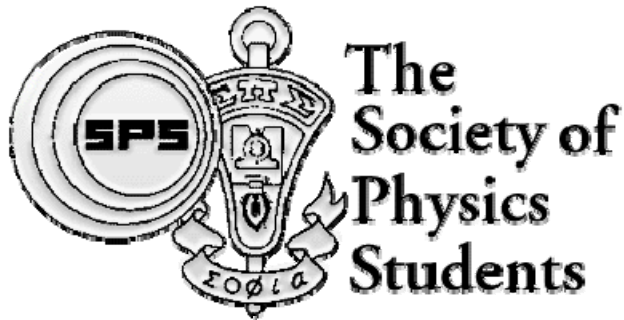


Society of Physics Students Zone 14 Regional Meeting Conference Report

**Mesa State College
Grand Junction, CO
November 10, 2007**

By: Dr. Chad A. Middleton, SPS Advisor, Mesa State College chapter



Colorado and Wyoming Chapters

Website: <http://home.mesastate.edu/~chmiddle/Zone14.htm>

On Saturday, November 10, 2007, the Mesa State College Chapter of the Society of Physics Students hosted a Zone 14 Regional Meeting with 35 students and faculty attending from 5 colleges & universities. The colleges/universities represented included Metropolitan State College of Denver, the University of Wyoming, the University of Colorado, Denver, Colorado State University, and Mesa State College.

The conference began at 9 am in the Medesy Hall lobby where the attendees registered for the conference and were given nametags and a conference schedule spelling out the day's activities. An informal breakfast was provided which included a variety of pastries, juice, and coffee. This casual setting provided a relaxed environment where the conference attendees could meet one another.

The morning session began with opening remarks from Dr. Russ Walker, the department chair of the Department of Physical and Environmental Sciences, and was followed by an introduction of the invited speaker given by Krystyna Dillard-Crawford, the Zone 14 Associate Councilor and 2006-07 MSC SPS President. Dr. Christopher L. Halloway, research scientist from the National Institute of Standards and Technology (NIST), followed with two invited 1-hour talks entitled "*Metamaterials and Metafilms: Overview and Applications*" and "*Propagation and Detection of Signals before, during and after a Building Implosion*".

The morning session was then followed with an hour-long lunch break. Conference attendees were entertained with two physics demonstrations carried out by several MSC SPS students. The physics demonstrations included the implosion of a 55-gallon drum and MSC student Rick Johnston laying on a bed-of-nails while having a cinder block smashed on his chest by the brute force of a sledgehammer. These physics demonstrations showcased some of the activities performed here on the MSC campus.

The afternoon session was divided in two with 10 presentations delivered by SPS students and faculty members on topics including research, outreach, and community service events. Dividing the afternoon session was a tea and cookie break. During the break conference participants were able to witness the poster presentation.

After the closing remarks were delivered by MSC SPS President Allison Cormier, several of the conference participants met at a local restaurant to recap on the day's events. The Zone 14 Regional Conference provided an excellent opportunity for several SPS chapters to gather and to showcase some of the research and activities being carried out by SPS students and local chapters.





ABSTRACTS

“Metamaterials and Metafilms: Overview and Applications”

Dr. Christopher L. Holloway,
National Institute of Standards and Technology (NIST) Electromagnetics Division

In recent years, there has been a great deal of attention directed towards metamaterials (i.e., engineered or man-made materials). In the context of electromagnetics, examples of these are artificial dielectrics, photonic bandgap structures, and frequency-selective surfaces. More specifically and recently there have been studies on the properties and potential applications of double negative (DNG) materials. DNG materials are a class of metamaterials, also known as negative-index materials, backward media (BW), or left-handed materials, for which the effective permittivity and effective permeability are simultaneously negative. This class of metamaterials has a wide range of potential applications in electromagnetics, optics, electronics, and *fairy tales*: (1) shielding materials, (2) low-reflection materials, (3) substrate materials, (4) antenna applications, (5) electronic switches, (6) the so-called perfect lens, (7) resonators, and (8) cloaking objects (*from Klingon's ships to Harry Potter*).

Metamaterials are commonly engineered by arranging a set of scatterers embedded throughout a region of space in a specific pattern so as to achieve some desirable bulk behavior of the material. This concept can be extended by judiciously placing scatterers in a two-dimensional pattern at a surface or interface. This surface version of a metamaterial has been given the name metafilm. More specifically, a metafilm is a surface distribution of electrically small scatterers characterized by electric and magnetic polarizability densities. These metafilms can be used in many of the same applications as metamaterials, however, the metafilms easier to design and manufacture.

