Colloquium Schedule
Fall 2014 – Spring 2015
Department of Physics
Colloquia are scheduled at 4:30 PM every Friday and are subject to change.

Colloquia will be held in PS 161.

Refreshments will be served.

Colloquium Committee:
Dr. Britt, Dr. Efthimiou, Dr. Klemm (Chair), and Dr. Luo
# Colloquia Speakers by Date

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* Click on the Date or Speaker’s name for more details! *
Optical frequency combs produced by ultrafast mode-locked lasers have revolutionized precision spectroscopy and time metrology, culminating in the 2005 Nobel Prize in Physics. I will present a new technique for extending frequency combs to the highly desirable yet difficult-to-achieve mid-infrared range - the region of fundamental molecular fingerprints. The technique is based on subharmonic optical parametric oscillation (OPO) that can be considered as a reverse of second harmonic generation. Using ultrafast erbium or thulium fiber lasers as a pump, we produce frequency combs that can be more than octave wide, e.g. span from 2.5 to 6 µm without gaps. I will talk about coherent properties of the generated mid-IR combs, as well as their applications including trace molecular detection via absorption spectroscopy. Working in the Fourier domain allows taking advantage of massive parallelism of spectral measurements (thanks to the broad spectrum), as well as very high speed of data acquisition (thanks to the coherent nature of the frequency combs), up to 1M spectral points in a fraction of a second.
Airway Surface Brush Sweeps Lungs Clean: Polymer Physics Helps Us Breathe Easier

Michael Rubinstein

The classical view of the airway surface liquid (ASL) is that it consists of two layers – mucus and periciliary layer (PCL). Mucus layer is propelled by cilia and rides on the top of PCL, which is assumed to be a low viscosity dilute liquid. This model of ASL does not explain what stabilizes the mucus layer and prevents it from penetrating the PCL. I propose a different model of ASL in which PCL consists of a dense brush of mucins attached to cilia. This brush stabilizes mucus layer and prevents it penetration into PCL, while providing lubrication and elastic coupling between beating cilia. Both physical and biological implications of the new model will be discussed.

University of North Carolina
WISE Comets: The Largest Sample of Comets in the Infrared, so far...

NEOWISE is the NASA Planetary Division-funded mission that utilizes data from the Wide-Field Infrared Survey Explorer (WISE) spacecraft to detect and characterize moving objects. NEOWISE has provided the largest statistical sampling of infrared observations of comets in various states of activity, containing a variety of types of comets. This data set provides a unique opportunity to discern the trends in their observable properties and compare the ensemble properties between comet types, and may allow us to discern subtypes. The WISE spacecraft has discovered 22 new cometary bodies and observed over 160 comets while the spacecraft was cryogenically cooled, yielding the largest sample of comets yet observed at thermal-IR wavelengths. This collection offers a diverse range of comet behavior including highly active and inactive bodies from both long period comet (LPC) and short period comet (SPC) populations. The survey has also observed a significant number of objects in related populations, such as Centaurs and Scattered Disk Objects (SDOs). The mission continues, after the spacecraft was placed in hibernation in February of 2011 and was restarted in December of 2013, and is well on its way to double the sample of comets observed utilizing the two shorter wavelengths of the spacecraft.

We have conducted analyses of the physical properties of the NEOWISE-observed comets. In particular, our analysis constrains the quantity and nature of the ejected coma dust for large particles, and provides estimates of the nucleus sizes and albedos, as well as the production rates and extent of the CO/CO2 gas species. WISE is sensitive to CO and CO2 emission lines that fall within the 4.6 micron band pass (W2), at 4.3 and 4.7 microns, respectively. The quantity of dust present is found from the signal in the three other bands, centered at 3.4, 12, & 22 microns, and the dust signal in W2 is deduced, such that excess signal in W2 can be identified. We find detectable signal excess in nearby comets ~1AU distance from the Sun, as well as those as distant as 4.5AU, and approximately a third of both LPCs and SPCs show 4.6 micron infrared excess in our data. We will discuss in depth the properties of the comets observed by WISE and derived from the sample of comets to date. We will also present the possibilities of a more complete sample of cometary objects with future missions.

Acknowledgements: This work was supported by NEOWISE, which is a project of JPL/CalTech, funded by the Planetary Science Division of NASA.
Over the last few years, attempts have been made to unify many aspects of the freezing behavior of glasses, granular materials, gels, supercooled liquids, etc. into a general conceptual framework of what is called jamming behavior. This occurs when particles reach packing densities high enough that their motions become highly restricted. A general phase diagram has been proposed onto which various materials systems, e.g. glasses or granular materials, can be mapped.

We will discuss some recent applications of resonant and non-resonant soft X-ray Grazing Incidence Scattering to mesoscopic science, for example the study of magnetic domain wall fluctuations in thin films. For these studies, we use resonant magnetic x-ray scattering with a coherent photon beam and the technique of X-ray Photon Correlation Spectroscopy.

