Friday, November 19, 2010

Registration & Breakfast – 08:00 Lobby of Life Sciences Building

Session A – 08:30 111 Life Sciences Building (PSAPS)
08:30 – 08:45 Fully Differential W-prime Production and Decay in Arbitrary Models, Yaofu Zhou, Illinois Institute of Technology
08:45 – 09:00 The Daya Bay Experiment, Emily Draeger, Illinois Institute of Technology
09:00 – 09:15 Extensions to the Gaudi framework for the Daya Bay Experiment, Brandon Seilhan, Illinois Institute of Technology
09:15 – 09:30 Data Acquisition for the Daya Bay Reactor Neutrino Experiment, Qun Wu, Illinois Institute of Technology
09:30 – 09:45 Recent Results from MINOS, Nicholas Graf, Illinois Institute of Technology
09:45 – 10:00 The Long Baseline Neutrino Experiment, Robert Zwaska, Fermilab
10:00 – 10:30 Coffee Break – Lobby of Life Sciences

Session B – 08:30 104 Engineering 1 Building (PSAPS)
08:30 – 08:45 Rheology Predictions using the Discrete Slip-Link Model with Finite Extensibility, Marat Andreev, Illinois Institute of Technology
08:45 – 09:00 The role of particle inertia in microrheological data analysis, Andres Cordoba, Illinois Institute of Technology
09:00 – 09:15 Dielectric relaxation as an independent examination of relaxation mechanisms in entangled polymers using the discrete slip-link model, Ekaterina Pilyugina, Illinois Institute of Technology
09:15 – 09:30 D’yakonov-Perel’ spin relaxation for degenerate electrons in the electron-hole liquid, Matthew Mower, University of Missouri
09:30 – 09:45 Magneto-electric Control of Spin Waves, Tianyu Liu, Department of Physics and Astronomy, University of Missouri-Columbia
09:45 – 10:00 Inelastic Neutron Scattering from Hydrogen Adsorbed in Nanoporous Carbons, Raina Olsen, University of Missouri Columbia
10:00 – 10:30 Coffee Break – Lobby of Life Sciences

Session C – 10:30 111 Life Sciences Building (PSAPS)
10:30 – 11:00 Theory lessons from the Tevatron for the LHC (Invited), Zack Sullivan, Illinois Institute of Technology
11:00 – 11:30 Recent Results and Prospects for CMS (Invited), Wesley Smith, University of Wisconsin
11:30 – 11:45 Using charm tagging to discover the Higgs in semi-leptonic channel, Arjun Menon, Illinois Institute of Technology
11:45 – 12:00 New Experiments with Antiprotons, Daniel Kaplan, Illinois Institute of Technology
12:00 – 12:15 Simulation of Phi Meson Photoproduction Observation at RHIC through φ→K⁻K⁺ and φ→K-long, Jonathan Bruckman, Creighton University
12:15 – 12:30 J/ψ→μμ from 7 TeV pp collisions in ATLAS: physics with the first data, Andrew Nelson, Iowa State University
12:30 – 14:00 Lunch

Session D – 10:30 104 Engineering 1 Building (PSAPS)
10:30 – 11:00 Watching Atoms Move with Ultra-fast X-Rays (Invited), Eric Landahl, DePaul University
11:00 – 11:30 Graphene for Nanoelectronics: Important Practical Issues (Invited), Joseph Lyding, University of Illinois at Urbana Champaign
11:45 – 12:00 Observation of scale invariance and universality in two-dimensional Bose gases, Chen-Lung Hung, The University of Chicago
12:00 – 12:15 X-ray Photon Correlation Spectroscopy measurements from the dynamics of Alpha Crystallin, Vidanage Nuwan Karunarathne, Northern Illinois University
2010 PSAPS/CSAAPT Meeting

12:15 – 12:30  Density-functional studies of a vacancy in graphene, Mohammad Sherafati, University of Missouri, Columbia

12:30 – 14:00  Lunch

Session E – 14:00  111 Life Sciences Building (PSAPS)
14:00 – 14:30  The Advanced Photon Source Upgrade (Invited), Derrick Mancini, Argonne National Laboratory
14:30 – 14:45  BioCAT, Thomas Irving, Illinois Institute of Technology
14:45 – 15:00  Hard X-ray Zone Plates Fabricated with Ultrananocrystalline Diamond Molds for 60-nm-resolution, Michael Wojcik, Illinois Institute of Technology and Argonne National Laboratory
15:15 – 15:30  Localization of quantum objects in an expanding universe and cosmologically induced classicality, Caroline Herzenberg, Argonne National Laboratory (retired)
15:30 – 16:00  Coffee Break – Lobby of Life Sciences

Session F – 14:00  104 Engineering 1 Building (PSAPS)
14:00 – 14:30  Piezomagnetism, the Piezo-Barkhausen Effect, and Metal Fatigue (Invited), Thomas Erber, Illinois Institute of Technology
14:30 – 14:45  Nanofluids for Heat Transfer: An Engineering Approach, Elena Timofeeva, Argonne National Laboratory
14:45 – 15:00  Synchronization in the presence of resonant coupling, David Mertens, University of Illinois, Urbana-Champaign
15:00 – 15:15  Quantum Statistical Aspects of Anderson Localization with Second Quantized Fields, Clinton Thompson, Indiana University - Purdue University Indianapolis
15:15 – 15:45  Coffee Break – Lobby of Life Sciences

Education Workshop – 15:00  103 E1 Building (PSAPS & CSAAPT)
15:00 – 17:00  7 ways to Do Inquiry

Session G – 16:00  111 Life Sciences Building (PSAPS)
16:00 – 16:15  Field Enhancement Factor in RF Photocathode Guns at AWA/ANL - a proposed study, Eric Wisniewski, Illinois Institute of Technology and Argonne National Laboratory
16:15 – 16:30  Conformal Field Theory Approach to Black Hole Entropy, Kayleigh Cassella, Indiana University - South Bend
16:30 – 16:45  Developing a Nonresonant Acoustic Transducer Backing for Superheated Liquid Dark Matter Detectors, Emily Grace Kuehnemund, Indiana University South Bend
16:45 – 17:00  The Origin of Galactic Arms Is An External Orbit, Stewart Brekke

Session H – 15:45  104 Engineering 1 Building (PSAPS)
15:45 – 16:00  Mixing by cutting and shuffling in quasi-2D granular flows, Ivan Christov, Northwestern University
16:00 – 16:15  Mixing Properties for Cutting and Shuffling a Line Segment, Marissa Krotter, Northwestern University
16:15 – 16:30  The role of crossover recombination and inversion in determining gene spacing in a chromosome, Brian Clark, Illinois State University
16:30 – 16:45  Near-Field Studies of Temperature Induced Structural Changes in Supported Lipid Bilayer Systems, Merrell Johnson, Indiana University-Purdue University Indianapolis
16:45 – 17:00  Supported Stacked Lipid Bilayers, Curt DeCaro, Northern Illinois University

Poster Session – 17:00 – 18:30  EXPO Hermann Union Building

Buffet Banquet – 18:30  EXPO Hermann Union Building
20:00 – 20:30  Seeing Order in Chaos, Robert Krawczyk, Illinois Institute of Technology

Saturday, November 20, 2010

Registration & Breakfast – 08:00  Lobby of Life Sciences Building
Session I – 08:30 111 Life Sciences Building (CSAAPT)

08:30 – 08:45  Improvements to the Learning Environment using Technology, Ray Burnstein, Illinois Institute of Technology

08:45 – 09:00  Identifying the resources of the urban physics student, Mel Sabella, Chicago State University

09:00 – 09:15  What's New and Exciting in Particle and Astro-Particle Physics, Christopher White, Illinois Institute of Technology

09:15 – 09:30  Variations on the vibrating string lab, Andrew Morrison, DePaul University

09:30 – 10:15  Acoustics and the Classroom (Invited), Stephen Lind, Trane Acoustics Lab

10:15 – 10:45  Coffee Break – Lobby of Life Sciences

Session J – 08:30 104 Engineering 1 Building (PSAPS)

08:30 – 08:45  Matter and force particle modeling with a four-dimensional spin-based space, Steven Mulhall, Hospira, Inc

08:45 – 09:00  Thermodynamics and Panpsychism, Explored (II), Ted Erikson, R/E Unltd. Chicago Section APT

09:00 – 09:15  In Search of Event Horizons using the Equivalence Principle, John Laubenstein, IWPD Research Center

09:15 – 09:30  Four-dimensional Physical Space, Thomas Sills, Wilbur Wright College

09:30 – 09:45  The Formation of Spaces in the Universe and Its Expansion, James Wang, CNTV

09:45 – 10:00  North/South Deep Fields Demolish the Copernican Principle, Charles Sven

10:00 – 10:30  Coffee Break

Poster Session – 10:00 – 12:00  Lobby of Life Sciences Building

Session K – 10:45 111 Life Sciences Building (CSAAPT)

10:45 – 11:00  Interesting Stories in the Life of Isaac Newton, Scott Beutlich, Crystal Lake South High School

11:00 – 11:15  Establishing a nuclear and particle physics instructional thread in the Chicago State University Physics Program, Chaan Thomas, Chicago State University


11:30 – 11:45  The Ballistic Pendulum - What else is it good for?, Paul Dolan, Northeastern Illinois University

11:45 – 12:00  Proportional reasoning as a predictor of success in introductory physics (Invited), Steven Kanim, New Mexico State University

12:00 – 14:00  Lunch

Session L – 10:30 104 Engineering 1 Building (PSAPS)

10:30 – 10:45  Photoproduction at Relativistic Heavy Ion Collider with STAR, Yury Gorbunov, Creighton University

10:45 – 11:00  Time resolved Compton scattering for a model fermion-boson system, R. Wagner, Illinois State University

11:00 – 11:15  Decomposition based imaging in longitudinal obstacle arrangements, Ben Rogers, Illinois State University

11:15 – 11:30  Superluminality vs causality in quantum mechanics, Ben Shields, Illinois State University

11:30 – 11:45  Einstein’s time dilation in relativistic two-particle system, Matt Morris, Illinois State University

11:45 – 12:00  Why do charged particles have the same magnitude of charge e? Dennis Crossley, University of Wisconsin-Sheboygan

12:00 – 12:15  Compressed Air/Vacuum Transportation Techniques, Shyamal Guha, Texas Southern University

12:15  PSAPS Meeting Ends

Education Workshop – 13:30 111 Life Sciences Building (CSAAPT)

13:30 – 15:30  Workshop on NTIPERS: Research-Based Reasoning Tasks for Introductory Mechanics
Oral and Poster Presentation Abstracts

Friday, November 19, 2010

Session A – 08:30

111 Life Sciences Building (PSAPS)

08:30  Fully Differential W-prime Production and Decay in Arbitrary Models

Yaofu Zhou, Illinois Institute of Technology

We present the fully differential production and decay of a W-prime boson, with arbitrary vector and axial-vector couplings, to any final states at leading order. We develop a computer code that interfaces with the MadEvent event generator, which takes any Lagrangian involving a W-prime boson and produces the W-prime width, effective couplings to fermions, and other information related to model-independent measurements. We provide numerical predictions of the contribution of a W-prime boson to l^+/-nu and single-top-quark production in models with standard-model-like couplings, topflavor models, and five dimensional left-right symmetric gauge theory.

08:45  The Daya Bay Experiment

Emily Draeger, Illinois Institute of Technology

The goal of the Daya Bay Reactor Neutrino Experiment is to determine the last unknown mixing angle ($\theta_{13}$) to 0.01 in $\sin^2(2\theta_{13})$. The experiment is using eight identical detectors that are placed in three underground experimental halls. These halls are located at different baselines from six reactor cores. This talk will present a brief overview and current status of the Daya Bay experiment.

