Physics Lecture Series | Spring 2011 Seminar Series

This semester's seminar series is sponsored by United Space Alliance
1/31/2011

Research into Practice - Practice Informing Research: A case from the physical science laboratory for elementary teachers
Milijana Suskavcevic, Associate Director for Research School, Science, and Technology Program Wiess School of Natural Sciences, Rice University

Presentation Abstract

The guided inquiry approach rooted in Powerful Ideas in Physical Science (PIPS) curriculum used in teacher preparation courses at undergraduate level offers many innovative activities and creative approaches in learning and teaching science. However, not every unit developed in this curriculum has equal clarity. As an alternative to PIPS' unit on composite density, we developed a unit treating the same concept with a somewhat simplified approach using an orange to illustrate the concept of system's density. Teachers involved in the study tested whether they could average the densities of these components to find the value for the density of the system. The unit is flexible enough to be introduced in inquiry based classrooms at several grade bands and at different levels of sophistication – from basic qualitative description of the behavior of the orange in different liquids to quantitative calculations of the buoyant force which selected liquids exert on the orange. The study has been carried out among several populations of pre-service teachers (n=484) through physical science courses, with statistically significant differences in teacher content test scores – higher for the group treated with the newly developed approach over the group that used the existing PIPS activities for densities of systems.

2/07/2011

The Fabrication of Thin Film Solar Cells on the Surface of the Moon
Alex Ignatiev, Hugh Roy and Lillie Cranz Cullen Professor of Physics, Chemistry, and Electrical and Computer Engineering, Director, Center for Advanced Materials, UH

Presentation Abstract

The ubiquitous presence of solar energy in space begs for its significant utilization for the supply of energy for use by humankind - whether on Earth or in space. To that end, the striving of man to move into the cosmos will require extensive amounts of energy, principally in the form of electrical energy, to support man's continuous presence in space. Further, energy needs on the Earth will continue to increase, and the solar energy present in space can be harnessed to support those Earth needs for increased electrical energy. The Moon presents a unique opportunity to generate the extensive amounts of emery that will be required by humankind in the future. The use of the indigenous resources of the Moon can yield the fabrication of solar cells directly on the surface of the Moon by thin film growth technology in the vacuum environment of the Moon. This can be accomplished by the deployment of a moderately-sized (~200kg) crawler/rover on the surface of the Moon with the capabilities of preparation of the lunar regolith for use as a substrate, evaporation of the appropriate semiconductor material for the solar cell structure, and deposition of metallic contacts and interconnects. This
unique process will allow for the emplacement of a lunar electric power system that can supply extensive electrical energy for lunar and cis-lunar space use, and in an expanded version provide considerable amounts of electrical energy to the Earth through power beaming technologies.

2/14/2011

**The 2007 Chinese ASAT Test - Implications to the Impact of Space Warfare on the LEO Environment**
David Talent, Visiting Assistant Professor of Physics, UHCL

Presentation Abstract

Over the past several decades there has been increasing concern regarding the growth of the orbital debris population in the Low Earth Orbit (LEO) environment. Even under the best of circumstances the debris population may be expected to increase under conditions of ambient use by the space-faring nations of the world. As the numbers of debris objects increases so does the threat of collision with high-value operational assets. Thus, given the importance of minimizing orbital debris in LEO, it is obvious that any nation conducting anti-satellite (ASAT) tests should do so in a responsible fashion - minimizing the long-term deposition of large numbers of orbital debris objects at operational LEO altitudes. The objectives of this paper are four-fold: (1) to describe Oceanit’s Phenomenological Orbital Debris Model (PODEM) as developed from it’s precursor -- the Particle-In-a-Box (PIB) model, (2) to present validating evidence of the usefulness of PODEM by application to the 1985 Solwind ASAT test, (3) to examine the long term impact of the Fengyun-1C ASAT test on the LEO environment utilizing PODEM, and most importantly, (4) to examine two contrasting space warfare scenarios based on multiple Fengyun-1C-equivalent (F1C-E) events. Once the nature and function of the PODEM model have been described and validated by examination of the historical case, the impact of the Chinese ASAT test on the LEO environment using PODEM will be described. It will be shown that it may well take close to 500 years for 85% of this debris to leave the LEO environment by natural means. Finally, using 100 F1C-E events to model two space warfare scenarios, one at an altitude of approximately 450 km and the second at approximately 1050 km, it will be shown that the high altitude scenario results in an acceleration of runaway debris growth that is completely unacceptable.

2/21/2011

**Dealing with Rare and Extreme Space Weather Events**
Dan Fry, Space Radiation Analysis Group, Johnson Space Center

Presentation Abstract

Lectured Cancelled

Solar Proton Events (SPEs) are relatively rare occurrences when the Sun sends large numbers of energetic particles out into the heliosphere. Primarily protons with energies that can exceed 1GeV, these events can damage spacecraft, telecommunications satellites, and even Earth-based power grids, and can last from a few days to more than a week. Events appear to occur randomly over a 7 year period enveloped by the solar cycle. Since the advent of the modern space era, only a few hundred events have been observed. This talk will address various ways that can be utilized to assess SPE risk when working with such small sparse data sets.