We find that at the ordering temperature the domains of an antiferromagnetic system, namely Dysprosium metal, behave very much also like a jammed system and their associated fluctuations exhibit behavior which exhibit some of the universal characteristics of jammed systems, such as non-exponential relaxation and Vogel-Fulcher type freezing. We will also discuss studies of other systems in this class, such as the dynamics of nanoparticles in entangled polymer networks.

http://sinhagroup.ucsd.edu/
Titan: Ingredients for Life

Catherine Neish

NASA's Cassini mission has revealed Saturn's larger moon Titan to be a world rich in the "stuff of life." Reactions occurring in its dense nitrogen-methane atmosphere produce a wide variety of organic molecules, which subsequently rain down onto its surface. If these molecules mix with water found in cryovolcanic lavas or impact melts on Titan's surface, they may react to form biological molecules such as amino acids. In this presentation, I will report on experimental work seeking to determine the type and quantity of biomolecules formed under conditions analogous to those found in transient liquid water environments on Titan. These reactions are intriguingly similar to reactions that may have occurred on the early Earth, and provide clues to the origin of life on our own world and worlds throughout the universe.
September 29, 2014

Thermoresponsive hydrogels - what can scattering methods tell us?

C.M. Papadakis

Thermoresponsive, polymeric hydrogels respond in a controlled and reversible way with a volume change to a small change of temperature across the cloud point. These switchable and nanostructured materials are of great interest for controlled molecular ultrafiltration, for instance. A widely used thermoresponsive polymer is poly(N-isopropylacrylamide) (PNIPAM) which exhibits a cloud point at 32 °C. We investigate self-assembled, physically crosslinked thermoresponsive hydrogels formed by amphiphilic, symmetric triblock copolymers having short, fully deuterated polystyrene (P(S-\(d_8\))) end blocks and a large (PNIPAM) middle block. In my talk, I will describe the structural properties as a function of temperature [1] as well as on the kinetics of the collapse of the micelles and their subsequent aggregation [2,3]. Small-angle neutron scattering (SANS) with contrast matching allowed us to reveal the core-shell structure of the micelles as well as the network structure. We found that, at the cloud point, the shell collapses and the distance between the P(S-\(d_8\)) cores shrinks abruptly [1]. The changes are reversible upon cooling. Using in-situ, real-time SANS following a temperature jump across the cloud point, we characterized the collapse and the subsequent aggregation behavior in a micellar solution in D\(_2\)O [2,3]. We obtain information on many length and time scales.

Technische Universitaet Muenchen

http://www.professoren.tum.de/en/papadakis-christine/
Though a serviceable, if still developing, theory of the evolution of life exists, almost nothing is known about the very initial stages of the process. In these initial stages, known as prebiotic evolution, chemical systems appeared which were sufficiently lifelike for biological evolution to begin. In this talk I will begin with a brief discussion why a better understanding of the process of prebiotic evolution is crucial for any kind of rational estimate of the likelihood that humans will observe extraterrestrial life. Then I will describe the paradox, often attributed to Manfred Eigen, which plagues the simplest, 'naked gene' models for prebiotic evolution, demonstrating that this is essentially a problem in statistical physics. I will describe a class of models, associated with Stuart Kauffman and others, which avoid the paradox. Finally I will describe our work on a variant of the latter models, in which the imposition of the constraint that life-like systems are not in chemical equilibrium leads to qualitatively new results. In particular, our results suggest that deserts might be better than ponds for initiating life. A few details of the models and simulations will be described as time allows.

One year ago, the astronomy community was gripped with anticipation as sungrazing comet C/2012 S1 (ISON) was just weeks away from an unprecedented close encounter with the Sun on November 28, 2013. Comet ISON held the potential of being a spectacular nighttime object - but its fate hinged on surviving a passage that would take it to within just 1.1-million kilometers of the solar surface. To the great disappointment of a global audience, the comet did not survive, fading rapidly in the hours surrounding perihelion and disappearing from sight in the following days. For the first half of the talk I will recap some of the background regarding ISON, and highlight the main points of interest during its well-observed final year of approach to the Sun. I will focus in particular on the final few days and hours of the comet’s passage, with images recorded by solar-observing spacecraft. The second half of the talk will focus on how, using numerous sources of observational and modeling evidence, we are now able to paint a coherent and very compelling picture of how, why, and when, comet ISON was catastrophically destroyed as it approached the Sun on Thanksgiving Day, 2013.
Dynamics of Molecular Transformers in Silico

Prem Chapagain

Proteins are the molecular machines responsible for maintaining the biological self-organization in living cells. However, in order to perform their molecular functions, protein molecules themselves must fold into highly specific 3-dimensional shapes known as the native states. The information to fold to a functional native state of a protein is encoded in its one-dimensional string of amino acids, the primary sequence. However, structural conversion from the native state is a frequently observed process such as in the aggregation and fibrilization of amyloidogenic proteins, which is thought to be a critical process in the development of a variety of neurodegenerative diseases such as Alzheimer’s, Parkinson, Huntington, and prion diseases. A new class of proteins known as transformer proteins has recently emerged. The transformer proteins can undergo structural transformations that allow them to perform multiple functions, and they are re-defining the general perspective of sequence-structure-function relationship. In this talk, I will discuss the computer simulations of some model protein systems that shed light on the protein folding dynamics, including structural transitions in amyloidogenic proteins as well as the alpha helix to beta barrel structural transformation of the C-terminal domain of the transcription factor RfaH.

