1/25/2016

From Physics Undergrad to Seismolab -- Exploiting Earth's Ambient Vibrations to Map Earthquake Hazards and Study Gravity Waves

Daniel Bowden, Graduate Student in Geophysics, Caltech Seismology Laboratory

Abstract: For me, a career in Earth Science is the perfect way to apply what I've learned about physics and waves to really make a difference in the world. I started as Physics Bachelors student, and was blown away by a summer internship with IRIS. Since then, I worked for a year with the USGS installing seismometers and monitoring Twitter, and now study Seismology as a graduate student. We've learned that the Earth is constantly humming with tiny vibrations from the oceans and wind, and my research uses those tiny vibrations to watch waves propagate across a city or even the entire U.S. The research is all based on the basic wave equation, but the challenge is learning how to extract those tiny signals and turn them into useful maps. We can measure how those waves are affected by local geology, and where they are focused or amplified. If an earthquake hits here on the San Andreas in California, those waves will act just the same, and I hope to someday use my technique to help improve building codes for a city.

Geophysics research is a great balance between theory, computations and hands on field work. I'm also working with a physics LIGO team, who study Gravity waves from outer space, to install seismometers deep in a mine in South Dakota. For them, the Earth vibrations that I call data are a source of instrument noise, and we hope to work together to better understand those signals. Traveling a mile underground is quite an experience, and lets me work with geologists and mining professionals who really know what they're doing.

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2/1/2016

No Seminar, meeting with students and the UHCL Writing Center

2/8/2016

Unconventional Property of Multi-gap Superconductors

Ju H. Kim, Professor of Physics, UHCL

Abstract: Superconductivity is the most important macroscopic quantum phenomenon discovered. This phenomenon which arises as the result of effective attractive pairing interaction between two negatively charged particles within a single electronic band in conventional superconductors has been well understood. However, unusual superconducting state property can appear in multi-gap superconductors such as MgB2 and iron pnictides where electrons from multiple electronic bands participate in pairing interactions. This unconventional property includes fractionation of Abrikosov vortices, broken time reversal symmetry, fractionation of Josephson vortices in SIS
junctions, and unconventional current-phase relation. I will discuss how these phenomena arise in multi-gap superconductors and in tunnel junctions involving these superconductors.

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2/15/2016

**Linear Scaling Method for Computational Chemistry**

**Christopher Tymczak**, Professor of Physics, TSU

**Abstract:** In this presentation we report on advances and new techniques in linear scaling computational chemistry. Computational chemistry has become an essential tool in the understanding of nano-systems. These methods and techniques are a computational microscope for studying the behavior of atoms and molecules at the very small (nano-scale). However, traditional computational chemistry methods scale as the cube of the system size, severely limiting the size of the systems which can be addressed to only a few hundred atoms. Linear scaling techniques can alleviate these issues allowing for the simulation of complex molecular systems up to several thousand atoms.

**Bio:** Dr. Tymczak has specialized in the identification, development, and implementation of new scientific codes for exploiting advanced computing resources impacting large scale computation in diverse areas in Many-body physics, Quantum Chemistry and ab initio Molecular Dynamics. He is an Associate Professor of Physics at Texas Southern University, Houston, where he is spearheading the integration of supercomputing resources into various STEM programs, as well as the founder and director of the Texas Southern High Performance Computing Center (TSU-HPCC). At Los Alamos National Laboratory, Dr. Tymczak is a permanent scientific associate within the FreeON initiative, involving the development of a massively parallel linear scaling quantum chemistry methods, currently under development in collaboration with Dr. Matt Challacombe (T-12) and Dr. Anders Niklasson(T-1). He is one of the first to exploit wavelet based methods in large scale computing for understanding the electronic structure of materials. For the last four years, he has advanced the FreeON development through the exploitation of advanced data structures and advanced machine architectures. FreeON is now recognized as one of the first quantum chemical codes with demonstrable scalable parallelism within large-scale parallel clusters.

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2/22/2016

**Finding Our Origins with the Hubble and James Webb Space Telescopes**

**Jonathan P. Gardner**, NASA Goddard Space Flight Center

**Abstract:** Astronomers try to answer the biggest question of all: "How did we get here?" Using a flood of data from the Hubble Space Telescope, other space missions, large telescopes on the ground and super-computer simulations, we are starting to piece together the history of how simple particles, mass and energy that formed in the Big Bang changed over time to become galaxies, stars and planets today. In this talk, I will discuss some of the most important astronomical discoveries of the last 20 years, and the role that space telescopes have played in those discoveries. The next decade looks equally bright with Hubble and the promise of its successor, the James Webb Space Telescope. I will describe Hubble’s greatest
accomplishments and how they lead to the reasons we are building Webb.

