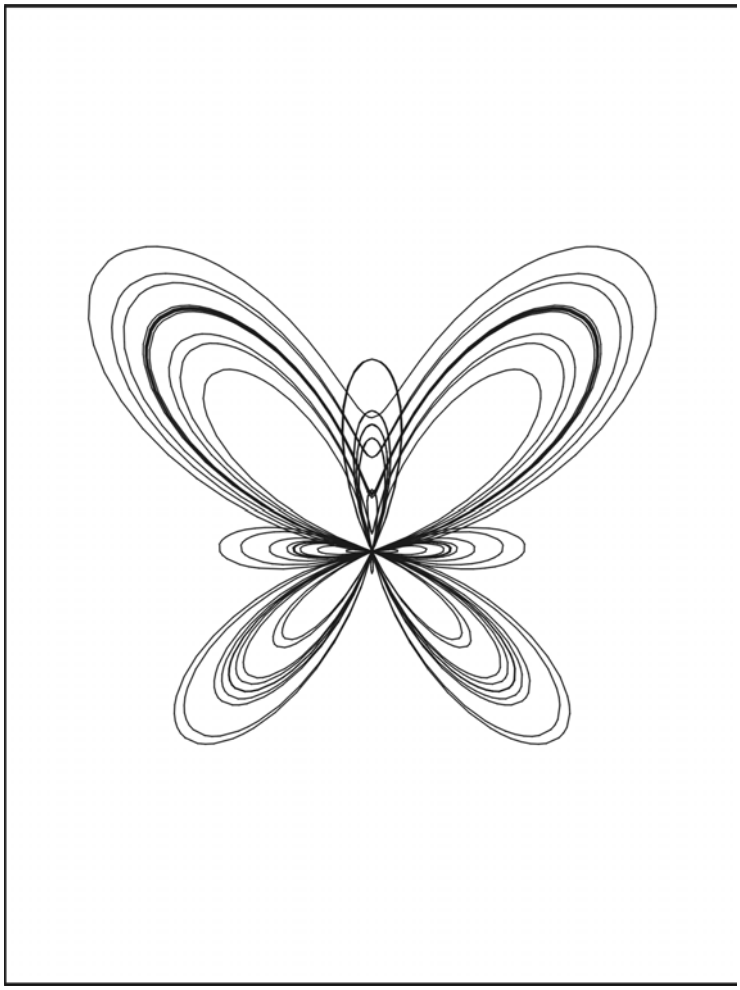
Program

18th Annual

USA/USM/SELU
Mini-Conference on Undergraduate Research in Science and Mathematics



April 9, 2009
Instructional Lab Building
Department of Physics
University of South Alabama

Schedule of Talks

All events are in room 250 of the Instructional Lab Building

Time	Title	Speaker
9:30—10:00	Registration / Get Aquainted	
10:00—10:20	***Observation of Quantum Mechanical Tunneling in Low Energy Nuclear Reactions***	Josue R. Morales-Cifuentes
10:20—10:40	***Do These Waters Meet ADEM Requirements of Water Quality?***	Chip Curtis
10:40—11:00	***Classical Orbits of PT-Symmetric Quantum Potentials***	Kyle Fortenberry
11:-00—11:15	Break	
11:15—11:45	****Search for New Physics at the BABAR and CMS Experiments***	Romulus Godang
11:45—12:15	***Isospin Breaking Measurement at the BABAR Experiment***	William Ashbee, Christopher Buchanan, Sarah Naylor
12:15—1:20	Lunch at Student Center	
1:20—1:40	***3D Displacement and Frequency Noise Free Interferometry Prototype***	Christopher Schneider
1:40—2:00	***Martensitic Transformation in V_3Si as Manifested in Resistivity, Magnetization,and Nuclear Magnetic Resonance***	Rajendra P. Khadka
2:00—2:20	***Moving Superconducting Flux Quanta with High Currents in Low-Impurity V_3Si and $LuNi_2B_2C$: Ordered Flow and Flux-Core-Size Effects***	Sunhee Moraes
2:20—2:40	***Investigating Induced Dipoles on Nanoclusters Due to an External Electric Field***	Zachary K. Bond
2:40—2:50	Break	
2:50—3:10	***Using Index of Dissimilarity to Describe Social or Economic Segregation***	Andrew Garcia
3:10—3:30	***Using Kelvin Force Probe Microscopy to Determine Contact Potential Difference.***	Richard Williams
3:30—3:50	***What Goes Up Must Go Round!***	Tyler McCleery
3:50—4:20	****Energy and Energy Policy***	Justin Sanders

* Faculty talk

Observation of Quantum Mechanical Tunneling in Low Energy Nuclear Reactions

Josue R. Morales-Cifuentes and J. M. Sanders
Department of Physics
University of South Alabama

We bombarded a lithium fluoride target with a 90 keV proton beam and observed the emission of energetic helium isotopes from the collision. We found that the measured helium isotope energies matched well with the theoretical predictions based on the break-up of a nucleus produced by the fusion of a proton and a lithium nucleus. This implies that the proton undergoes quantum mechanical tunneling.