09:00  Extensions to the Gaudi framework for the DayaBay Experiment

Brandon Seilhan, Illinois Institute of Technology

The DayaBay reactor neutrino experiment has adopted the Gaudi software framework developed and maintained by various LHC collaborations. Daya Bay has no inherent time discretization such as beam crossings or spills present in accelerator based experiments. This talk outlines extensions to the framework by the Daya Bay collaboration to allow continuous, time-correlated analysis and Monte Carlo production.

09:15  Data Acquisition for the Daya Bay Reactor Neutrino Experiment

Qun Wu, Illinois Institute of Technology

The Daya Bay Reactor Neutrino Experiment is designed to precisely measure the last unknown neutrino mixing angle ($\theta_{13}$). The goal is to measure $\sin^2(2\theta_{13})$ with a precision down to 0.01 or better. To reach this goal, the Daya Bay experiment employs multiple detectors in different sites. The data acquisition system designed for the experiment consists of VME-based front-end electronics system, trigger system and on-par data acquisition. A detailed view of the Daya Bay data acquisition system will be given.

09:30  Recent Results from MINOS

Nicholas Graf, Illinois Institute of Technology

The MINOS long-baseline experiment is using the NuMI neutrino beam to make precise measurements of neutrino flavor oscillations in the "atmospheric" neutrino sector. MINOS observes the $\nu_\mu$ disappearance oscillations seen in atmospheric neutrinos, tests possible disappearance to sterile $\nu$ by measuring the neutral current flux, and extends our reach towards the so far unseen $\theta_{13}$ by looking for $\nu_e$ appearance in this $\nu_\mu$ beam. The magnetized MINOS detectors also allow tests of CPT conservation by discriminating between neutrinos and anti-neutrinos on an event-by-event basis. The intense, well-understood NuMI neutrino beam created at Fermilab is observed 735km away at the Soudan Mine in Northeast Minnesota. High-statistics studies of the neutrino interactions themselves and the cosmic rays seen by the MINOS detectors have also been made. MINOS started taking beam data in May of 2005 and is now nearing the end of it's five-year run.

09:45  The Long Baseline Neutrino Experiment

Robert Zwaska, Fermilab

The Long Baseline Neutrino Experiment (LBNE) is a proposed facility comprising a long-baseline neutrino beam from Fermilab and detectors in the Deep Underground and Science and Engineering Laboratory (DUSEL) in Lead, South Dakota. This experiment will undertake detailed investigation of neutrino mixing parameters, particularly
searching for evidence of CP violation in the lepton sector. At Fermilab, an intense muon-neutrino beam will be produced using 120 GeV protons from the Main Injector synchrotron and a conventional target, horns, and decay pipe system. 1300 km away, in DUSEL large detectors will observe neutrino interactions from neutrinos that have transited from Illinois to South Dakota. The large detectors required for these measurements will also enable more precise measurements of the proton lifetime, diffuse (relic) neutrinos from ancient supernovae, and provide large samples of neutrinos from galactic supernovae. I will describe the physics under investigation, the plan for the experiment, and show examples of beam devices and detectors from previous facilities.

During elongational experiments, the chain extends more than in shear flow, violating the assumption of Gaussian strand statistics, exploited in earlier implementations of the model. Therefore, finite extensibility (i.e. the tension going to infinity at finite elongation) is included in the model and its effect on flow predictions is examined.

08:45 The role of particle inertia in microrheological data analysis

Andres Cordoba, Illinois Institute of Technology
Jay Schieber, Illinois Institute of Technology
Tsutomu Indei, Illinois Institute of Technology

Viscoelastic properties of condensed soft matter can be estimated by following the trajectory of an embedded micron-sized in a method called passive microbead rheology. The technique can probe time and length scales where traditional rheological techniques cannot reach. This makes the technique well suited to analyze the rheological and mechanical properties of highly heterogeneous materials such as protein networks (e.g.: collagen and F-actin). The Generalized Stokes Einstein relation (GSER) is the most widely used model to analyze microbead rheology results. GSER does not explicitly take into account particle inertia. However, upon closer inspection we find that the derivation of this equation did not eliminate particle inertia effects in a rigorous, self-consistent way. Here we present a complete and self-consistent model and show that it can be used to analyze materials with a wide spectrum of relaxation time scales.

Our starting point for microbead rheology data analysis is a stationary generalized Langevin equation (GLE) for the bead momentum and position. We use a multi-mode Maxwell model plus a purely elastic element to describe the relaxation modulus of the medium. Relaxation times lower than the minimum observable relaxation time are coarse grained into a single purely viscous element. The non-Markovian process described by the GLE can be written as an Ornstein-Uhlenbeck process by introducing new random variables with white noise spectra. Furthermore, using the zero particle-mass limit of the power spectral density (PSD) and detailed balance, a Ornstein-Uhlenbeck process without particle inertia was obtained. The models were used to simulate bead trajectories for single and multi-mode Maxwell modulus. Time domain statistics can be transformed to frequency domain to obtain the PSD. Since the dynamic modulus of the medium and the PSD are determined by the same set of parameters, the original material
properties, which were used as input for the simulation, can be recovered. These Monte-Carlo iterations have been used to develop and test microbead rheology data analysis procedures.

**09:00 Dielectric relaxation as an independent examination of relaxation mechanisms in entangled polymers using the discrete slip-link model**

*Ekaterina Pilyugina, Illinois Institute of Technology*  
*Jay Schieber, Illinois Institute of Technology*

Dielectric spectroscopy is often used as a complementary tool for investigating the relaxation properties of a viscoelastic medium. The method is to apply a small electric field to polymers with permanent dipoles and the response of the system is investigated by measuring the relaxation of the dielectric permittivity. If the polymer chain has permanent dipoles, then the dielectric response should reflect the structural properties of the investigated polymer. For example, it has been shown that for so-called type-A polymers, where the dipoles are parallel along the backbone of the chain, the complex dielectric permittivity is proportional to the Fourier transform of the autocorrelation function of the end-to-end vector $R(t)$.

Also, comparison of the experimentally measured relaxation modulus $G(t)$ with the autocorrelation function of the end-to-end vector for linear monodisperse type-A polymers has shown a relationship between these two functions for linear polymers, namely, $G(t) \propto R(t)^2$. However, this relationship is based on assumptions about the relative contributions of constraint release and chain sliding dynamics to the relaxation modulus. Previous comparisons of contributions to the relaxation modulus of monodisperse and bidisperse linear chains showed significant differences between tube and slip-link theories. Molecular probe rheology experiments [C. Liu et al., *Macromol.*, 2006, 39(21), 7415-7424] are in agreement with slip-link theory predictions, and not tube models. Dielectric relaxation can provide an additional independent check on the contributions of these two relaxation mechanisms. Also of interest is star-branched polymers where tube theories typically cannot explain both dielectric and viscoelastic behavior simultaneously [H. Watanabe, *Macromol. Rapid Commun.* 2001, 22, 127-175].

**09:15 D'yakonov-Perel' spin relaxation for degenerate electrons in the electron-hole liquid**

*Mathew Mower, University of Missouri*

We present an analytical study of the D'yakonov-Perel' spin relaxation time for degenerate electrons in a photo-excited electron-hole liquid in intrinsic semiconductors exhibiting a spin-split band structure. The D'yakonov-Perel' spin relaxation of electrons in these materials is controlled by electron-hole scattering, with small corrections from electron-electron scattering and virtually none from electron-impurity scattering. We derive simple expressions (one-dimensional and two-dimensional integrals respectively) for the effective electron-hole and electron-electron scattering rates which enter the spin relaxation time calculation. The electron-hole scattering rate is found to be comparable to the scattering rates from impurities in the electron liquid - a common model for n-type doped semiconductors. As the density of electron-hole pairs decreases (within the degenerate regime), a strong enhancement of the scattering rates and a corresponding slowing down of spin relaxation is predicted due to exchange and correlation effects in the electron-hole liquid. In the opposite limit of high density, the original D'yakonov-Perel' model fails due to decreasing scattering rates and is eventually superseded by free precession of individual quasiparticle spins.

**09:30 Magneto-electric Control of Spin Waves**

*Tianyu Liu, Department of Physics and Astronomy, University of Missouri-Columbia*  
*Giovanni Vignale, Department of Physics and Astronomy, University of Missouri-Columbia*

There has been tremendous interest in recent years in the electric manipulation of spin. Here we consider the control of spin waves--collective excitations of spins -- that can be transported without real charge transfer. This provides the path to develop low-power-consuming spintronic devices -- spin wave logic devices, which is based on deep-submicrometric interferometer operating at room temperature. The essential element of the proposed logic devices is a spin-wave phase shifter. A great deal of effort has been devoted to shift the phase by a spatially varying magnetic field, either extrinsic or intrinsic (by passing the spin wave through a non-uniform magnetic texture). In this work we introduce a new mechanism, in which the phase of spin waves is controlled by an electric field, via the spin-orbit...
coupling of this electric field to the electrons that mediate the magnetic interaction. We refer to this new mechanism as magneto-electric control of spin waves. We discuss how this mechanism works in three basic models of magnetism: the RKKY model (for metals), the double exchange model, and the superexchange model (for insulators). We show, in particular, how a topological interference mechanism, analogous to the Aharonov-Casher effect for spin-carrying particles, can be realized for spin waves in a ring of ferromagnetic material.

09:45 Inelastic Neutron Scattering from Hydrogen Adsorbed in Nanoporous Carbons
Raina Olsen, University of Missouri Columbia
Matthew Beckner, University of Missouri Columbia
Haskell Taub, University of Missouri Columbia
Carlos Wexler, University of Missouri Columbia
Inelastic neutron scattering from adsorbed hydrogen offers a powerful tool to probe the local adsorption environment of storage material. We present theoretical calculations of transition energies, form factors, and Debye-Waller factors as a function of pore size. We find that both rotational and vibrational transitions energies are highly variable in sub-nm pores. We will also show recently measured INS spectra of hydrogen adsorbed on four different carbon samples and discuss the preliminary interpretation of their spectral features.

10:00 Coffee Break – Lobby of Life Sciences

Session C – 10:30
111 Life Sciences Building (PSAPS)

10:30 Theory lessons from the Tevatron for the LHC (Invited)
Zack Sullivan, Illinois Institute of Technology
The Tevatron will be remembered for the discovery of the top quark and several new heavy hadronic states. However, the most lasting effect may be the theoretical understanding of the data that is required to interpret high precision measurements in QCD. I describe how recent observations at the Tevatron have influenced our expectations, from calibration signals for jets and leptons to the composition of the isolated lepton data sample. These recent discoveries will have a profound influence on our ability to interpret the LHC data sample, and to search for new signals of physics, such as a Higgs boson or supersymmetry.

11:00 Recent Results and Prospects for CMS (Invited)
Wesley Smith, University of Wisconsin
The CMS experiment at the Large Hadron Collider (LHC) has collected and analyzed data since spring 2010 at a center of mass energy of 7 TeV. In addition to measurements of well established standard model processes, first results of searches for new physics in this energy domain have been carried out. The performance of the CMS experiment, its first results and prospects for the future will be presented.

11:30 Using charm tagging to discover the Higgs in semi-leptonic channel
Arjun Menon, Illinois Institute of Technology
Zack Sullivan, Illinois Institute of Technology
We introduce a complementary channel to discover the Higgs boson at the Large Hadron Collider (LHC) through its decay to $W^+W^-$, where one boson decays to leptons, and the other decays to a charm+jet. One of the advantages of this channel over that involving dileptons is the potential to directly measure the invariant mass of the Higgs boson.

