# Physics Senior Research Oral Presentations

Time of Presentation 3:57

**Muon Coincidendce Counting as an Undergraduate Experiment**

**John Hennen**

**Advisor: Dr. Brian Fick**

**Abstract:** Cosmic ray muons are detected by placing two scintillators with attached photomultiplier tubes in line with one another such that incident rays with strike both detectors in coincidence. The use of a Data Acquisition Board in counting and analyzing this coincidence allows for a plethora of experiments appropriate for undergraduate laboratories in exploring properties of cosmic rays. These experiments include muon flux at sea level, muon flux as a function of zenith angle and solid angle of the two detectors, cosmic ray shower studies and muon lifetime experiments. From the data collected, students can quantify the speed of muons through analysis of time dilation and known altitude of muon creation. Attenuation of muons can also be analyzed as a function of atmospheric depth and density. Thus far several groups have successfully used the apparatus in experiment have quantified muon flux both generally and from specific directions.

Time of Presentation 4:10

**Modification to the Scanning Tunneling Microscope Laboratory**

**Erich Kinder**

**Advisor: Dr. John Jaszczak**

**Abstract:** We will discuss changes and improvements implemented in The Scanning Tunneling Microscope (STM) laboratory. This laboratory is a part of the Modern Physics Lab. It is used as an instructional training facility for junior level physics students. We added a section to the laboratory, where students measure the electron tunneling current of the STM. This current is then related to the distance between the tip and sample. From this information the work function is computed. Additionally, we designed and constructed an electrochemical process for etching ultra-sharp STM tips. This modified version of the lab is now in use by students taking Modern Physics Lab allowing students to take quantitative data during the time allotted during the class.

Time of Presentation 4:23

**Long Term Viability of Solar Cells Sensitized with Bacteriorhodopsin**

**Chris Schafer**

**Advisor: Dr. Craig Friedrich**

**Abstract:** Simple chemical solar cells were produced through electrodeposition of the protein bacteriorhodopsin, using aluminum as a substrate and a potassium electrolytic solution. Testing was conducted on the order of two hours; the first five minutes were in ambient light followed by 115 minutes of direct exposure to a white incandescent bulb. Of the five samples from the first round of manufacture, four showed an average increase of 200mV upon activation of the bulb. Three of the samples showed an exponential decrease in voltage during the 115 minutes of exposure, with one holding at the maximal value. Repeating the production technique of the original five, four new samples were manufactured. Of these four, three showed the same increase of 200mV. Two of the four samples showed periodic changes in voltage during the exposure. Subsequent testing of the nine samples resulted in a near complete loss of photoactivity. From these results, it is proposed that extended exposure to the electrolytic solution resulted in the denaturing of the protein and deactivation of the sample.

Time of Presentation 4:36

**Comparing Exotic Particle Simulations to Auger Showers**

**Nathan Kelley-Hoskins**

**Advisor: Dr Brian Fick**

**Abstract:** Work is presented on developing a neural network program to classify double cosmic ray showers. Cosmic ray research provides a method to study particle physics at ultra high energies (> 10^20 eV). The Pierre Auger Observatory detects cosmic rays, and their subsequent showers in the atmosphere. The final analysis of cosmic ray showers is constructing a plot of the amount of mass in the shower at any particular time, where the original particle determines the structure of the plot. On rare occasions, a second shower will take place among the interactions of the first shower, and this will cause a distortion in the shower's mass plot. By simulating theoretical exotic particles hitting the Auger array, a neural network is trained with the goal of having it successfully classify Auger showers as either single or double showers.

Time of Presentation 4:49

**The Temperature Dependence of the Latent Heat of Fusion of Water**

**Tony Szedlak**

**Advisor: William Cantrell**

**Collaborators: Alexander Kostinski, Alexandria Johnson**

We present new measurements demonstrating the strong temperature dependence of the latent heat of fusion of water. These measurements diverge from Kirchoff's relation quite noticeably. In addition, we submit that the latent heat of fusion measured at any given temperature is subject to the type of calorimeter used. Use of a heat flux differential scanning calorimeter (DSC) produced different results from a power-compensated DSC. The entropic reasons for these discrepancies are discussed. The precise measurement of the latent heat of fusion is critical to calculating the dynamics of computer simulated clouds, since heat released in a nucleating cloud increases its buoyancy. Increased knowledge of the heat released in nucleation allows for more accurate weather forecasts.

Time of Presentation 5:05

**The Determination of Carbon Nanotube Capacitance by Cyclic Voltammetry**

**Dan Freeman**

**Advisor: Yoke Kim Yap**

**Abstract:** Experiments were conducted attempting to ascertain the capacitive characteristics of carbon nanotubes fabricated using different growth techniques. Specifically, cyclic voltammetry was used to determine the capacitance of carbon nanotube samples grown with plasma-enhanced chemical vapor deposition on low-resistivity silicon wafers as 42.4 $\mu F/cm^2$ in 6M KOH solution. Future work will include the testing of samples grown using different techniques. This presentation will discuss the utility of cyclic voltammetry as a technique to measure capacitance in irregular or undersized samples, several possible growth techniques for carbon nanotubes, and the broader motivation for using carbon nanotubes as a material in capacitors.

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