Do These Waters Meet ADEM Requirements of Water Quality?

Chip Curtis and Madhuri S. Mulekar
Department of Mathematics & Statistics
University of South Alabama

All streams, rivers, and lakes are classified by Alabama Department of Environmental Management (ADEM) according to their designated use in Alabama. These classifications include navigable, fish and wildlife, human contact, swimming, and drinking water. The Clean Water Act of 1972 (namely Section 303D) was passed to regulate all United States waters and see that the minimum criteria for water quality is met as determined by individual states. Water quality is an important issue because it affects the safety of humans and other animals and plant life. For example, if a lake is classified for swimming and does not meet the requirements, it becomes a health hazard to all of those who swim in it. This project analyzes water quality at several stations on Dog River Watershed.

Classical Orbits of PT-Symmetric Quantum Potentials

Kyle Fortenberry and Lawrence Meade
Department of Physics and Astronomy
University of Southern Mississippi

Recently, Bender and many collaborators have studied the quantum mechanics of Ptsymmetric Hamiltonians. Even though such Hamiltonians are often complex, their spectra can be real. In this paper, we study the purely classical motion of a particle subject to the same PT-symmetric forces with real energies. It is found that particles subject to such forces wander off into the complex plane in interesting ways. In addition, we study the inverse square force; we plot the trajectory of particles in the complex plane with their initial energies having a complex component

Search for New Physics at the BABAR and CMS Experiments

Dr. Romulus Godang
Department of Physics
University of South Alabama

The precise measurements of CP violation and the CKM unitarity triangle play an important role to understand the matter-antimatter asymmetry in our Universe. Measurements around the world have confirmed the basic structure of the Standard Model. However, they also tell us that the Standard Model is an incomplete theory. Its source may lie in the properties of the Higgs bosons beyond the Standard Model at the eV scale. The Higgs bosons responsible for breaking the electroweak symmetry of the Standard Model have yet to be discovered. Discovery of the Higgs and the extra dimensions of space would be a revolutionary step in the history of science. I will describe the current status of CP violation measurements at the BABAR experiment at Stanford Linear Accelerator Center and search for new physics at the CMS experiment at CERN Large Hadron Collider.

Isospin Breaking Measurement at the BABAR Experiment

William Ashbee, Christopher Buchanan, Sarah Naylor, Dr. Romulus Godang
Department of Physics
University of South Alabama

An isospin isospin at Upsilon(4S) resonance is important input for many B meson measurements at B factories. It is due to electromagnetic interactions and the mass different of the up and the down quarks, however, the recent studies show the isospin violation can be significantly large. We present a technique to measure the isospin violation at Upsilon(4S). The data was collected with the BABAR detector at the PEP-II e+e- storage ring at the Stanford Linear Accelerator.

3D Displacement and Frequency Noise Free Interferometry Prototype

Christopher Schneider
Department of Chemistry and Physics
Southeastern Louisiana University

Displacement and Frequency Noise Free Interferometry (DFI) is a new method of gravitational wave detection. It distinguishes itself from other forms of gravitational wave detectors by using multiple interferometers for redundant sensing of the displacement of the test masses to suppress all displacement noise. In 2008, a prototype employing four mach-zehnder interferometers propagating in 3-dimensions was made at the National Astronomical Observatory in Tokyo, Japan. This work included designing, building, aligning, and testing the interferometer. The method was found to be a plausible method for implementation in future large scale detectors.

Martensitic Transformation in V_3Si as Manifested in Resistivity, Magnetization, and Nuclear Magnetic Resonance

Rajendra P. Khadka, Albert A. Gapud, and Sunhee Moraes
Department of Physics
University of South Alabama
Lloyd L. Lumata and Arneil P. Reyes
National High Magnetic Field Laboratory
David K. Christen
Oak Ridge National Laboratory
James R. Thompson
University of Tennessee – Knoxville

The Martensitic transformation is a *displacive* structural transformation in the crystal structure of a solid – so-called because the resulting change in the structure is due to a slight shift in the position of atoms displacing within the unit cell (as opposed to a *diffusive* transfer of atoms to another unit cell). This is known to occur in a few superconductors in the non-superconducting or "normal" state, at a certain temperature above the superconducting transition critical temperature T_c, and can be manifested via various measurements. The novelty of this study is that three separate measurements *for the same sample* of the A15 superconductor, V_3Si, reveal such a transformation at around the *same temperature* $T_M > T_c$: (i) as a shift in the curvature of the plot of electrical resistivity versus temperature T, (ii) as a *peak* in magnetization versus T, and (iii) as a *splitting* of peaks in the nuclear magnetic resonance (NMR) of the ^{51}V nucleus. Details of these measurements and the implications of the results are discussed.