In addition, this channel avoids large recently discovered QCD backgrounds to leptons from heavy flavor decays. This mechanism motivates the study and creation of a dedicated charm tagger, as a 60% charm tagging efficiency in the relevant kinematic range could lead to a 5-sigma discovery of a 165 GeV Higgs boson in 6.5 fb^-1 of integrated luminosity at a 14 TeV machine.

11:45 New Experiments with Antiprotons
Daniel Kaplan, Illinois Institute of Technology
Fermilab operates the world's most intense antiproton source. Newly proposed experiments can use those antiprotons either parasitically during Tevatron Collider running or after the Tevatron Collider finishes in about 2011. For example, the annihilation of 8 GeV antiprotons might make the world's most intense source of tagged D^0 mesons, and thus the best near-term opportunity to study charm mixing and, via CP violation, to search for new physics. Other precision measurements that
could be made include properties of the X(3872) and the charmonium system. An experiment using a Penning trap and an atom interferometer could make the world's first measurement of the gravitational force on antimatter. These and other potential measurements using antiprotons could lead to a broad physics program at Fermilab in the post-Tevatron era.

**12:00**  Simulation of Phi Meson Photoproduction Observation at RHIC through $\phi \rightarrow K^+K^-$ and $\phi \rightarrow K$-short K-long

*Jonathan Bruckman, Creighton University*

Ultra-peripheral collisions of nuclei have no physical overlap of the nuclei. The nuclei interact through large electromagnetic fields. These fields are treated as a flux of photons, which scales as $Z^2$, making heavy ion collisions an attractive tool for studying photoproduction. At RHIC (Relativistic Heavy Ion Collider), these collisions are done with heavy ions (e.g. gold, copper, etc.) accelerated to relativistic speeds ($v > .99c$). Individual photon energies can exceed 3GeV, allowing for the production of a wide range of particles. This talk will focus primarily on the underlying physics of these types of reactions, and the techniques used for analyzing the data. The possibility of measuring the photoproduction at STAR of phi mesons in ultra-peripheral collisions through the $\phi \rightarrow K^+K^-$ and $\phi \rightarrow K$-short K-long decay channels will also be discussed using simulated kinematics and simulated detector acceptance of these particles.

**12:15**  $J/\psi \rightarrow \mu\mu$ from 7 TeV pp collisions in ATLAS: physics with the first data

*Andrew Nelson, Iowa State University*

ATLAS has a rich charmonium and beauty physics programme. With the first few pb-1 of 7 TeV collision data collected at the LHC, ATLAS has started probing the new energy regime with decays of the $\psi$ and Upsilon families of mesons into pairs of muons. The first physics measurement, possible with less than 1 pb-1 of data, is the fraction of $J/\psi$ mesons produced in B-hadron decays. We present preliminary results for this measurement, and discuss issues surrounding the measurement of the differential cross section and $J/\psi$ polarization.

**12:30**  Lunch

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**Session D – 10:30**  104 Engineering 1 Building (PSAPS)

**10:30**  Watching Atoms Move with Ultra-fast X-Rays (Invited)

*Eric Landahl, DePaul University*

The goal of ultrafast science is the measurement and control of transient phenomena at atomic time-scales and length-scales. We seek to answer the questions: How does a system approach equilibrium after sudden perturbation? Can intermediate states be manipulated in real time to alter outcomes? What new exotic behaviors can be identified under transient conditions? I will show how these questions can be answered by making molecular movies using ultrafast lasers and synchrotron radiation. As an example I will visualize the competing nonlinear effects that govern charge, heat, sound, and light transport in semiconductor materials at short time-scales, and discuss the prospects for the study of both increasingly fast as well as increasingly complex systems.

**11:00**  Graphene for Nanoelectronics: Important Practical Issues (Invited)

*Joseph Lyding, University of Illinois at Urbana Champaign*

Graphene, a one atom thick hexagonal mesh of carbon atoms, has generated considerable excitement in the physics and engineering communities due to its intriguing array of physical properties. However graphene’s electronic properties are strongly influenced by substrate interactions, edge effects and grain boundaries. We are studying these effects by combining ultrahigh vacuum scanning tunneling microscopy with an atomically clean graphene deposition technique. For sub-10nm wide graphene quantum dots we observe that the metallic state associated with zigzag edge symmetry extinguishes the semiconducting quantum size effect gap, suggesting that armchair symmetry edges will be needed for nanoscale graphene transistor applications. Another observation is that by decreasing the graphene-substrate separation by less than one atomic diameter can result in a strong electronic mixing wherein the substrate electronic structure can be seen through the graphene. Graphene that is being grown for electronic applications is currently polycrystalline, which means that there are grain boundaries in graphene films. We are studying these boundaries with atomic resolution to elucidate the electronic transition between grains. Finally, this talk will present a new metallization method that is capable of
producing sub-5nm wide metal lines that can be used to contact nanostructures such as graphene and carbon nanotubes.

11:30 Is There a Pairing Glue in High Temperature Superconductors?
John Zasadzinski, Illinois Institute of Technology

Conventional superconductors are described by a pairing glue in which Cooper pairs form by the mutual exchange of phonons, the quanta of lattice vibrations. Whether a pairing glue scenario describes high temperature superconductors is hotly debated, especially since the superconductivity is expected to originate in Cu-O plane described by the Hubbard model. We demonstrate that experimental tunneling data on the high Tc superconductor Bi2212 exhibits a reproducible dip feature reminiscent of phonon structures in conventional superconductors. The tunneling conductance can be fit with an Eliashberg theory extended to d-wave symmetry. The resulting electron-boson function indicates that spin fluctuations serve as the pairing glue. In particular, a long lived spin excitation, the resonance mode, serves as the primary boson responsible for pairing. A comparison of extracted electron self energies to those obtained from the Hubbard model show good agreement.

11:45 Observation of scale invariance and universality in two-dimensional Bose gases
Chen-Lung Hung, The University of Chicago

The collective behavior of a many-body system near a continuous phase transition is insensitive to the details of its microscopic physics. Characteristic features near the phase transition are that the thermodynamic observables follow generalized scaling laws. The Berezinskii-Kosterlitz-Thouless (BKT) phase transition in two-dimensional (2D) Bose gases presents a particularly interesting case because the marginal dimensionality and intrinsic scaling symmetry result in a broad fluctuation regime which manifests itself in an extended range of scale-invariant and universal behavior. We study this universal behavior by probing the density profiles and fluctuations of ultracold cesium atoms in a 2D optical trap at various temperatures and interaction strengths across the BKT phase transition. We report the observation of a global invariance of scale and a universal description of 2D gases under proper power-law scaling with respect to the thermal de Broglie wavelength and the 2D interaction strength. The extracted universal thermodynamic functions confirm the wide BKT critical regime, provide a sensitive test to the universality prediction by the classical-field and the quantum Monte Carlo calculations, and point toward a growing density-density correlations in the critical regime. Our assay raises new perspectives to explore further universal phenomena in the realm of classical and quantum critical physics.

12:00 X-ray Photon Correlation Spectroscopy measurements from the dynamics of Alpha Crystallin
Vidanage Nuwan Karunaratne, Northern Illinois University
Janae DeBarto, Argonne National Laboratory
Justin Berry, Boston University School of Medicine
Laurence Lurio, Northern Illinois University
George Thurston, Rochester Institute of Technology
Alec Sandy, Argonne National Laboratory
Suresh Narayanan, Argonne National Laboratory
John Weizeorick, Argonne National Laboratory

Alpha Crystallin is one of the major soluble proteins involved in the formation of a transparent mammalian eye lens. It has chaperone like behavior and may play a key role in maintaining lens transparency by preventing condensation of other lens proteins. We report here X-ray Photon Correlation Spectroscopy (XPCS) measurements of protein diffusion within concentrated suspensions of Alpha Crystallin. Dynamics were measured as a function of temperature (2°C to 35°C) and protein concentration (64 mg/ml to 377 mg/ml). The overall observed diffusion rates imply that the proteins exist in a glassy or gel phase, even at concentrations where equivalent hard sphere system would still be liquid. We interpret these results within the context of strongly interacting proteins, with interactions possibly mediated by subunit exchange among Alpha Crystallin oligomers.

12:15 Density-functional studies of a vacancy in graphene
Mohammad Sherafati, University of Missouri, Columbia
Birabar R.K. Nanda, University of Missouri, Columbia
Zoran S. Popovic, Vinca Institute of Nuclear Sciences
Sashi S. Satpathy, University of Missouri, Columbia
George Thurston, Rochester Institute of Technology
Laurence Lurio, Northern Illinois University
Alec Sandy, Argonne National Laboratory

We study the electronic structure of graphene with a single vacancy using density-functional and tight-binding calculations. We show that the magnetic moment appears due to spin-polarization of both sp² dangling orbitals and pₓ zero mode state. Due to trigonal Jahn-Teller lattice distortion, the sp² dangling orbitals mediate unequal interactions
between them to form three non-degenerate and non-dispersive bands, out of which one is occupied in both the spins and one is completely unoccupied. The zero mode state, lying on the Fermi level, undergoes spin-split to form an unpaired spin state. From lattice Green's function for a graphene sheet with monovacancy, we show that the zero mode state resides on the majority sublattice. The analytical expression for the zero mode, using linear energy dispersion, shows the $1/R$ decay of the mode with the distance, $R$, from the vacancy center, which is also compared with the full-band numerical result.

12:30 Lunch

Session E – 14:00
111 Life Sciences Building (PSAPS)

14:00 The Advanced Photon Source Upgrade (Invited)
Derrick Mancini, Argonne National Laboratory

The Advanced Photon Source (APS) at Argonne National Laboratory is a flagship within the Department of Energy’s suite of light sources. It is the western hemisphere’s brightest synchrotron-based source of x-rays – contributing to groundbreaking discoveries in physical and biological sciences with over 5000 users. For the first time since its dedication in 1996, the APS is planning to undergo an extensive upgrade. A major milestone for the upgrade was DOE approval of the CD0 mission need statement on April 22, 2010. The goals of the upgraded APS will be to provide the world’s brightest source of x-rays above 25 keV, x-ray pulses of 100-fold shorter duration approaching 1-ps and enhanced spatial resolution down to a few nanometers. The enhanced capabilities will enable exploration of phenomena in real materials, under real conditions, in real time. In this talk I will describe our current plans for the APS Upgrade and attempt to identify some of the key scientific questions and technical challenges it will be able to address.

14:30 BioCAT

Thomas Irving, Illinois Institute of Technology

The Biophysics Collaborative Access Team (BioCAT) is organized as a NIH Biotechnology Research Resource located at the Advanced Photon Source Argonne National Laboratory. Central to the facility is Beamline 18ID dedicated to structural studies of partially ordered biological materials using small and wide-angle X-ray scattering (SAXS), small- and wide-angle fiber diffraction, and X-ray micro-emission and micro-absorption spectroscopy. X-ray scattering and diffraction studies that have been addressed include macromolecular small-angle solution scattering, small-angle diffraction of muscle and connective tissue, oriented fibers of filamentous viruses, and various model membrane systems. A new emphasis is on microprobe emission spectroscopy, micro-x-ray absorption spectroscopy and micro-diffraction of biological tissues. The talk will focus on an overview of these capabilities and present some future prospects.