2/28/2011
Plasma Physics Applications to Aerospace Technology
Alfonso Tarditi, Research Assistant Professor of Physics, UHCL

Presentation Abstract
As NASA is re-aligning its objectives towards a longer term and longer range exploration in space (extended life of the ISS, missions far from low-Earth orbit), new technologies are required to address the main challenges of future space flight, to allow faster, more efficient payload transfers and safe, longer presence in space. Plasma science, while traditionally driven largely by fusion energy research, is increasingly becoming a key element in providing answers to these critical challenges, with technologies like electromagnetic-augmented heavy-lift propulsion, plasma-assisted combustion, in-flight lightning effects protection, micrometeorites and orbital debris and space radiation countermeasures, space weather forecasting, electric space propulsion, plasma actuators and magnetohydrodynamic steering for hypersonic atmospheric flight. This talk will present a review of these technologies with the emphasis on near-term, low-cost developments that could foster a stronger collaboration between UHCL and the NASA Johnson Space Center.

3/07/2011

Structural and Optical analysis of InAs/GaSb Superlattices
Donna Stokes, Associate Professor of Physics, UH

Presentation Abstract
There is a growing demand for mid- to far-infrared (3 – 30 mm) detectors for applications such as infrared countermeasures and chemical and biological sensors. Devices which are currently available based on the HgCdTe system suffer from fast Auger recombination rates which affect the sensitivity of the device and hence its performance. Recent studies on the use of the InAs/GaSb system in the active region of such detectors has shown great promise due to the systems type-II band alignment, strong interband absorption and reduced recombination rates. However, due to growth and structural issue, performance of this system has been limited. In this talk, the detailed of an x-ray diffraction study of the strain in planar and self-organized nanostructured InAs/GaSb superlattices grown by molecular beam epitaxy as the active region of infrared detectors will be presented. Misfit strain in superlattices, grown with either InSb or GaAs interfaces, has been determined for both the superlattice layers and the interfaces. Results from this study shows that the magnitude and sign of this strain, which is dependent on the interfacial bond, is crucial in governing the morphology of the superlattice. In addition, the result indicates that the nanostructure formation does reduce the optical response of the materials and may limit its use for detector applications.

3/21/2011

Gamma-Ray Bursts, Shocks, and Relativistic Jets
Tim Giblin, Space Flight Instructor, Johnson Space Center

Video Presentation Abstract
Deciphering the physical nature of Gamma-Ray Bursts (GRBs) has challenged astrophysicists for more than four decades, though great strides have been made in the last 15 years that have proven GRBs to be the most energetic explosions in the Universe. Observations of the prompt high energy gamma-ray emission (~250 keV) have provided insight into the complex behavior of
the central engine, while long-lived fading afterglow emission has revealed clues about the extended energy dissipation. GRB theory suggests a "collapsar" as the GRB progenitor, a massive star that produces a relativistic outflow from the collapse of the core. In this talk I will review our current understanding of GRBs and present advancements in GRB science from the Swift and FERMI spacecraft.

3/28/2011

**How much can you enhance student thinking?**
John Clement, Physics Instructor, St. Pius X High School

Video Presentation Abstract

It is now known that it is possible to significantly increase students' scientific thinking ability. Recent data shows that this can be done significantly in only a 4 week course in physics. Some ideas on how this can be done will be presented. Since there is now evidence that student thinking ability has gone down over the last 30 years, this is a vital topic. Physics Education materials are helpful, but you must go beyond them.

4/04/2011

**Studying Active Galactic Nuclei through GRMHD and Radiation Transport Models**
Guy Hilburn, Ph.D. Student, Rice University

Video Presentation Abstract

Nearby low luminosity active galactic nuclei offer unprecedented theoretical laboratories to study a number of astrophysical processes and outstanding problems. A myriad modeling suite for LLAGN's will be discussed, with emphasis on maximal consistency at each simulation step. This suite includes a general relativistic magnetohydrodynamic accretion disc evolution scheme to build a global LLAGN parameter library, a unique Monte Carlo radiation transport code modified for regions of high magnetic field and velocity anisotropy, localized MHD shearing box models to examine magnetic turbulence saturation levels, and particle-in-cell simulations to study particle acceleration on microscopic scales. This combination of tools provides the ability to accurately model spectral energy distributions, emission maps, and light curves, from sources such as M87 and Sagittarius A*. Results of in-progress modeling will be shown, and the strengths and weaknesses of each step in the modeling process will be examined.

4/11/2011

**Biological Issues in Space Radiation Protection with Shielding**
Honglu Wu, Laboratory Manager, Radiation Biophysics Laboratory, JSC

Video Presentation Abstract

The development of effective means to protect astronauts from space radiation exposure is essential for exploration missions. Exposure to gamma or X-rays can generally be reduced by heavy materials placed between the radiation source and the individual. Typically, the absorbed dose decreases exponentially as a function of the shielding thickness. However, the
effectiveness of shielding as protection from space radiation exposure is compounded by a number of issues. Space radiation consists of primarily energetic charged particles and secondary neutrons, and the dose-depth relationship follows the Bragg curve distribution for each primary particle of a given entrance energy. The largest dose is delivered at end of a particle's path, generating a peak in the Bragg curve (Bragg peak). The biological effects along the path of the particle cannot be predicted solely based on the physical dose, particularly in the Bragg peak region. The shielding effects for space radiation are further complicated as secondary particles generated from the bombardment of primary particles can be more damaging biologically. The presentation will discuss these biological issues that need to be addressed in the development of a strategy for space radiation protection with shielding.