Moving Superconducting Flux Quanta with High Currents in Low-Impurity V_3Si and $LuNi_2B_2C$: Ordered Flow and Flux-Core-Size Effects

Sunhee Moraes, Albert A. Gapud, and Rajendra P. Khadka
Department of Physics
University of South Alabama
A collaboration with:
Ames National Laboratory
National High Magnetic Field Laboratory
Oak Ridge National Laboratory
University of Tennessee

Superconductors conduct electricity with zero resistivity and are also capable of excluding applied magnetic fields from its interior (producing a well known magnetic "levitation" effect). Above a certain critical field magnetic flux starts penetrating: In so-called type II materials, this occurs in the form of *quantized* flux, or "fluxons," each of which has a non-superconducting ("normal") core sustained by a *vortex* of superconducting current. This study explores the magnetic-field dependence of the *size* of these cores as manifested specifically in the dynamics of fluxons. Fluxons can be made to *move* by applied electric current via a Lorentz force; they also interact repulsively to form equilibrium configurations. In this study, fluxons are driven towards a highly ordered "free flux flow" (FFF) dynamic state. To avoid "pinning" by sample defects, this is done in high-quality, single-crystal samples of two low-T_c superconducting compounds V_3Si and $LuNi_2B_2C$. A recent theoretical model by Kogan and Zelezhina predicts how the field-dependent fluxon core size affects FFF. **Result:** the present measurement turn out to be highly consistent with this model. In addition, details of the measurement, made technically challenging by the need for high currents of up to 60 Amperes, are also discussed.

Investigating Induced Dipoles on Nanoclusters Due to an External Electric Field

Zachary K. Bond and Hye-Young Kim
Department of Chemistry and Physics
Southeastern Louisiana University

The static polarizability of a nanocluster is an important quantity that can be used in calculation of the fully retarded van der Waals interaction between nanoclusters. The static polarizability of a cluster is a tensor, in general, and shows strong variance in magnitude and direction in the local induced dipole moment on each particle within the nanocluster. In the present work where the full many-body interactions are included, we show that the static polarizability can also be used as an indicator of the instability of the nanocluster. The instability is directly related to the "polarizability catastrophe" observed in our calculation of finite-size clusters and our numerical result of the instability agrees with that predicted from analytic calculations for infinite-size clusters. The instability depends on several factors which include: cluster size, cluster shape, and substance (density and atomic/molecular polarizability). Results of nanoclusters within non-uniform electric fields will also be presented.

Using Index of Dissimilarity to Describe Social or Economic Segregation

Andrew Garcia and Madhuri S. Mulekar
Department of Mathematics & Statistics
University of South Alabama

Sociologists, demographers, and economists often use the index of dissimilarity, *D*, to describe the extent of racial, ethnic, spatial, or areal dissimilarity (or segregation) of different socio-economic groups. Although introduced as a measure of residential segregation, it has been widely used to measure inter-group income inequalities. Over the years, different studies have interpreted it differently. Some researchers have even argued how other interpretations are misleading. This presentation will describe and compare how index of dissimilarity is used in practice.

Using Kelvin Force Probe Microscopy to Determine Contact Potential Difference

Richard Williams
Department of Chemistry and Physics
Southeastern Louisiana University

The work function of a material is defined as the energy required to remove an electron from the bulk of the material to a point directly outside the material's surface. Kelvin Force Probe Microscopy is a method for measuring work functions of materials using a Kelvin Force Probe, a small vibrating gold tip. The task was to design and construct a vacuum experiment to measure the charge distribution on the surface of materials. The Kelvin Probe was housed in a vacuum chamber with a 3-axis stage system to bring a sample into electrical contact with the probe and perform a 2D raster scanning motion. The end result is a mapping of measure charge to surface location.

What Goes Up Must Go Round!

Tyler McCleery and Lawrence Mead
Department of Physics and Astronomy
University of Southern Mississippi

Seeds of maple trees increase their dispersion range by extending the fall time through autorotation. The seed remains in the air longer than it would without rotating, which increases its chances for being blown laterally by the wind therefore increasing its dissemination. It is my intent to determine which physical parameters control the autorotation and therefore maximize this dissemination.

I started this project under the guidance of Professor Lawrence Mead in the summer of 2007. My first task was to analyze what parameters control the motion of the seed. Through dimensional analysis I used these parameters to derive equations for the dependent variables: terminal velocity, rotational speed, and coning angle. I then measured the parameters and dependent variables using various experimental techniques.

My next step is to correlate these values with the derived equations and test my theory. If the equations are correct, I will be able to study more closely how each parameter affects the terminal velocity. If the equations are not correct, I will use my experimental data to guide the correction of the derived equations.