14:45 Hard X-ray Zone Plates Fabricated with Ultrananocrystalline Diamond Molds for 60-nm-resolution

Michael Wojcik, Illinois Institute of Technology and Argonne National Laboratory
Vishwanath Joshi, Argonne National Laboratory
Anirudha Sumant, Argonne National Laboratory
Ralu Divan, Argonne National Laboratory
Leonidas Ocola, Argonne National Laboratory
Ming Lu, Brookhaven National Laboratory
Derrick Mancini, Argonne National Laboratory and Illinois Institute of Technology

To fabricate sub-100-nm-resolution hard x-ray zone plates with maximum focusing efficiency, structures with an aspect ratio greater than 20 are needed. Aspect ratio is given by the ratio of the outer zone width, which is proportional to the achievable resolution, and the thickness of the zone plate, which is related to the efficiency [1]. The maximum achievable aspect ratio is mainly determined by the materials used as an electroform mold in zone plate fabrication. Different materials have been used as molds, such as organic polymer [2] and hydrogen silsesquioxane (HSQ) [3], but these materials do not maintain their mechanical stability at high aspect ratio. Though different fabrication techniques can be used to compensate for the lack of material stability, using better-suited materials is a more fundamental path towards very high aspect ratios. Ultrananocrystalline diamond (UNCD) is a form of carbon composed of 2-5 nm grains of diamond, which can be deposited by microwave plasma chemical vapor deposition [4] as non-conducting thin film. UNCD is ideally suited as a mold material because of its mechanical and dielectric properties, as
well as its resistance to radiation. Fabrication is a multi-step process begun by first patterning HSQ on the UNCD film [5]. The UNCD is then etched with oxygen reactive ion etching using the HSQ as the etch mask. Au is then electroplated into the UNCD mold. We will discuss our first fabrication of zone plates with UNCD as the mold material and measurement of the focusing properties of zone plates with a 60 nm outer zone width and an aspect ratio of 10.

5. M. J. Wojcik et al., presented at EIPBN 2010

15:00 Electrodeposition Assisted X-ray Lithography: Single Step Approach
John Katsoudas, Illinois Institute of Technology
This paper reports on the development of a novel single-step approach for the formation of patterned metal deposits from metal salt solution using X-ray lithography. The approach is based on simultaneously exposing the substrate to masked X-rays within an electric field, and utilizes the effects of radiolysis and potentiostatic electrodeposition.

15:15 Localization of quantum objects in an expanding universe and cosmologically induced classicality
Caroline Herzenberg, Argonne National Laboratory (retired)
Independent studies by different authors have proposed that classicality may be induced in quantum objects by cosmological constraints presented by an expanding universe of finite extent in space-time. Cosmological effects on a quantum system can be explored in one approach by considering an object at rest in space with a universal Hubble expansion taking place away from it, and developing a Schrödinger type governing differential equation incorporating an intrinsic expansion speed. Wave function solutions to this governing equation exhibit pronounced central localization. The extent of concentration of probability depends on mass; objects with small masses tend to behave in a delocalized manner as ordinary quantum objects do in a static space, while quantum objects with large masses are concentrated into much smaller regions. To develop a criterion for classicality, we consider that if the size of the localized region of concentrated probability density is larger than the size of the corresponding extended object, then quantum behavior could be expected; whereas if the region of high probability density for the location of the center of mass is smaller than the size of the object, the object would behave in a more classical manner. The resultant size threshold for classicality accords with results of other studies examining these issues based on uncertainty relations and wave packets. This size threshold is informative for the case of compact extended objects and, as the constraint applies to the center of mass of the system, does not lead to inconsistencies for quantum correlations between distant entangled quantum objects. While local decoherence may lead to classicality under a variety of conditions, cosmologically induced classicality would appear to cause fundamental limitations on quantum behavior in our universe.

15:30 Coffee Break – Lobby of Life Sciences

Session F – 14:00
104 Engineering 1 Building (PSAPS)

14:00 Piezomagnetism, the Piezo-Barkhausen Effect, and Metal Fatigue (Invited)
Thomas Erber, Illinois Institute of Technology
Piezomagnetism generally refers to the generation of magnetic fields by mechanical means such as tension of compression including plastic deformations. Typically applying a stress of 2x10^4 lbs/in^2 ~ 140 MPa to AISI 1018 steel is sufficient to induce magnetizations of the order of 5x10^-3 emu/cm^3 ~ 5 A/m due to alterations of the ferromagnetic domain structures by mesoscopic stress fields. These magnetizations result in variable flux densities of approximately 10 mG ~ 1 uT in the vicinity of the steel specimens, and fields of this magnitude can easily be detected with flux gate magnetometers. Measurements show that it is possible to correlate the detailed variations of stress, strain and magnetic field (B) during every individual loading cycle, and to track the evolution of the piezomagnetic hysteresis as microscopic damage accumulates and the steel specimen approaches fatigue failure.

A logical refinement of this approach is to measure changes in the cross-coupling between the mechanical and magnetic microstructures.
by detecting abrupt changes in the piezomagnetic field, analogous to the ordinary Barkhausen effect. Experiments confirm that this is indeed feasible, and that flux jumps corresponding to magnetization changes exceeding $3 \times 10^{-5}$ emu are easily detectable. The systematics of these pulse patterns and their relation to the fatigue limit will be discussed.

(Joint work with S.A. Guralnick and W. Tong, Dept. of Civil Engineering, IIT and C.U. Segre, Dept. of Physics, IIT)

14:30 **Nanofluids for Heat Transfer: An Engineering Approach**

*Elena Timofeeva, Argonne National Laboratory*

*Wenhua Yu, Argonne National Laboratory*

*David France, Argonne National Laboratory*

*Dileep Singh, Argonne National Laboratory*

*Jules Routbort, Argonne National Laboratory*

Evaluation of cooling efficiency, i.e. ability to remove heat from the heat source, includes assessing contributions from thermal conductivity, viscosity, specific heat, and density of the fluid and also depends on the applied flow regime. An overview of systematic studies that address the complexity of nanofluid systems and advance the understanding of nanoscale contributions to viscosity, thermal conductivity, and cooling efficiency of nanofluids is presented. A nanoparticle suspension is considered as a three-phase system including the solid phase (nanoparticles), the liquid phase (fluid media), and the interfacial phase, which contributes significantly to the system properties because of their extremely high surface-to-volume ratio in nanofluids. The approach to nanofluids as three-phase systems (instead of traditional consideration of nanofluids as two-phase systems of solid and liquid) allows for deeper understanding of correlations between the engineering parameters, nanofluid properties, and cooling performance. The factors contributing to the fluid cooling efficiency will be discussed first, followed by a review of nanofluid engineering parameters and a brief analysis of their contributions to basic thermophysical properties. The systems engineering approach will be used to describe how various nanofluid parameters contribute to the systems cooling performance. The latter also offers insights into the principles of the efficient nanofluid design.

14:45 **Synchronization in the presence of resonant coupling**

*David Mertens, University of Illinois, Urbana-Champaign*

*Richard Weaver, University of Illinois, Urbana-Champaign*

We recently published experimental results for many small motors---cell phone vibrators---glued to and interacting through a resonant elastic plate. Like the Kuramoto model, the coupling between our oscillators depends on the sine of the angle between the oscillators, but unlike the Kuramoto model the strength of the coupling is frequency dependent. This gives rise to new behavior in the system, including history-dependent (bistable) behavior and unstable oscillator frequencies. In this talk, after summarizing the experimental results, we will present a simple dynamical model for the system that correctly reproduces and clarifies the key behaviors observed.

15:00 **Quantum Statistical Aspects of Anderson Localization with Second Quantized Fields**

*Clinton Thompson, Indiana University - Purdue University Indianapolis*

*Gautam Vemuri, Indiana University - Purdue University Indianapolis*

*Girish Agarwal, Oklahoma State University*

The quantum statistical aspects of Anderson localization of light were studied by numerically simulating the propagation of light through a disordered medium consisting of 100 waveguides that are coupled through nearest neighbor interactions. Three different input field statistics were compared: a coherent field, a thermal field, and a single-mode squeezed field to investigate the effects of a non-classical input field. It was found that there is an enhancement of fluctuations in the output light due to the disorder in the medium. The results also indicated a superbunching of localized light. An important outcome of the sub-Poissonian statistics of the input light is that the total output fluctuations were suppressed. Two different distributions for the medium's disorder were compared, a Gaussian and a Rectangular, and it was found that for a given disorder the light localized faster for a Gaussian distribution than for a Rectangular distribution. We also found that the localized light is non-Gaussian even if the input field is a coherent field. Lastly, two photon intensity-correlations are presented for different input states.

15:15 **Coffee Break – Lobby of Life Sciences**
Field Enhancement Factor in RF Photocathode Guns at AWA/ANL - a proposed study

Eric Wisniewski, Illinois Institute of Technology and Argonne National Laboratory

RF Photocathode guns have become an important electron source for HEP electron machines, light sources and FELs. Understanding the various electron emission processes in the gun is essential to optimization. These processes include, but are not limited to, photo-emission and field emission. The field-emitted current is produced even when the laser is off, hence it is often referred to as "dark current". This dark current causes beam-loading and secondary emission which are undesirable. Fowler-Nordheim equation is generally accepted as a description of the theory of field emission and works quite well for field emission from sharp points. However, in the RF cavity, with field emission from broad-areas, the theory requires the addition of a field enhancement factor beta which is not well understood. The value of beta is traditionally derived from a Fowler-Nordheim plot. The field enhancement factor can also be derived from a measurement of the threshold for Schottky-enabled photo-emission. At ANL's Advance Wakefield Accelerator (AWA), we propose to do a side-by-side comparison of the field enhancement factor obtained using each method on the same gun under the same conditions. In so doing we hope to gain a deeper understanding of the field emission enhancement.

Conformal Field Theory Approach to Black Hole Entropy

Kayleigh Cassella, Indiana University - South Bend

Kerr black holes are rotating black holes which depend upon two parameters, the total mass $M$ and total angular momentum $L$. In the case of extreme Kerr black holes, the mass and angular momentum can be related through $a=GM/c^2$ where $a$ is the Kerr parameter and $a=L/(Mc)$ . Because of this relation in an extreme Kerr black hole, the two horizons normally present in the non-extreme Kerr geometry coincide into one horizon, $r_{eH}$ . It has recently been conjectured that extreme Kerr black holes are relatable to a two-dimensional conformal field theory through holographic dualities with central charge $[1]$. This duality between the extreme Kerr black hole and a conformal field theory in two-dimensions can be examined through consideration of the black hole's entropy. After adopting special boundary conditions in the near horizon geometry of the extreme Kerr black hole, asymptotic symmetry generators can be shown to exist which form a copy of the Virasororo algebra and thus yield a central charge. The boundary conditions were determined so that the charges associated to the symmetry generators are finite $[1]$. Given this central charge, the Cardy formula is utilized to yield an entropy, $S=2\pi k_B^*k_B^*(L/hbar)$ which reproduces the Bekenstein-Hawking entropy found through the relationship, $S=(k_B^*c^3)/(4\hbar^*G)*(Area)$. This current research is the first step toward understanding of the near extreme Kerr correspondence to a conformal field theory. Understanding the near extreme Kerr generalization is practically relevant given the nearly extreme black hole observed in the sky, GRS 1915+105 which has a mass equal to 14 times that of our sun and hence $L/(GM^2) > .98$. Due to the near extreme nature of GRS 1915+105, emissions released due to accreting matter should be well described by the corresponding conformal field theory.