In this talk, we will introduce and summarize the theory and applications of metamaterials and metafilms. We will also summarize the research of EEEL Division 818 in these new classes of materials.

“Propagation and Detection of Signals Before, During, and After a Building Implosion”

Dr. Christopher L. Holloway
National Institute of Standards and Technology (NIST)
Electromagnetics Division

The National Institute of Standards and Technology (NIST) is involved with a project related to homeland security. In this project we will investigate communications problems for first-responders (firefighters and police) in disaster situations (i.e., collapsed buildings). We will also be investigating various schemes for locating firefighters and civilians who may have portable radios or cell phones and are trapped in voids in the collapsed building. Part of this work utilizes buildings that are scheduled to

be imploded. We place rf transmitters in various locations in the building. The transmitters will transmit at frequencies near public safety and cell phone bands (approximately 50 MHz, 150 MHz, 250 MHz, 400 MHz, 900 MHz, and 2 GHz). Once the transmitters are in the building, the building will be imploded. We measure the received signals, before, during, and after the building is imploded. Once the building is down, we investigate various location schemes which will involve searching with directional antennas and connecting instruments to some of the metal debris located on the perimeter of the collapsed building.

We have finished three such set of experiments, one in a 13 story apartment complex in New Orleans, a second one at the Veterans Stadium in Philadelphia, and a third one at the Convention Center in Washington, DC. In this presentation, we will summarize the experiments in New Orleans, Philadelphia, and Washington DC. This will be a multi-media presentation where we will show photos, videos, and News clips of the building implosion. We will also show primary results of the data we collected and discuss some of the interesting propagation effects we observed.

“Properties of p-n junctions in doped silicon photovoltaic cells”

Sherry Orton
Department of Physical & Environmental Sciences
Mesa State College

To construct a photovoltaic cell, doped silicon is layered to form a p-n junction similar to that in diodes and transistors. The properties of that junction, combined with the band gap of the material, determine the electrical characteristics of the cell, and its ultimate ability to produce electricity.

“Fluorine NMR study of Antimony Penta-Fluoride”

Heidi Martin, Frances Rivera with Professor Rudiger Michalak
Department of Physics & Astronomy
University of Wyoming

Antimony pentafluoride, SbF_5 , is a very viscous liquid at room temperature whose structural details are not well understood. The distribution and relative abundances of fluorine coordination clusters as a function of temperature are of great interest for the emerging catalyst role of doped SbF_5 . A fluorine NMR (Nuclear Magnetic Resonance) study between the vaporization and solidification temperatures of SbF_5 was carried out.

The data was obtained on a standard Bruker liquid NMR Spectrometer at moderate field value (400 MHz). We analyzed the raw data with a baseline correction, Fourier transform, and phasing. The point height, relative height, and line position of each peak was determined as a function of temperature.

The data show clearly three distinct fluorine coordination's throughout most of the studied temperature range. This is a significant improvement to the only available earlier NMR data on which much recent structural simulation of fluorine clusters has been based.

“Higher Dimensional Gauss-Bonnet FRW Cosmology”

Dr. Chad A. Middleton
Department of Physical & Environmental Sciences
Mesa State College

We examine the effect on cosmological evolution of adding a Gauss-Bonnet term to the standard Einstein-Hilbert action for a $(1 + 3) + d$ dimensional Friedman-Robertson-Walker (FRW) metric. By assuming that the additional dimensions compactify as a power law as the usual 3 spatial dimensions expand, we solve the resulting dynamical equations and find that the solution may be of either de Sitter or Kasner form depending upon whether the Gauss-Bonnet term or the Einstein term dominates

***“Higher Dimensional Gauss-Bonnet FRW Cosmology
with a Cosmological Constant”***

Krystyna Dillard-Crawford
Associate Zone 14 Councilor
Society of Physics Students

Working on the model previously investigated by Andrew et. al., we have been exploring the influence of a cosmological constant term on the Einstein + Gauss-Bonnet field equations. Looking at a special case when the Gauss-Bonnet constants are related to the cosmological constant, we obtain a solution for the Hubble parameter and the scale factor.

“Patent Law and Scientific Careers”

Rebecca Hale

Patent law is an important part of scientific activity. Researchers benefit from a basic understanding of the laws governing the issuance of patents, as well as their enforcement. Likewise, an education in the sciences can be applied to a career in law.