Florida International University

ROOM CHANGE! PHYSICS COLLOQUIUM WILL BE HELD IN HEC 117!
NASA's Cassini mission has revealed Saturn's larger moon Titan to be a world rich in the "stuff of life." Reactions occurring in its dense nitrogen-methane atmosphere produce a wide variety of organic molecules, which subsequently rain down onto its surface. If these molecules mix with water found in cryovolcanic lavas or impact melts on Titan's surface, they may react to form biological molecules such as amino acids. In this presentation, I will report on experimental work seeking to determine the type and quantity of biomolecules formed under conditions analogous to those found in transient liquid water environments on Titan. These reactions are intriguingly similar to reactions that may have occurred on the early Earth, and provide clues to the origin of life on our own world and worlds throughout the universe.
October 31, 2014

Pending

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November 7, 2014

Pending

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November 14, 2014

NO COLLOQUIUM

Football Game
November 21, 2014
Pending

Richard Averitt

University of California – San Diego

http://www-physics.ucsd.edu/fac_staff/fac_profile/faculty_description.php?person_id=1142
November 28, 2014

Thanksgiving Day!

No Colloquium
December 5, 2014

Final Exams!

No Colloquium
January 16, 2015

Tony Heinz

Columbia University

http://heinz.phys.columbia.edu/
Asteroids are essential to our understanding of the history of our Solar System. Unlike the major planets, which have undergone major alterations from a variety of physical, geological, and atmospheric processes, asteroids are minimally altered objects that enable us to look back at the cosmochemical variations in the early Solar System.

My research utilizes reflectance spectroscopy of asteroids throughout the Solar System to remotely infer their compositions. Each asteroid population contributes to our understanding of the Solar System as a whole. The dynamical lifetimes of near-Earth asteroids (NEAs) are far shorter than the age of the Solar System and the population is regularly replenished from within the Main Asteroid Belt through a series of complex dynamical interactions. Compositional measurements in conjunction with Main Belt source regions models enable the use of NEAs as compositional tracers from elsewhere in the Solar System. Knowledge of the compositions of asteroids in the Main Belt teaches us about the composition of solids in the Solar nebula, the chemical evolution of these solids, and the subsequent mixing that has occurred since the formation of the Solar System. I will highlight my recent results and discuss how spectroscopy of these objects can be used to understand the formation and evolution of our Solar System.
January 30, 2015

Pending
February 6, 2015

Lori Feaga

University of Maryland
February 13, 2015

Pending
The ordering of small molecules, programmed with functional groups for specific non-covalent interactions, can lead to robust, dynamic, and functional monolayers or thin films. Our group studies these assemblies under well-controlled environments by atomic-resolution scanning tunneling microscopy (structural characterization) and X-ray photoelectron spectroscopy (chemical characterization). These studies allow new insights in the roles of electrostatic, transition metal coordination, and van der Waals interactions in two-dimensional assembly, as well as in the formation of crystalline organic thin films. Three new results will be highlighted in this presentation to illustrate these ideas around the theme of designing the molecular building blocks for efficient self-assembly into well-defined systems with potentially transformative electronic or chemical function. Recent results from our lab demonstrate the on-surface redox assembly of platinum with a dipyridyl tetrazine ligand on a single crystal gold surface into 1D chains of interest for the single site Pt(II) centers as catalyst sites. We have designed molecules with intramolecular charge separation for parallel, offset stacking to produce crystalline organic films. We have also demonstrated triggered switching of surface architectures in a dynamic solution-solid interface environment. These studies open new opportunities in designing organic materials for organic semiconductors, sensors, catalysts and photovoltaics.
February 27, 2015

Pending

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March 6, 2015

APS Meeting

No Colloquium
March 13, 2015

Spring Break

No Colloquium
The recent advent of atomically thin 2-dimensional materials such as graphene, hexa boronitride, layered transition metal chalcogenide and many strongly correlated materials, has provide a new opportunity of studying novel quantum phenomena in low dimensional systems and utilizing them for novel electronic devices. In particular, graphene has been provided us opportunities to explore exotic transport effect in low-energy condensed matter systems and the potential of carbon based novel device applications. In this presentation I will first discuss the exotic quantum transport behavior discovered in graphene nanostructures in the relation to the device applications beyond CMOS operation. In addition, I will discuss the new type of material classes based on 2-dimensional van der Waal materials and their heterostructures including atomically thin vertical Schottky junction and p-n heterojunction based on the vdw assembly of transition metal dichalcogenides and graphen. Unlike conventional p-n junctions, here charge transport and photovoltaic response of the devices are found to critically depend on the interlayer recombination process between majority carriers mediated by tunneling across the interface. We demonstrate the enhanced optoelectronic performances in the vdw heterostructures, suggesting that these a few atom thick interfaces may provide a fundamental platform to realize efficient, fast and tunable bipolar electronics, photovoltaics, and optoelectronics.
April 3, 2015

Pending