SOCIETY OF PHYSICS STUDENTS

RANDOLPH COLLEGE

ZONE 4 MEETING 2009

Speaker & Abstract List

Times are Tentative

Please see program schedule for additional events, and website for updates and more information: http://physics.randolphcollege.edu/sps

Saturday, April 18: Martin Science Building, Room 315

9:30 Invited Speaker: Dr. Robert Loughman, Hampton University

Additional Authors: M. Patrick McCormick, James M. Russell III, William Smith, Bill Paterson, Omar Torres, John Anderson, Stanislav Kireev, and Hovakim Nazaryan, Department of Atmospheric and Planetary Sciences, Hampton University

Atmospheric and Planetary Science Research Opportunities at Hampton

A planetary atmosphere is a fascinating natural environment, in which radiation, chemistry and dynamics interact in several interrelated physical systems. Controlled experiments in the conventional sense are impossible, complicating the task of characterizing these complex (and even chaotic) systems. Sustained measurement campaigns provide the data necessary for applications such as weather forecasting and climate monitoring, while more targeted measurements focus on problems such as biomass burning and stratospheric ozone depletion. The Department of Atmospheric and Planetary Sciences at Hampton University is intimately involved in the research that enables these atmospheric measurements. Our faculty includes the Principal Investigators for several recent NASA missions, and our research activities have been consistently supported by NASA, NOAA and the Department of Defense. The scientific basis for our ongoing research will be described, as well as the research opportunities available for undergraduate and graduate students at Hampton University.

10:15 (or 10:30) Student ORAL Presentations

Ralph Edezhath, University of Maryland

Additional Authors: Dr. Zackaria Chacko and Christopher Krenke, University of Maryland

An extension to the Standard Model: Scalar Quirks

We will discuss the motivation, qualitative nature and collider signals of an extension to the Standard Model. The extension involves adding new scalar particles that are charged under a new SU(3) confining group (infracolor) that is similar to the SM strong color, but are at a different mass scale. They are also charged under the SM strong color. An overview of the Standard Model will also be given.

… (continued) Saturday, April 18: Martin Science Building, Room 315**,** 10:15 (or 10:30) Student ORAL

Stephanie Ferrone, University of Maryland, Baltimore County

Advisor: Todd B. Pittman, Associate Professor, Department of Physics, UMBC

Quantum Interference Effects with Multimode Fibers

The idea of quantum interference effects is one that is central to the problems of quantum computing and quantum teleportation, among other ideas at the forefront of scientific discovery. Of particular interest are quantum interference effects with entangled photons. Current work in this field is being done using the propagation of entangled photons in single mode fibers. However, the precision required to align single mode fibers prior to conducting any research is very high and thus takes great amounts of time to obtain and is easily disrupted. Therefore it would be greatly desirable to be able to replace single mode fibers in quantum research with multimode fibers. Before that is done, however, the properties of multimode fibers in photon entanglement experiments must be examined to determine how they compare to those of single mode fibers. The goal of this research, therefore, is to determine the comparative efficacy of multimode fibers with an eye to their replacement of single mode fibers in quantum research. This work was funded, in part, by the National Science Foundation (NSF) under grant No. 0652560.

Luke Alan Johnson, University of Maryland, College Park

Additional Authors: Xi Shao, K. Papadopoulos, University of Maryland

Using Particle-In-Cell (PIC) Simulations to Understand the Role of Surface Plasmon in Enhancing Transmission through Sub-Wavelength Aperture-Gratings

It has been demonstrated [1] and modeled [2] that by taking advantage of surface plasmons that flow along the apertures, higher than expected transmission at wavelengths longer than the diffraction limit can be achieved which yields the promise of improved resolution. We have modeled extraordinary transmissions through a periodic grating with sub-wavelength apertures in a two-dimensional particle-in-cell (PIC) code. Unlike previous modeling work [2], using a particle code enables us to have a kinetic-level view of the interaction between incident wave and collective motion of surface plasmons. In the simulation, the plasmonic slab is modeled by placing electrons in two metal blocks and the background ions are treated as stationary. Using broadband signals, transmission at wavelengths much longer than the aperture width has been generated. The ratio between transmission wavelength and aperture width can be as high as ~ 60. This is much larger than the diffraction limit ~1.

[1] T. W. Ebbesen, H. J. Lezec, H. F. Ghaemi, T. Thio, and P. A. Wolff. “Extraordinary Optical Transmission through Sub-wavelength Hole Arrays,” Nature, 391, 667. 1998.

[2] S. Astilean, P. Lalanne, and M. Palamaru. “Light transmission through metallic channels much smaller than the wavelength.” Opt. Commu., 175, 4-6, 265-273. 2000.

Stephanie Ann Sparks, Joshua Handal, Northern Virginia Community College

Experiments in Inductive Magnetic Levitation

The aim of this proposal is to experimentally investigate the relative velocity dependence of the repulsive force between a magnetic configuration called a Halbach array and a system of induction coils, and apply this principle to build a laboratory model of an inductionally levitating magnetic cart. Our goal will be to achieve measurable levitation at the minimal relative speed of the magnetic cart and inductors.

11:30 Invited Speaker: Dr. Tom Michalik, Randolph College (Martin 323)

Time Travel Paradoxes

The talk will explore some possible and impossible consequences of time travel.