“Droplet-Based Microfluidics: Novel technology through theoretical and computational advances”

Dane Taylor
Electrical Engineering
University of Wyoming

With the emergence of new droplet-based, small-scale fluidic technologies, there is a great need for interdisciplinary scientific research. While Classical Fluidics is in many ways a well-matured science, describing and predicting small-scale fluids is very much a new field. A major result of the silicon revolution and the push for developing smaller integrated circuits has been to provide the ability to manufacture at a very small scale. This has in turn led to new technologies such as micro-electromechanical (MEM) devices and precise surface structuring, which can ultimately be used for droplet manipulation. These developing technologies have in turn led to further technologies such as micro- and nano-scale pumps, “lab on chip” designs, new

methods of separating and sequencing genomes, “super-hydrophobic” surfaces, and nano-wicking fabrics to name a few. While the advent of silicon manufacturing has allowed for these new technologies, there has not been sufficient time for the development of a broad scientific base. Furthermore, the time investment required for the development of new prototypes has been a major limiting factor on progress. Computer simulations, namely the Lattice Boltzmann Method (LBM), allows for accurate simulation of small droplets. LBM, a discretized form of kinetic theory, allows for an accurate recovery of fluid conservation laws by time-stepping particle densities in a 6-dimensional phase space.

“Statistical Issues in Ensemble Quantum Computing”

Dr. David Collins
Department of Physical & Environmental Sciences
Mesa State College

In the standard model of quantum computing, information is represented via the states of a single quantum system, which can be prepared in a known initial state. Quantum algorithms are implemented by allowing the system to evolve under a sequence of unitary transformations, after which information is extracted by performing a projective measurement.

In the ensemble model of quantum computing, the algorithm is implemented on an entire ensemble of identical quantum systems, none of whose initial states are known with certainty. Measurement outputs consist of sample averages over the ensemble. These are inherently probabilistic. In this talk I shall discuss the implications of this for the Deutsch-Jozsa and Grover algorithms and provide constraints on the initial states of the ensembles for these algorithms to outperform their classical competitors.

“SPS Zone 14 Retrospective”

Dr. Richard J. Krantz
Physics Department
Metropolitan State College of Denver

As the outgoing Zone Councilor I will provide some historical perspective on SPS activities in Zone 14. As a result of this presentation I would like to initiate a discussion on 1) recruiting new members, 2) reinvigorating inactive chapters, and 3) engaging active chapters in zone-wide activities.

“Physics in the Regional Economy: the Community Prototyping Lab”

Dr. Randall Tagg
Physics Department
University of Colorado Denver

We have set up a new laboratory for students to develop prototypes for small businesses who need assistance in designing new products. The lab, called the Community Prototyping Lab (CPL), is a collaboration between a nonprofit called Micro Business Development (MBD), the University of Colorado Denver (UCD) (including both the downtown and health sciences campuses), Metropolitan State College of Denver (MSCD), and other institutions. Students at UCD may apply their work at CPL towards a

Certificate in Scientific Foundations of Technical Innovation. This certificate includes two design projects and six online short courses on topics in scientific instrumentation and laboratory methods, such as materials, actuators, electronic signal conditioning, sensors, optical systems design, etc. The goal is to enable physics students to come up to speed quickly on the various technical domains needed to make a working prototype for a client. Upon success, students are then guided to develop their own invention. We call this the "invent it forward" sequence where students first help a client and then help themselves by applying physics to real-world product design and innovation. The Community Prototyping Lab itself is designed to function as the ultimate inventor's "garage" to provide the supplies, tools, and instruments for such work.

“A New Grad Program for Physics at UWYO”

Dr. Rudy Michalak
Department of Physics & Astronomy
University of Wyoming

In S'08 the department of physics and astronomy adds a graduate program in condensed matter physics to its existing graduate program of astronomy. Exciting new condensed matter physics labs have been built in F'07 and will be built in F'08 which focus on applied aspects of thin film based magnetic storage (future RAM technology). Recently, the noble prize in physics has been awarded to pioneers in the field (giant magneto-resistance).

A comprehensive core of graduate classes is being developed to this end with emphasis on solid state physics (transport, magnetism, superconductivity, etc). The core courses are complemented by a variety of elective courses which will cover phenomena from plasma physics to nuclear and particle physics.

“Wave Tank Physics”

Dr. Bill Tiernan
Department of Physical & Environmental Sciences
Mesa State College

A simple water tank is a system that can produce a rich variety of wave phenomena that can be explored experimentally. The variation of wave speed with depth, dispersion, solitary waves, and internal waves can all be investigated with a simple wave tank. This talk will describe the process of building a wave tank and analyzing the speed of shallow water waves ($\lambda > h$) using a digital camera and free software available on-line.