Developing a Nonresonant Acoustic Transducer Backing for Superheated Liquid Dark Matter Detectors

Emily Grace Kuehnemund, Indiana University South Bend

The mass of the Universe is primarily composed of an unknown substance called dark matter. Dark matter is inherently invisible and has not yet been observed in any laboratory. The COUPP and PICASSO experiments are attempting to detect dark matter particles using superheated liquid targets. When a dark matter particle collides with a nucleus of the superheated liquid, it will cause an explosive phase transition from a liquid to a gas.

One way of registering these events is by measuring the sound waves produced. It was recently discovered by PICASSO that background radiation creates different sounds than potential dark matter particles. This research involves designing a backing for the acoustic sensors that allows for better differentiation between background events and potential dark matter events.
The Origin of Galactic Arms Is An External Orbit
Stewart Brekke
Pre-galactic arms were in sets of two or more orbiting each other. As the orbits of the pre-galactic arms decayed due to gravitational attraction they tangentially collided and attached in their fore-sections forming spiral galaxies which began rotating, converting their orbital motions into rotational motion of the newly formed spiral galaxy. One can observe especially in the galaxies such as M51, M61, M99, M100, M101, NGC151, NGC309, NGC613 and NGC2336 for example that the galactic arms came from external orbit, not as a result of an instability in a hypothetical pre-galactic disk as is the current thought for galactic origin.

Session H – 15:45
104 Engineering 1 Building (PSAPS)

Mixing by cutting and shuffling in quasi-2D granular flows
Ivan Christov, Northwestern University
Emre Yildiz, Northwestern University
Julio Ottino, Northwestern University
Richard Lueptow, Northwestern University
Recently, cutting and shuffling has been proposed as a new approach to understanding the mechanics of mixing in tumbled flows of granular materials. We explore how cutting and shuffling arises from streamline jumping in quasi-2D granular flows in tumbled non-circular containers. This mechanism is related to a type of discontinuous dynamical system called a piecewise isometry (PWI). PWIs are an emerging branch of mathematics and exhibit complex dynamics without any of the usual symptoms of chaos. Experiments are performed with a square tumbler, showing clearly that cutting and shuffling is the dominant mixing mechanism for short times. Finally, we illustrate the difference between cutting and shuffling and the well-known stretching and folding mixing dynamics through a simple example.

Mixing Properties for Cutting and Shuffling a Line Segment
Marissa Krotter, Northwestern University
Richard Lueptow, Northwestern University
Cutting and shuffling provides a new approach to analyzing and understanding mixing. We studied via computations the cutting and shuffling of a line segment made up of sub-segments of different colors, each with a different length. The degree of mixing after applying a variety of cutting and shuffling protocols was analyzed by considering the size of the longest unmixed sub-segment. Results indicate that at least six segments are needed for good mixing. Also, some shuffling permutations are more effective in providing good mixing, while others, specifically those in which the end segments are not re-arranged and those which are reducible permutations, provide poor mixing. Furthermore, the best mixing occurs when the ratio of one segment to the next smallest segment is an irrational number close to one. For certain integer ratios, the line segments periodically “reassemble” so that the degree of mixing is periodic with the number of cutting/shuffling operations. The cutting and shuffling approach may be applicable to the mixing of solid materials such as in granular systems.

The role of crossover recombination and inversion in determining gene spacing in a chromosome
Brian Clark, Illinois State University
Kevin Wabick, Illinois State University
Jacob Weidner, Illinois State University
The human genome consists of approximately 30,000 genes and other elements of DNA distributed over 23 pairs of chromosomes. Genes may be linked together in so far as they code for proteins that taken together can represent a single trait. Here we examine the role of crossover recombination between individual strands of DNA and inversion within a single strand of DNA in determining the spacing between two genes linked through their fitnesses via a computational simulation. Our model includes a population of haploid individuals with \( n \) genes per single strand of DNA. Two of the genes are linked through their fitness function, which can be additive, multiplicative, stochastic, or constant. Individuals are allowed to reproduce according to a function of their fitnesses. When two individuals are selected for reproduction, they each undergo an inversion with rate \( R_i \) and then are allowed to crossover with rate \( R_c \). Only offspring with two genes for the specified trait survive reproduction. We record the changes in gene spacings as the system evolves and show that the system has a small number of attractors who's stability is a function of inversion and crossover rates.
Near-Field Studies of Temperature Induced Structural Changes in Supported Lipid Bilayer Systems

Merrell Johnson, Indiana University-Purdue University Indianapolis
Ricardo Decca, Indiana University-Purdue University Indianapolis

Temperature controlled Near-Field Scanning Optical Microscopy (NSOM) was utilized in the study of the main first order phase transition, from the gel Lβ to fluid Lα of supported 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC) bilayers. Using a polarization modulating technique, we exploited the anisotropic nature of the acyl chains and simultaneously measured their effective retardance \( \Delta S = 2f\delta( n_\text{e} - n_\text{o} ) t / f\delta \), and optical orientation \( \Phi \), with respect to the system's axis. From the retardance we determine the birefringence \( (n_\text{e} - n_\text{o}) \) of the bilayer, by assuming that the acyl chain tilt, with respect to the membrane's normal to be \( \Phi \approx 32^\circ \). We show a change in \( \Delta S \) at the main phase transition temperature \( T_m \approx 41^\circ \) of \( \sim 3.84 \pm .3 \) mrad, which agrees well with previous values of \( (n_\text{e} - n_\text{o}) \). Observed \( \Delta S \) fluctuations and corresponding membrane dynamics around \( T_m \) will be also discussed.

Supported Stacked Lipid Bilayers

Curt DeCaro, Northern Illinois University

Supported Lipid Bilayers are a popular model system for cell membranes. The defined orientation of the system due to a solid substrate makes possible many measurements which are not in free-floating bilayers. A large concern to the community, however, is the effect that the substrate has upon the supported bilayer. Much previous work has been done to minimize that effect, by displacing the bilayer from the substrate, while still maintaining the well-defined orientation of the bilayer. Here we present, for the first time, a technique to deposit a specific number of bilayers on a silicon substrate. Stacks of up to five supported bilayers are deposited, and X-ray reflectometry shows that each stack preserves the orientation of the first, and that our bilayers exhibit full coverage of the one below, to the sensitivity of our measurements. Lastly, the gel to fluid phase transition for each stack is qualitatively studied, and an unbinding transition is observed.

Improvements to the Learning Environment using Technology

Ray Burnstein, Illinois Institute of Technology
Leon Lederman, Illinois Institute of Technology and Illinois Mathematics and Science Academy
Morrie Schulman, University of Texas, Austin

Technology has changed the learning environment of large classes with the use of hand controlled and other response devices. At the same time comprehensive software packages containing learning tools have been developed. The utility, economics, and flexibility of these systems have improved markedly within the last few years. Therefore it is useful to present a review of some of the current hardware and software systems available. We discuss how the technology might evolve to produce further changes in learning practices and research.

Identifying the resources of the urban physics student

Mel Sabella, Chicago State University
Sean Gallardo, Chicago State University

The Physics Program at Chicago State University has been investigating student learning for the past eight years in an effort to construct an effective instructional environment for the urban physics student. In our initial work, the targeted analysis on student content understanding caused us to miss the specific attitudes, thinking, and reasoning skills present in our students. As our research focus began to shift to identifying these other skills, we began to identify specific student resources that foster an active learning environment in the introductory physics course. In addition, we began to uncover a set of coherent, robust content knowledge that we had previously overlooked. Research studies on collaboration in the classroom and work on identifying intuitive and formal reasoning has since provided a rich, complex picture of student understanding and has informed the development of our instructional environment.

Supported by the NSF Course, Curriculum, and Laboratory Improvement Program and the NSF Robert Noyce Teacher Scholarship
2010 PSAPS/CSAAP T Meeting

Program (0632563, 0618128, 410068, 0833251)

09:00  What's New and Exciting in Particle and Astro-Particle Physics
Christopher White, Illinois Institute of Technology
I will review the current situation in particle and astro-particle physics as well as discuss where I think the field is going. Recent provocative results will be presented from the neutrino section. The report will include a brief status report from the Tevatron at Fermilab and the LHC at CERN. I will also remark on the political and funding situation and how this may affect future research efforts in the US and abroad.

09:15  Variations on the vibrating string lab
Andrew Morrison, DePaul University
The vibrating string laboratory is a classic of undergraduate physics courses all over. A common way of setting up a vibrating string lab is with a mechanical shaker and a non-magnetic string. A perhaps less common way of looking at a vibrating string is with a metal string and electromagnetic driving and/or detection. Variations on the introductory lab and pedagogic approaches which make the lab appropriate for advanced undergraduate labs will be presented.

09:30  Acoustics and the Classroom (Invited)
Stephen Lind, Trane Acoustics Lab
In May 2010 a new standard for classroom acoustics (ANSI/ASA S12.60 Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent, Site-Built Schools) was adopted by ANSI through the standards activities at the Acoustical Society of America (ASA). The intent of the standard is to provide learning spaces where communication is not impeded by the acoustical environment in the room. Important room parameters considered are reverberation time, noise levels due to building equipment, and noise levels intruding from sources outside of the learning space. Excessive background noise or reverberation in a classroom may interfere with speech communication and thus present an acoustical impediment to learning. All those in a classroom, including teachers and adult learners, will benefit from a classroom having the acoustical characteristics recommended in the standard. However, young children and persons with hearing, language, speech, attention deficit, or learning disabilities benefit even more. The standard is being made available without cost to the user. A brief overview of pertinent issues regarding room acoustics, transmission loss, and equipment noise will be presented. The requirements of the standard along with methods to evaluate rooms for conformance will be discussed.

10:15  Coffee Break – Lobby of Life Sciences

Session J – 08:30
104 Engineering 1 Building (PSAPS)

08:30  Matter and force particle modeling with a four-dimensional spin-based space
Steven Mulhall, Hospira, Inc.
A discreet, linear, four-dimensional space of functions representing either spin or harmonic oscillation is used to model wave equations of matter and force particles. It is shown that it is possible to describe known particles, from the massless bosons to the heaviest atomic nuclei, as elements of this functionalized linear space. The mathematical basis and overall structure of the model are described. All elements of the three generations of matter, photons, gluons, weak force bosons, gravitons and a wide variety of hadrons, including atomic nuclei, have been described. The structures of bosons derive directly from the possible interactions of the fermions in the model. The photons and gravitons have properties that are consistent with electromagnetism and gravitation, respectively. The model is qualitative with some semiquantitative results. Calculation of the magnetic moments of particles is discussed. Many concepts in particle physics derive naturally within the model, including: superpositions of states, color, confinement, and asymptotic freedom.

08:45  Thermodynamics and Panpsychism, Explored (II)
Ted Erikson, R/E Unltd
An update* on attempts to define a geometrical derivation of the fine structure constant. With surface to volume ratios as maximum for tetrahedrons and minimum for spheres the dimensionless ratio is in the ball park. The inscribed sphere with an identical area-to-volume as the
tetrahedron raises a sphere packing problem.


09:00 In Search of Event Horizons using the Equivalence Principle
* John Laubenstein, IWPD Research Center

Gravitational theories must be in compliance with the Equivalence Principle (EP), but there are any number of theories that claim to satisfy this requirement in addition to General Relativity (GR). Compliance with the EP is generally verified through experimental observation using the Earth’s gravitational field. This was originally attempted by Pound-Rebka in 1959, further refined in 1976 by the NASA-SA0 Rocket Red Shift experiment using hydrogen maser clocks and – just earlier in February of this year – verified to within 7 parts per billion by a team led by Holger Müller at the University of California – Berkeley using an atom interferometer. The evolution of these experiments is seen as strong evidence in support of GR; however, it must be noted that using the weak gravitational field of the Earth it is impossible to experimentally differentiate between several mathematical expressions. There are at least three equations that satisfy the EP to within 1 part per billion using the Earth’s gravitational field. This requires a sensitivity of nearly one billion times beyond the most accurate test of GR to date. Yet, each of these expressions suggests a different outcome for the location and presence of an event horizon. This presentation will explore the possibility of going beyond observational results to find an exact mathematical solution of the equivalence between the Doppler Effect and Gravitation Redshift without introducing GR.

