaches for General Problem Solving: Part 1: Research Background**

Andrew Mason, *University of Minnesota, Minneapolis*

We are developing internet based computer tutors to coach students in introductory mechanics as an extension of the Personal Assistant for Learning tool (PAL) by Reif and Scott (1999). This coach is intended to encourage a more expert-like way of thinking of problem solving in the context of solving a specific problem. This talk discusses the research background for the design and structure of the computer tutors.

**Computer Coaches for General Problem Solving: Part 2: Implementation and Design**

Qing Xu, *University of Minnesota, Minneapolis*

We describe three different types of computer tutors for student problem solving written in Adobe Flash to be accessible to students on the internet. The tutor is presented in three different modes that together combine the cognitive apprenticeship model with reciprocal teaching. We also describe the design of a study, including a pilot phase and a larger implementation phase, for an introductory calculus-based physics class for scientists and engineers.

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**1230 – 1345: Lunch, awards, business meeting (elections): *Location: TBA***