Bio: Jonathan P. Gardner is the Chief of the Observational Cosmology Lab at NASA’s Goddard Space Flight Center, and the Deputy Senior Project Scientist for the James Webb Space Telescope. He leads a group that studies the Universe as a whole, from its dramatic beginnings in the Big Bang, to the mysterious dark energy that will determine its future. The James Webb Space Telescope, the successor to the Hubble Space Telescope, will look backwards in time to find the first galaxies that formed after the Big Bang, to trace their evolution into galaxies like our own Milky Way, and to connect the formation of stars and planets with the history of our own Solar System.

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2/29/2016

The First Detection: The Birth of Gravitational Wave Astronomy

Mario Diaz, Professor of Physics and Director, Center for Gravitational Wave Astronomy, The University of Texas Rio Grande Valley for the LIGO-VIRGO Scientific Collaboration

Abstract: The Advanced LIGO (aLIGO) gravitational wave detectors operated a first scientific run from September 18, 2015 through January 12, 2016. In this talk I will describe some aspects of this run, comparing its sensitivity with the operation during the initial LIGO scientific runs where the last one - dubbed Enhanced LIGO S6 run- ended in 2010. And I will share with the audience the joy of the first detection! I will discuss some of the astrophysical implications of it as well as the promise for future discoveries once it aLIGO design sensitivity.

To view the recording, click the link below:
View the presentation recording

3/7/2016

A Novel Gaussian-Sinc Mixed Basis Set for Electronic Structure Calculations

Jonathan Jerke, Post-Doc at Texas Southern University

Abstract: A Gaussian-Sinc basis set methodology is presented for the calculation of the electronic structure of atoms and molecules at the Hartree–Fock level of theory. This methodology has several advantages over previous methods. The all-electron electronic structure in a Gaussian-Sinc mixed basis spans both the "localized" and "delocalized" regions. A basis set for each region is combined to make a new basis methodology—a lattice of orthonormal sinc functions is used to represent the "delocalized" regions and the atom-centered Gaussian functions are used to represent the "localized" regions to any desired accuracy. For this mixed basis, all the Coulomb integrals are definable and can be computed in a dimensional separated methodology. Additionally, the Sinc basis is translationally invariant, which allows for the Coulomb singularity to be placed anywhere including on lattice sites. Finally, boundary conditions are always satisfied with this basis. To demonstrate the utility of this method, we calculated the ground state Hartree–Fock energies for atoms up to neon, the diatomic systems H2, O2, and N2, and the multi-atom system benzene. Together, it is shown that the Gaussian-Sinc mixed basis set is a flexible and accurate method for solving the electronic structure of atomic and molecular species.

Bio: Jonathan Jerke got his degree in astrophysics at Yale University in 2010, where he studied cosmological parameters using the QUEST observatory. After graduation, he continued teaching for a few years and then restarted a program in electronic structure using insight into image processes afforded by the astrophysics education.

To view the recording, click the link below:
3/21/2016

**WB-57F - An Overview of NASA's High Altitude Research Aircraft**

Charles Mallini, Chief, WB-57 Project Office, Aircraft Operations Division, NASA Johnson

Abstract: NASA's arsenal of high altitude research aircraft includes the ER-2, Global Hawk and the WB-57F. This presentation will provide an overview of the WB-57 including its history, capabilities, and role within NASA's high altitude research fleet. A review of several recent science missions will also be discussed.

To view the recording, click the link below:
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3/28/2016

**The Shape Dynamics Description of Gravity**

Tim Koslowski, UNAM, Mexico D.F., ICN

Abstract:

Einstein gravity can be described as a fully relational dynamical system of spatial conformal geometry that evolves together with matter degrees of freedom. The conventional description of gravity in terms of spacetime geometry turns out to be a purely empirical description, that describes how weak matter fluctuations move along with gravity. The empirical predictions of the shape dynamics description of gravity are indistinguishable from General Relativity whenever the experienced spacetime geometry is nondegenerate, but the two descriptions have different domains of applicability.

I will start with a simple toy model, the Newtonian 3-body problem, to explain the relational first principles and the shape dynamics description of a fully relational system. I will then show how these ideas can be implemented to obtain the shape dynamics description of full Einstein gravity without ever referring to spacetime or its geometry. I will conclude with a few remarks about the features of the shape dynamics description of gravity.