09:15 Four-dimensional Physical Space
* Thomas Sills, Wilbur Wright College

The book, "What Einstein Did Not See: Redefining Time to Understand Space," presents a new paradigm for time and space. Its author, Thomas W. Sills, will demonstrate how new concepts create a new approach to 4D physical space that is different than 3D physical space. Einstein describes the space about mass M to be warped 3D space. In the new paradigm, an equation for speed through the fourth dimension about mass M compares to Einstein’s warped space. This equation, however, appears to grow to the square root of a negative value. Dr. Sills will demonstrate how this equation is a perfect way to understand the difference between 3D and 4D physical space. The invisible world of 4D space will be examined using four 3D projections from 4D space. Available at Amazon.com. Since 1974 Dr. Sills is an editorial consultant for the production of college physics and astronomy textbooks.

09:30 The Formation of Spaces in the Universe and Its Expansion
* James Wang, CNTV

This article considers multi-layered space. A model for longitudinal space is presented indicating the cause of interaction and relationship among the longitudinal spaces. An interpretation is presented for the real cause of the "gravitational force" phenomenon.

The universe as stated in physics can be large or small. It is believed that the universe is made up of many multi-layered, independent but interacting spaces and times. Here, we want to emphasize that the interaction we speak of is a one-way interaction from higher spaces to lower spaces. The effect may also be restricted to a limited number of spaces.

09:45 North/South Deep Fields Demolish the Copernican Principle
* Charles Sven

The physics of light restricts the parameters of one’s view. Recognizing such restrictions limits one’s inference. Prior to Deep Field South results, one had less restrictions then now. With both results in hand, the position of the viewer is greatly limited to that of a central position in our Universe. - As noted by NASA: “Though the field [deep] is a very small sample of the heavens, it is considered representative of the typical distribution of galaxies in space because the universe, statistically, looks largely the same in all directions.” - These isotropic North/South views are only possible with a very slow moving Earth located next to the epicenter of the Big Bang. - This is a continuation of my presentations at various APS meetings including the 41st Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics May 25–29, 2010; Houston, Texas Sven’s Abstract: E1.00044
Interesting Stories in the Life of Isaac Newton

Scott Beutlich, Crystal Lake South High School

Newton had three distinct periods in his life. His early life as a child and student. His middle years in his laboratory at Cambridge. And his later years as Master of the Mint and head of the Royal Society. This talk will hit on a few items in each period, but spend a little more time on the later years which are not included in most Physics classes.

Establishing a nuclear and particle physics instructional thread in the Chicago State University Physics Program

Chaan Thomas, Chicago State University
Sharif Onihale, Chicago State University
Mel Sabella, Chicago State University
Edmundo Garcia, Chicago State University
Kuhn Thomas, Chicago State University

Nuclear physics is an area of Physics that has many applications in the real world. While many students may be familiar with the specific applications used in military engagement, the medical fields, and terrorism countermeasures, they may not be aware that these applications are often based on discoveries in nuclear physics.

In spite of its widespread applications, the concepts of nuclear physics remain esoteric to both the general public and even to those using the technologies built upon its ideas. By exposing students to concepts of nuclear physics through Physics Education Research-based modules, we hope to both educate and excite all science students about this field. In order to accomplish this we will develop a thread which spans the introductory physics curriculum and engaged different majors at different levels. These modules will form a continuum which will gradually familiarize students with the field of nuclear physics. Education research and informal student feedback will be used to improve upon these modules.

A Paper Airplane Design Challenge for Inquiry and Content

Daniel Meyer, Illinois Institute of Technology

A Paper Airplane Design Challenge for Inquiry and Content

The “Ballistic Pendulum” (also known as a Blackwood Pendulum) is one of the classical, traditional experiments that is often done in introductory physics classes. While it can be one of the ‘plug & chug’ type of experiments, as opposed to the more preferred ‘exploratory’ experiment, it can still be quite a useful exercise for the students, in that it brings together nearly all the concepts that are covered in the ‘mechanics’ portion of the curriculum: linear motion (projectiles in particular), force, momentum, conservation of energy, and if one wishes, angular motion. The experiment can be performed with home-built apparatus, or with one of the many available commercial apparatus. Several variations of this experiment have previously been published, but those seem to all be variations in how one makes the measurements, rather than using the same apparatus (and data) for multiple studies; some of these do not even do both portions of the experiment – making a range prediction and then testing it. Even having done the prediction and the verification, one is left with the dangling question ‘what now’ – can this actually be use for something else? In this talk I will briefly review the experiment, including some suggestions as to how to make it effective, provide some typical data, and then go on to provide some suggestions as to what one can do with the apparatus and the data, beyond the usual experiment, emphasizing one particular extension that I have used and found to be effective.

Proportional reasoning as a predictor of success in introductory physics (Invited)

Steven Kanim, New Mexico State University

Instructors often describe differences in the level of preparation of introductory physics students at different institutions, and in different courses (for example, students in algebra-based versus calculus-based courses). As a measure of student preparation, instructors and researchers have used pretests of mathematics and of scientific reasoning ability as predictors. For example, Coletta has shown that students who score well on the Lawson Classroom Test of Scientific
Reasoning ability have higher Hake gains than students who do not. We have been looking at correlations between student performance on proportional reasoning pretest questions and scores on a conceptual final examination in a physics lab as part of our attempts to understand more about what constitutes adequate preparation for physics. In this talk I will describe the pretest questions we have been using and our attempts to better understand what is being measured by these questions. We have found that varying the context of these questions affects student performance even when the proportional reasoning content remains the same. This effect is more pronounced for women than for men. In addition, we have found strong sensitivities to wording for some of the questions we have asked. I will also describe curricula in development that we hope will be useful in strengthening students' proportional reasoning skill.

12:30 CSAAPT Lunch Break

Session L – 10:30
104 Engineering 1 Building (PSAPS)

10:30 Photoproduction at Relativistic Heavy Ion Collider with STAR

Yury Gorbunov, Creighton University

Interacting highly-charged ions carrying strong electromagnetic fields that act as a field of photons. The ions interact through photon-ion and photon-photon collisions at impact parameter more than twice the nuclear radius R_A, so no hadronic interactions occur. We present recent results of the STAR experiment at RHIC on \( \rho(770) \) production in AuAu collisions at various energies. STAR is also sensitive to the interference between two production modes: either ion can be the photon emitter or the target. We observed the coherent photoproduction of \( n\pi^+\pi^-\pi^+\pi^- \), which may be attributed to one of the poorly known excited states of \( \rho^0 \). As well in this talk we will present preliminary results based on data collected during run 10.

10:45 Time resolved Compton scattering for a model fermion-boson system

R. Wagner, Illinois State University
Q. Su, Illinois State University
R. Grobe, Illinois State University

We study the scattering of a boson with a fermion with full spatial and temporal resolution based on the one-dimensional Yukawa Hamiltonian. In quantum field theory this interaction is described by the annihilation and creation of bosons with intermediate virtual particle states. We show that this process can be modeled in the center of mass frame by a scattering potential, permitting us to interpret the absorption and re-emission processes in quantum mechanical terms of a characteristic force. This Compton force between the fermion and boson is repulsive for large distances and attractive for shorter spacings. We also examine the periodic dynamics of a fermion and a boson that are spatially confined to a ring-cavity in which they counter-propagate, enabling us to study interactions independent of the transients that characterize the (one-time) scattering event of two wavepackets.

11:00 Decomposition based imaging in longitudinal obstacle arrangements

Ben Rogers, Illinois State University
Q. Su, Illinois State University
R. Grobe, Illinois State University

I will describe the so-called decomposition based imaging algorithm for light scattering in turbid media. Such an algorithm may be used to reconstruct obstacles embedded in a medium such as milk-water mixture while being illuminated with light. Experimentally one measures the scattered light pattern associated with obstacles at various locations using a sensitive ccd camera. The data will serve as guidance to other theoretical tools including the Monte-Carlo based computer simulation and simple theoretical approximations such as the downstream model. The decomposition based imaging algorithm is tested systematically to study its validity and limitations.

11:15 Superluminality vs causality in quantum mechanics

Ben Shields, Illinois State University
Q. Su, Illinois State University
R. Grobe, Illinois State University

In classical mechanics the violation of causality is usually associated with the superluminal evolution of a signal that connects two events. The events are then called acausal. The violation of causality occurs also if there exists a moving reference system, from which the sequence of events can be observed in reversed order, therefore observing the
effect before its cause. The non-relativistic energy-momentum relation leads to a solution that permits superluminal velocities and therefore violate causality, while a relativistic energy-momentum relation will ensure subluminal motion and one would not expect the violation of causality. In my presentation I will give evidence about the violation of causality for a relativistic system under the quantum mechanical description. I will use localized as well as non-localized initial states and evolve them under relativistic quantum mechanical time evolution operators. Surprisingly, the total probability outside of the light cone turns out to be non-zero. This is a direct proof of the violation of causality. I will discuss the implication of such a counter-intuitive consequence.

11:30  

Einstein’s time dilation in relativistic two-particle system

Matt Morris, Illinois State University
Q. Su, Illinois State University
R. Grobe, Illinois State University

We study the orbits of two interacting particles described by a fully relativistic classical mechanical Hamiltonian. We use two sets of initial conditions. In the first set (dynamics 1) the system’s center of mass is at rest. In the second set (dynamics 2) the center of mass evolves with velocity \( V \). If dynamics 1 is observed from a reference frame moving with velocity \(-V\), the principle of relativity requires that all observables must be identical to those of dynamics 2 seen from the lab frame. Our numerical simulations demonstrate that kinematic Lorentz space-time transformations fail to transform particle observables between the two frames. This is explained as a result of the inevitable interaction-dependence of the boost generator in the instant form of relativistic dynamics. In spite of general inaccuracies of Lorentz formulas, the orbital periods are correctly predicted by the Einstein’s time dilation factor for all interaction strengths.

11:45  

Why do charged particles have the same magnitude of charge e?

Dennis Crossley, University of Wisconsin-Sheboygan

It is commonly observed that objects in a gravitational field experience a rate of acceleration that is independent of their mass. As a result, all massive objects with the same initial conditions follow the same trajectory in a gravitational field. It is seldom acknowledged, however, that since all charged particles have the same magnitude of charge \( e \), they experience acceleration in an electromagnetic field which is inversely proportional to their mass. Charged particles with the same initial conditions follow different trajectories in the same electromagnetic field. While the former case can be transformed to a Riemannian space in which objects follow geodesic paths (encoding the gravitational interaction in the geometry of space), the latter case cannot, which is at the heart of the failure of all attempts to unify gravity and electromagnetism into the formalism of general relativity. The recognition of this transforms the question in the title into one that focuses on dynamics rather than particle properties: Why is electromagnetic acceleration inversely proportional to mass?