… (continued) Saturday, April 18: Martin Science Building, Room 315

1:30 Student POSTER presentations (students will be by posters to answer questions)

Wai Sze Cheung, Randolph College

Additional Authors: Katrina Wiechmann, Peter Sheldon, Randolph College; Hank Yochum, Marcia Yochum, Sweet Briar College

Optical Spectroscopy of Defects in Yttrium Orthovanadate (YVO4) Crystals

Yttrium orthovanadate (YVO4) is an insulating crystal used in several important and emerging optical technologies such as a solid-state laser host material and in fiber optic components for telecommunications. We are engaged in a study of the growth-related and radiation-related point defects that result in discoloration of commercial quality YVO4. These defects can reduce the usefulness of the material. Alternatively, these same defects may actually play a beneficial role in the use of YVO4 for other applications, such as the observed Anti-Stokes Luminescence (light which is converted to a higher energy due to a two-photon process in the crystal) which could make the YVO4 a candidate for blue lasers. It has been surmised [1] that some of these "useful" defects are related to oxygen vacancies in the crystal, so we are exploring the effects on defects after annealing the YVO4 in Oxygen and other gas atmospheres.

[1] Anti-Stokes emission in undoped YVO4, W. Ryba-Romanowksi, S. Golab, P. Solarz, and G. Dominiak-Dzik, Applied Physics Letters, 80, 1183 (2002).

Doug Goncz, Northern Virginia Community College

Single Bubble Single Flash Sonoluminescence Apparatus Design

The use of lighter-weight, more supple transducers in Single Bubble Sonoluminescence (SBSL) practice may allow Single Bubble Single Flash Sonoluminescence through modulation of a single cycle of an otherwise continuous sinusoidal drive signal of very long extent (of order 10^6 cycles).

A trail of non-waterproof brass membrane transducers backed with thin layers of PbZTi piezoelectric material and suspended on an icosahedral frame made from toothpicks showed some interesting behaviors: 1) The resonant frequency increased from the air-resonance to the water-resonance smoothly as the assembly was slowly immersed, and 2) an amplifier using a 9 volt battery sufficed to produce loud volumes.

It seems clear from these experiments that a fillable polyhedron with faces containing supple transducers should allow AGC (Automatic Gain Control) operation using a personal computer to obtain a stable drive level, and that on-the-fly additions to the drive would allow 1) observation of a single flash in a train of non-emitting bubble oscillations, and 2) the addition of harmonics to the drive signal, which might allow record-setting emission intensities to be reached.

On the table are the original toothpick frame, much decayed from handling, and somewhat repaired; a more sturdy frame made of soldered rings of aluminum wire sized to receive supple transducers; the supple transducers; some scraps of transducers of the type used in standard SBSL practice; and some aluminum rings commercially available which almost fit the supple transducers.

… (continued) Saturday, April 18: Martin Science Building, Room 315, 1:30 Student POSTER

Doug Goncz, Northern Virginia Community College

Air-Assisted Water Rocket

The principle of the water rocket is found as early as 1865 in "Voyage a Venus" by Achile Eyraud, and a worldwide community of amateur water-rocketeers compete with and entertain each other with "Aquajets" from the smallest hand-held child's toy to two-stage missiles designed to ascend 300 meters by the reaction force to water expelled by high pressure inert gases or air.

SPS-level college students can easily complete the disclosed design, made from very common materials, and most importantly, do "real physics" with the resulting tube-launched water rocket by collected measurements of first, initial pressure and water mass fill, then at apogee by triangulation with a simple survey tool, the altitude reached.

The most difficult part of fabrication is using a hand electric power drill and hole saw to cut a hole in the end of a large food can, leaving sharp edges which must be smoothed with a file before assembly into a cylinder, leaving the edges inside where there is very little risk of injury.

Catherine Khoo and Nema Marjana, Randolph College

Additional Author: Kacey Meaker, University of California, Berkeley (Randolph College ’08)

The Human-Sized Hamster Wheel Power Generator

In 2007, The Randolph College Society of Physics Students started planning to design and build a human-sized hamster wheel that would be connected to a generator which will store our human-powered energy in batteries, or will directly power small appliances. The main goals of this research, design, and build project are: For the students to be in charge of and have a design and build experience of something on a larger scale than is typical seen in the classroom; to learn and then to teach about energy use and alternative power sources; and to have the students learn to work as a team, first-years through seniors, men and women, US and international students, and bring this college community together in a fun building activity.

Katrina Wiechmann, Randolph College

Additional Author: Tom Michalik, Randolph College

Measuring Proper Motion of Barnard’s Star

Stars of the night sky are generally considered to be fixed points, not changing noticeably over generations of observations. While most stars seem to appear in the same place year after year, some change location noticeably, the best example being Barnard’s Star. Barnard’s star is closer to Earth than any other star except Proxima Centauri. It also appears to move across the sky faster than any other star. This change in apparent location is caused by the movements of our Solar System and the motion of the star in question, and is known as proper motion. Using the astrometric capabilities of the MIRA software along with precise positional information for reference stars from the Tycho satellite star catalogue, the position of Barnard’s star is computed relative to the reference stars. We calibrate a series of images of Barnard’s Star taken in the Randolph College Observatory between 2001 and 2008 in order to independently determine the coordinates of Barnard’s Star, revealing how these change over time. By measuring changes in the celestial coordinates, Right Ascension and Declination, we determine the proper motion of Barnard’s star and compare this measurement to the accepted value of 10.25” per year.

… (continued) Saturday, April 18: Martin Science Building, Room 315

2:00 (or 2:15) Invited Speaker: Dr. Chris Hughes, James Madison University
Microfluidic Devices: Better Biology Through Physics and Chemistry

3:45 Invited Speaker and Field Trip: Dr. Tatiana Toteva, Randolph College
Earthquake Physics and the Randolph College Seismograph

Dr. Toteva will discuss Earthquake Seismology and then will take the group to see the Randolph College Seismograph. Van leaves from Main Hall at 4:15 pm.