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4/4/2016

**Nanostructured Oxide Semiconductors for Solar Fuel Generation**

Oomman Varghese, Associate Professor of Physics, UH

Abstract: The relation between anthropogenic carbon dioxide and weather patterns around the world are becoming increasingly evident. Fossil fuel burning is known to be the primary cause of atmospheric carbon dioxide accumulation. In order to make a paradigm shift, it is necessary to develop technologies to generate fuels through carbon free routes or by carbon recycling. Nanostructured oxide semiconductors have demonstrated promising characteristics as photocatalysts to utilize sunlight for fuel production using both these strategies. The presentation gives an overview of the solar fuel production strategies. The development of nanostructured
metal oxide photocatalysts and their use in converting sunlight into hydrocarbon or carbon free fuels will be discussed in detail.

Bio: Dr. Oomman K. Varghese received Ph.D. in Physics from Indian Institute of Technology (I.I.T.) Delhi, India in 2001. He carried out post-doctoral research initially in Department of Electrical Engineering, University of Kentucky, Lexington, KY and later in Materials Research Institute, The Pennsylvania State University, PA. At Penn State, he pioneered the work on titania nantoube arrays for applications in environmental sensing and solar energy conversion. From 2007 to 2010 Dr. Varghese was Chief Scientist at Sentech Corporation, PA. In 2011 he joined Semiconductor Process Development division of First Solar, Perrysburg, Ohio, a world leader in solar module manufacturing. He then moved to Department of Physics, University of Houston, Texas, where he is presently an Associate Professor. He is currently involved in the development of nanomaterials and devices for advanced solar cell technologies, solar fuel generation via carbon dioxide recycling, hydrogen generation by solar water splitting and environmental sensors. He is a co-author of the book Light, Water, Hydrogen: The Solar Generation of Hydrogen by Water Photoelectrolysis (Springer, 2007). He has also contributed to three patents (one issued and two pending), a book chapter and over ninety refereed publications. His publications have received more than 23000 citations and his current h-index is 62. He is ranked 9th in the Thomson Reuters' list of World's top 100 Materials Scientists in the past decade. Thomson Reuters gave him the title 'Highly Cited Researcher' and included him in the list of 'World's Most Influential Scientific Minds 2014'.

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4/11/2016

Feedback in Galaxies

Eric M. Schlegel, Vaughan Family Professor, Physics & Astronomy Astrophysicist University of Texas at San Antonio

Abstract: Feedback has been recognized as a necessary ingredient in galaxies to explain how star formation is curtailed. The question of how that feedback works has been a problem. I will summarize the literature for models of feedback, then present some of the observations that support the concept, if not the models.

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4/18/2016

Modeling of Secondary Neutron Production in Proton Radiotherapy

Mark Harvey, Assistant Professor of Physics, TSU

Abstract: Secondary neutrons are a main source of stray and leakage radiation outside treatment fields in proton radiotherapy and therefore, pose a risk to patients for the development of second cancers. In addition, the nozzle components of the proton therapy unit remain "hot" some time after the treatment and induce time-dependent decays from mixed neutron/gamma-ray fields, which potentially put radiation therapists at risk for excessive cumulative dose exposures post treatment. The accuracy of the nuclear physics model used to predict stray neutron fields in proton radiotherapy is not clearly understood. The TOOl for PArticle Simulation (TOPAS) was used to calculate the therapeutic absorbed dose and neutron spectral fluence from a proton treatment unit using three nuclear physics models: the Bertini model, the Binary Cascade model and the INCL4/ABLA model. TOPAS is based on the platform of the Geant4 Monte Carlo Toolkit.
The purpose of this research is to compare and quantify differences in predictions from these models for an un-modulated and a range modulated 160 MeV proton therapy beam in 1) characteristics of the therapeutic absorbed dose and 2) stray neutron fields produced by a proton radiotherapy unit using the default Bertini model as the baseline of comparison. The therapeutic absorbed dose was calculated in a water phantom downstream of the nozzle exit, while the neutron spectral fluence was calculated in air. The ambient dose equivalent per therapeutic absorbed dose ($H^*(10)/D$) of the secondary neutrons produced by the nozzle components was also calculated for each model. Based on these calculations, we determined $H^*(10)/D$ at the isocenter, 1 m downstream from the isocenter, and at lateral distances of 1 m from the isocenter. Our results indicate that calculations of the therapeutic absorbed dose ratios are in good agreement for all three nuclear models. However, the $H^*(10)/D$ values differed somewhat at the isocenter with or without range modulation using the alternative models for intranuclear cascade processes.

Lecture cancelled campus closed due to weather conditions

5/02/2016

The Jazz of Physics: The Secret Link Between Music and the Structure of the Universe

Stephon Alexander, Professor of Physics, Brown University

Abstract: In this talk I discuss the various ways that music, in particular, jazz improvisation is linked with modern physics and cosmology. I will focus on counterintuitive the motion of quantum particles and reveal analogies with jazz improvisation. I will also discuss large scale structure and its connection to musical acoustics.

Video Presentation