12:00  

Compressed Air/Vacuum Transportation Techniques

Shyamal Guha, Texas Southern University

General theory of compressed air/vacuum transportation will be presented. In this transportation, a vehicle (such as an automobile or a rail car) is powered either by compressed air or by air at near vacuum pressure. Four version of such transportation is possible. In all versions, a "c-shaped" plastic or ceramic pipe lies buried a few inches under the road surface. This pipe carries compressed air or air at near vacuum pressure. In type I transportation, a vehicle draws compressed air (or vacuum) from this buried pipe. Using turbine or reciprocating air cylinder, mechanical power is generated from compressed air (or from vacuum). This mechanical power transferred to the wheels of an automobile (or a rail car) drives the vehicle. In type II-IV transportation techniques, a horizontal force is generated inside the plastic (or ceramic) pipe. A set of vertical and horizontal steel bars is used to transmit this force to the vehicle on the road (or to a rail car on rail track). The proposed transportation system has following merits: virtually accident free; highly energy efficient; pollution free and it will not contribute to carbon dioxide emission. Some developmental work on this transportation will be needed before it can be used by the traveling public. The entire transportation system could be computer controlled.

12:15  

End of PSAPS Meeting
**P-01** Detection of a Sub-Threshold Signal by Addition of Noise  
*Clinton Thompson, Indiana University - Purdue University Indianapolis*  
*Gautam Vemuri, Indiana University - Purdue University Indianapolis*

The effect of adding noise on a signal below the threshold of a detector is investigated analytically and numerically. Addition of exponentially correlated colored noise makes the signal detectable, but for Gaussian white noise, the signal is not detectable. Increasing the intensity of noise causes the signal-to-noise ratio (SNR) to exhibit a resonance-like behavior as a function of noise intensity. The correlation time of the noise affects the maximum value of the SNR, and the amplitude and frequency of the signal influence the noise level for which this maximum increase occurs.

**P-02** The role of particle inertia in microrheological data analysis  
*Andres Cordoba, Illinois Institute of Technology*  
*Jay Schieber, Illinois Institute of Technology*  
*Tsutomu Indei, Illinois Institute of Technology*

Viscoelastic properties of condensed soft matter can be estimated by following the trajectory of an embedded micron-sized in a method called passive microbead rheology. The technique can probe time and length scales where traditional rheological techniques cannot reach. This makes the technique well suited to analyze the rheological and mechanical properties of highly heterogeneous materials such as protein networks (e.g.: collagen and F-actin). The Generalized Stokes Einstein relation (GSER) is the most widely used model to analyze microbead rheology results. GSER does not explicitly take into account particle inertia. However, upon closer inspection we find that the derivation of this equation did not eliminate particle inertia effects in a rigorous, self-consistent way. Here we present a complete and self-consistent model and show that it can be used to analyze materials with a wide spectrum of relaxation time scales.

Our starting point for microbead rheology data analysis is a stationary generalized Langevin equation (GLE) for the bead momentum and position. We use a multi-mode Maxwell model plus a purely elastic element to describe the relaxation modulus of the medium. Relaxation times lower than the minimum observable relaxation time are coarse grained into a single purely viscous element. The non-Markovian process described by the GLE can be written as an Ornstein-Uhlenbeck process by introducing new random variables with white noise spectra. Furthermore, using the zero particle-mass limit of the power spectral density (PSD) and detailed balance, a Ornstein-Uhlenbeck process without particle inertia was obtained. The models were used to simulate bead trajectories for single and multi-mode maxwell modulus. Time domain statistics can be transformed to frequency domain to obtain the PSD. Since the dynamic modulus of the medium and the PSD are determined by the same set of parameters, the original material properties, which were used as input for the simulation, can be recovered. These Monte-Carlo iterations have been used to develop and test microbead rheology data analysis procedures.

**P-03** Limits on Theories of Wavefunction Collapse  
*Christopher Godfrey, Missouri Western State University*

The rGRWf model (Tumulka 2006) is a proposed solution of the measurement problem of quantum mechanics involving a stochastic nonlinear wave equation embedded in a relativistic framework. Its primary feature is a mechanism that suppresses superpositions of macroscopically different states for macroscopic systems. However, the Free Will Theorem (FWT) (Conway and Kochen 2007, 2009) purports to prove that no theory that is both non-deterministic and relativistic can reproduce all possible measurement results on a system of two entangled spin-one particles. Recently we have examined both the rGRWf model and the FWT and have shown how underlying assumptions in the postulates of the FWT rule out certain classes of realistic physical theories. Here we discuss new results on the underlying assumptions and the characteristics of physical theories permitted by the axioms of the FWT.

**P-04** Studies of Detector Backgrounds at a Muon Collider using G4beamline  
*Joseph Kozminski, Lewis University*  
*Mary Cummings, Muons, Inc.*  
*Elizabeth De Waard, Lewis University*  
*David Hedin, Northern Illinois University*  
*Stephen Kahn, Muons, Inc.*  
*Aaron Morris, Northern Illinois University*
While the synchrotron radiation from muons in a circular TeV-scale muon collider is not a significant background, there are numerous other backgrounds present which could affect the quality of potential physics studies. The predominant backgrounds include high energy electrons from the muon decays, synchrotron radiation from the decay electrons, hadrons produced in photonuclear interactions, and, to a lesser extent, Bethe-Heitler muons. We will present Monte Carlo studies of these detector backgrounds in a 1.5 TeV center of mass energy muon collider using G4beamline, a single-particle tracking program based on the Geant4 simulation toolkit.

Characterization and development of photocathodes using Angle Resolved Photoemission Spectroscopy (ARPES)

Daniel Velazquez, Illinois Institute of Technology
Timothy McNamee, Illinois Institute of Technology
Jeff Terry, Illinois Institute of Technology
Richard Rosenberg, Argonne National Laboratory
Katherine Harkay, Argonne National Laboratory
Marion White, Argonne National Laboratory
Linda Spentzouris, Illinois Institute of Technology
Jeffrey Terry, Illinois Institute of Technology

High performance electron accelerators typically use metal or semiconductor photocathodes for beam production. New sources with higher electron yield, lower emittance, (or both) would enhance performance of future accelerators. This is an incentive to improve cathode characteristics by design, and to do systematic, detailed comparisons of different cathodes. We present our implementation of a system to study cathodes using surface physics techniques, such as angle-resolved photoemission spectroscopy (ARPES). We are currently building a time-of-flight (TOF) detection based ARPES system at Argonne National Laboratory. This system will enable studies of how beam emittance and intensity depend on cathode properties. These could include material composition, characteristics such as surface roughness, and novel cathode designs.

How to treat Particle Inertia in Microrheological Analysis of Viscoelastic Liquids and Solids

Tsutomu Indei, Illinois Institute of Technology
Jay Schieber, Illinois Institute of Technology
Andres Uribe, Illinois Institute of Technology
Ekaterina Pilyugina, Illinois Institute of Technology

Rheological properties of material can be often estimated by tracking a small particle embedded in it. Generalized Stoles-Einstein relation (GSER) relates the dynamic modulus of material and mean-square-displacement of the probe particle. Particle inertia and material inertia are not included in GSER. We will show how to include particle inertia in GSER in general cases, and show that an approach based on Mason’s derivation of GSER [Rheo. Acta 39, 371 (2000)] is not self-consistent, but result is correct. We will show effects of particle inertia embedded in Maxwell fluid.

Plutonium Speciation on Iron Corrosion Products

Daniel Olive, Illinois Institute of Technology
Donald Reed, Los Alamos National Laboratory
Michael Richmann, Los Alamos National Laboratory
Hasitha Ganegoda, Illinois Institute of Technology
Tim McNamee, Illinois Institute of Technology
Daniel Velazquez, Illinois Institute of Technology
Jeff Terry, Illinois Institute of Technology

Accurate models for actinide solubility are required to understand
2010 PSAPS/CSAAPT Meeting

actinide fate and transport in the environment. Understanding the influence of iron on oxidation state, and therefore solubility, of the actinides is of utmost importance with regards to waste repositories such as the Waste Isolation Pilot Plant (WIPP) where iron based packaging will far exceed the mass of the emplaced transuranic waste.

Reduction of Pu(VI) to Pu(IV) has been observed in short term studies. New results, obtained from x-ray absorption spectroscopy, on long term versions of those studies indicate the possibility of addition reduction to Pu(III) operating on the timescale of several years.

P-09 Study of Gamma Ray Astrophysics
Lidens Cheng, Illinois Institute of Technology
Taiyo Wilson, Illinois Wesleyan University
John Poirier, University of Notre Dame

Project GRAND (Gamma Ray Astrophysics at Notre Dame) is a cosmic ray experiment located on the University of Notre Dame's campus. The detector array measures 100 m × 100 m and consists of 64 huts of proportional wire chambers (PWC) that are used to study solar particles and particles from extragalactic sources. The use of tracking detectors provides superior angular resolution and simultaneous particle identification. The detectors are most sensitive to particles in the 10 to 500 GeV range with the highest sensitivity at 56 GeV. Thus, Project GRAND is ideal for studying solar gamma rays. In addition, when high energy gamma rays strike the atmosphere, muon secondaries detectable by GRAND are produced. These muons act as signatures for gamma ray primaries and can be used to find potential angular and temporal concurrences with gamma ray bursts detected by NASA’s Swift. As of recently, the data acquisition system for Project GRAND has been improved for efficiency purposes and its data is still being cross-referenced to the data provided by Swift.

P-10 Non-destructive X-ray Spectroscopy Methods for use in Study of Iron Age-Persian Period Arrowheads
Mitchell Miller, Illinois Institute of Technology

Non-destructive x-ray spectroscopy methods are commonly used to determine the composition and structure of unidentified samples. A novel application of these methods is to use a high energy (>80 keV) synchrotron source in the study of archeological artifacts thereby probing the bulk material instead of just the surface. Using x-ray fluorescence and diffraction, the raw materials and methods used in manufacturing arrowheads from several Iron Age-Persian Period Middle Eastern archaeological sites were investigated. The fluorescence spectrum provides information about the relative composition of the bulk while the 2D diffraction pattern can yield details about the composition of the majority bronze phase as well as highlight differences in thermo-mechanical techniques. The results obtained from analysis of the fluorescence spectra indicate that the arrowheads are bronze, composed primarily of a leaded copper – tin alloy. The addition of lead to copper-tin alloys, which would reduce the cost of the composite metal and improve the fluidity of the melt, may be more commonplace than previously thought. Data from both fluorescence and diffraction spectra will be presented.

P-11 High Energy X-Ray Tomography of an Ancient Egyptian Isis Statuette
Nathan Majernik, Illinois Institute of Technology

High energy x-ray tomography can be used to nondestructively examine the internal, macroscopic, structure of objects made of materials too dense for conventional CT imaging. Regions of differing x-ray absorption coefficients can be identified with a spatial resolution on the order of 50 micrometers. This technique can be applied to the study of archeological artifacts where avoiding damage is a crucial consideration. In particular, an Egyptian statuette of the goddess Isis (c. 1000-500 B.C.E.) was imaged. This figure has a core cast of bronze, covered by a layer of plaster used to form fine details and adhere gilt. The tomographic reconstruction illustrates the fidelity of the bronze cast versus the finished product since the regions of bronze are distinguishable from those of the plaster and gilt. Additionally, the size and distribution of voids in the cast bronze are illuminated. This void distribution and other structural details are used to confirm that casting was done in a single piece.

P-12 Using diverse experiences to emphasize the professional nature of teaching: The CSU Noyce Program
Michele Dillan, Chicago State University
Mel Sabella, Chicago State University
Andrea Van Duzor, Chicago State University

As Noyce Scholars at Chicago State University and future science teachers, we are engaged in a diverse set of experiences including
seminars on education and education research, conference attendance, journal clubs and science education internships that serve professional development functions. These experiences in contexts beyond the classroom, highlight the professional nature of science teaching, and introduce us to the diverse resources available for science teachers in Chicago. By partnering with institutions such as the Museum of Science and Industry, the Adler Planetarium, and the Southeast Environmental Task Force we are able to ground ourselves in the intellectual and cultural resources of Chicago. Through these experiences we are building a network of support that will aid us in continuing to improve our craft as teachers in high needs areas. This poster will highlight how the professional nature of science teaching permeates through the CSU Noyce Program as well as present examples of the specific internships that we have been involved with as a result of the program.

P-13 Assessing the Impact of Diverse Instructional Techniques in the Introductory Physics Course

Sean Gallardo, Chicago State University
Mel Sabella, Chicago State University

Over the past several years, the introductory mechanics class at Chicago State University has included several research-based instructional techniques aimed at improving student understanding of physics concepts. These techniques include pretests, Tasks Inspired by Physics Education Research (TIPERS), discussion questions, clicker question sequences, interactive PowerPoint lectures, and research-based laboratories. In addition, we have changed how we package our coursework by introducing a workbook that places these diverse pieces into a coherent unit.

P-14 A multi-institutional effort to develop effective learning environments for the urban setting

Anthony Escuadro, Harold Washington College, City Colleges of Chicago
Jaime Millan, Harold Washington College, City Colleges of Chicago
Daniel Russ, Olive-Harvey College, City Colleges of Chicago
David Zoller, Olive-Harvey College, City Colleges of Chicago
Mel Sabella, Chicago State University

The Physics faculty at Chicago State University, Harold Washington College and Olive Harvey College are engaged in an NSF project to implement research-based instructional materials and assess student learning in the introductory physics classes at our urban institutions. The project utilizes an instructional approach that builds on the strengths of the diverse student populations we work with. In this poster we report on the process through which we have been establishing flexible learning environments by sharing resources and experiences during three semesters of implementation. In particular, we present the physical, technological and instructional resources that we use to generate greater student engagement and more effective student-student and student-instructor interactions and we discuss our assessment of student content learning and attitudes at our institutions.

P-15 Center of the Universe Located by Triangulation of NASA Data

Charles Sven

The Very Well Scrubbed NASA’s seven year accumulation of CMB Data is not homogeneous, but has a unique geography. NASA’s overall results have remained the same noting that every CMB point is unchanging; the composite study is like a unique fingerprint. As a result of this work, each point on the CMB sphere can be catalogued; characteristics and coordinates noted. With this information in hand one may use these points in locating earth vis-à-vis the technique of triangulation.

P-16 Internal Strain Distribution of Zeolites by Coherent X-ray Diffraction

Wonsuk Cha, Sogang University
Sanghoon Song, Sogang University
Nak Cheon Jeong, Sogang University
Kyung Byung Yoon, Sogang University
Ross Harder, Argonne National Laboratory
Ian K. Robinson, University College London
Hyunjung Kim, Sogang University

The zeolites are crystalline aluminosilicates having nanometer-sized pores which are spaced regularly and uniformly. They have been widely used in industry as catalysts, ion exchangers, and adsorbents. Zeolites are usually synthesized with hydro-thermal reactions. In this study, we measured coherent x-ray diffraction on zeolite microcrystals in order to get the internal strains developed during the synthesis or calcination processes. The experiments were performed at the 34-ID-C
P-17  **FM and Raman Studies of Imperfections in Nb surfaces for Superconducting RF cavities**

*Chaoyue Cao, Illinois Institute of Technology*

Future linear colliders such as the ILC will incorporate superconducting RF (SRF) cavities made from Nb. Problems with SRF cavities are often linked to surface imperfections, such as pits which form near welds. We have performed AFM measurements of such pits in conjunction with Raman spectroscopy. It is found that the Raman spectrum associated with Nb oxides is significantly enhanced inside such pits. The AFM measurements indicate that this enhancement is due to surface roughness and a corresponding increase in surface area.

P-18  **Z-Matrix Conversion: Implementation and Improvement of the Cumulative Rotational Matrix Algorithm (CRM)**

*Irina Papuc, Illinois Institute of Technology*

In most chemical applications, molecular conformation is traditionally expressed in terms of bond lengths, bond angles, and dihedral angles, which are often readily available and are studied in relation to optimization problems and other such concerns. However, Cartesian coordinates are an accepted standard for most physical and mathematical problems as well as major modeling software, so the z-matrix-Cartesian conversion problem is a significant process that allows for cross-disciplinary molecular studies from the chemical as well as the physical and mathematical point of view. Z-matrix conversion is closely linked to the Molecular Distance Problem, which requires determination of Cartesian coordinates for atoms with some known interatomic distances and bond angles but unknown torsion angles. Several procedures have been developed for both conversions with known and unknown torsion angles implementing quaternions, rotational matrices, vectors, and random arrays. In this paper we implement a rotational matrix-based algorithm in the case of known torsion angles, termed by this paper’s author as the Cumulative Rotational Matrix method (CRM), and add croschecks to ensure molecular symmetry based on the VSEPR theory. The CRM method was utilized in the conversion of internal coordinates for a variety of given molecules to their respective Cartesian conformations. The method’s algorithmic complexity, computational speed, and overall atomic proximity were analyzed by way of big-O analysis, speed tests with implementation of the C language’s built-in time function, as well as three-dimensional Cartesian plots, respectively. The algorithm’s success in reproducing the molecules in Cartesian space was evaluated by comparison with professional molecular editing software. The simulations were run on a 2.2 GHz Intel core 2 duo Macintosh computer with memory 2gb 667 MHz DDR2 SDRAM.

P-19  **Increased levels of systemic inflammation in the elderly are associated with reduced microstructural integrity of brain tissue**

*Stephanie Harmon, Illinois Institute of Technology*

Aging is associated with upregulation of inflammation-associated genes in the brain. Inflammatory mechanisms are shown to be upregulated in regions of the aged brain known to be vulnerable to deposition of Alzheimer’s disease pathology. The purpose of this work was to test the hypothesis that high levels of circulating inflammatory markers in the elderly are associated with changes in the microstructural integrity of white matter tissue, as assessed with diffusion tensor MRI.

Serum samples from 320 non-demented elderly participants of the Rush Memory and Aging Project [1], were assayed for C-reactive protein (CRP) and tumor necrosis factor-alpha (TNFα) and stratified into groups of high and low systemic inflammation based on a composite measure of CRP and TNFα. The first 15 MRI-eligible participants from the upper quartile (age = 81.2 ± 3.6 years) and the first 14 participants from the lower quartile (age = 81.2 ± 6.1 years) were taken. Diffusion tensor imaging (DTI) data were collected for all subjects on a 1.5T GE MRI scanner using a 2D spin-echo echo-planar DTI sequence.
This work demonstrated that in elderly persons without dementia, high levels of systemic inflammation were associated with significantly lower FA and higher trace values in white matter throughout the brain. These results are in agreement with the findings of a recent study on the association of inflammation with the microstructural integrity of brain tissue in younger subjects [2]. The recently published study showed FA changes primarily in frontal regions, while our study revealed FA and trace changes throughout the brain. This used a diffusion-encoding scheme with twice as many diffusion directions, significantly improving DTI results. In conclusion, our work suggests that high levels of systemic inflammation in the elderly may be a risk factor for reduced microstructural integrity of brain tissue.


**P-20 The Roles of Inversion and Recombination In Mean Gene Copy Number**

*Jacob Weidner, Illinois State University*
*Kevin Wabick, Illinois State University*
*Brian Clark, Illinois State University*

There are multiple copies of a number of genes within an individual's DNA, and the number of copies of some genes varies greatly within a population. This copy number variation can be beneficial in the case of the CCL3L1 gene in humans, which has been linked to resistance to the HIV virus [1]. There are also numerous examples of extra copies being detrimental as is the case of Down's syndrome. Here, we are primarily focused on exploring the roles recombination and inversion have in determining the mean gene copy number in a population. We also include a discussion of the roles of mutation and explicit and implicit fitness in determining gene copy number. Individuals are modeled by a single strand of DNA consisting of a set number of genes assigned to different traits. The target fitness value for one specific trait is varied both in a sinusoidal waveform as well as at random and the individual and population responses are observed.

**P-21 The Role of Inversion and Recombination on Linked Genes**

*Kevin Wabick, Illinois State University*
*Jacob Weidner, Illinois State University*
*Brian Clark, Illinois State University*

The spatial organization of linked genes in an individual or population is not well understood, and the definition or classification of the form of linkage between genes can vary from researcher to researcher. In models, genes can be explicitly linked via a user defined mathematical fitness equation or implicitly linked through the reproduction operations of inversion and recombination (crossover), for example. In our simulation, individuals are modeled by a single strand of DNA consisting of a set number of genes assigned to one of two different traits. While, individuals are selected to reproduce according to their explicit fitness (and linkage) as calculated with the two most fit genes assigned to one specific trait, the actual mechanisms of inversion and recombination play a critical role in determining genetic organization. We discuss the role of inversion and recombination on genetic organization in a system where each individual is constrained to a fixed total number of genes and the trait of interest is constrained to two genes.

**P-22 Searching for Hazardous Asteroids**

*Brian Elwood, Chicago State University*
*Kimberly Coble, Chicago State University*
*Andy Puckett, University of Alaska at Anchorage*
*Stephanie Cortes, University of Arizona*

Along with collaborators at the University of Alaska at Anchorage, we are searching for hazardous asteroids using astronomical images. A variety of measurements of a selected asteroid’s orbit are collected and added to an astrometry file. This improves the ability of predicting the asteroid’s position in the future. The images were taken with the WIYN 0.9-meter telescope at Kitt Peak National Observatory outside Tucson, AZ and analyzed using Astrometrica, ImageJ, and Find_ Orb.

**P-23 The Implementation of Research-Based Science Education Curricula at an Urban University**

*Kimberly Coble, Chicago State University*
*Brian Elwood, Chicago State University*
*Melissa Nickerson, Chicago State University*
*Andrew Puckett, University of Alaska at Anchorage*
*Travis Rector, University of Alaska at Anchorage*

Chicago State University has partnered with the University of Alaska at Anchorage to implement their RBSEU (Research-Based Science Education for Undergraduates) curricula in both our introductory and advanced undergraduate astronomy courses. The curricula engage
students in the scientific enterprise, with real research. We have adapted three of the RBSEU projects: "Killer Asteroids", "Photometric Redshift", and "Making Color Images" for use with our students. We have also administered course assessments for the introductory courses. We describe our implementation in the introductory course, preliminary research on the effectiveness of the materials, and the successes and challenges we face as the project expands to different instructional environments. We also describe the research results of students working on these projects as part of their advanced undergraduate astronomy training.

P-24 Using the Big Ideas in Cosmology to Teach College Students

Virginia Hayes, Chicago State University
Kimberly Coble, Chicago State University
Janelle Bailey, University of Nevada Las Vegas
Geraldine Cochran, Florida International University
Donna Larrieu, Chicago State University
Roxanne Sanchez, University of Nevada Las Vegas
Kevin McLin, Sonoma State University
Lynn Cominsky, Sonoma State University

Recently, powerful new observations and advances in computation and visualization have led to a revolution in our understanding of the universe. These gains have been vast, but their impact on education has been limited. We are bringing these tools and advances to the teaching of cosmology through research on undergraduate learning in cosmology as well as the development of a series of web-based learning modules. In order to investigate student ideas about the structure, composition, and evolution of the universe, our group has developed an open-ended cosmology survey. We administered the survey prior to instruction and conducted follow-up student interviews using the survey. Preliminary results regarding student misconceptions in cosmology, student attitudes toward inquiry, and directions for instruction in cosmology will be presented.