Western Michigan University

Department of Physics Colloquia

2018-19

Speaker: Gregory Kintz

INVIS Technology – Sunnyvale, CA

Monday, October 15, 2018

"Wide Bandwidth Achromatic Planar Silicon Lenses: Translating Technology into Products in Silicon Valley"

Abstract: New technologies are constantly being brought to market by start-ups in Silicon Valley, but real success is a combination of hard work, funding and luck. Previous start-ups include both commercial successes and failures and cover a wide range of technologies including display technologies, bio-medical instruments, glucose sensing technologies and surgical robotic systems.

A review of the technology of Wide Bandwidth Achromatic Planar Silicon Lenses, the market opportunity and market reality will be presented with lessons learned for the up and coming entrepreneurs.

Speaker: Javier Garcia, Ph.D.

Caltech

"Modeling the X-ray Emissions from Accreting Black Holes"

Monday, October 22, 2018

Abstract: In the region close to compact object such as black holes (or neutron stars), the extreme conditions created by the strong gravitational field produces copious amounts of energetic radiation (ultra-violet, X-rays, and Gamma-rays). The interaction of this radiation with the surrounding material results in observables that carry important physical information. X-ray spectral and timing techniques provide direct

access to the accretion physics on these systems, such as the black hole spin, the location of the inner-edge of the accretion disk, its ionization stage and composition, among others.

In this talk, I will discuss the development of modern relativistic reflection models and how they can be used for the interpretation of the X-ray spectrum from supermassive black holes in AGN and stellar-mass black holes in binary systems. I will show examples of the implementation of our new models to observational data from several X-ray observatories (e.g., RXTE, Swift, XMM-Newton, Suzaku, and NuSTAR), and discuss current outstanding issues, such as the large iron abundances frequently required to fit the reflection spectra, controversies on the disk truncation, the origin of the soft excess in AGN, and the effects of high density in the observed spectra.

Speaker: J. Deprince

Physique Atomique et Astrophysique, Université de Mons, Belgium

"High-density plasma environment effects on the atomic structure and X-ray K lines in ions of astrophysical interest"

Monday, October 29, 2018

Abstract: Emission lines in the X-ray spectral region from accreting black holes have observed widths and shifts that imply an origin very close to the compact object. The intensity of these lines can provide insight into the effects of special and general relativity in the emitting region as well as insight into some properties of the compact object itself, such as its spin. Recent studies seem to reveal that the plasma electronic density of such an accretion disk can reach values up to 10^{21} - 10^{22} cm^{-3}. Such a high-density may affect the atomic structure and processes corresponding to the ionic species present in the plasma. However, atomic data used in the standard programs to model astrophysical X-ray spectra are computed assuming an isolated ion approximation. This shortcoming is thought to be the major reason for the inconsistencies with the observed data.

In this talk, I will introduce X-ray astronomy and show the importance of X-ray lines from accreting black hole as diagnostic tools. I will show how high-density plasma environment can affect the atomic structure and processes, and how these effects can be taken into account in atomic computational methods. Finally, I will present a sample of results obtained recently to quantify these effects on some atomic parameters for cosmologically abundant ions such as those of iron and oxygen.

Speaker: Dr. Robert H. Giles

University of Massachusetts Lowell

"Biomedical Applications of Terahertz Technologies"

Monday, November 5, 2018

Abstract: Over the past few decades, researchers have made significant progress on exploring the potential biomedical applications of terahertz frequency spectroscopic and imaging instrumentation. Advances in terahertz source/receiver hardware have facilitated these developments, promising new operative screening options for meeting the standard care challenges in cancer. Since the terahertz radiation is a non-invasive and non-ionizing illumination source proven for characterizing biomolecules, terahertz imaging techniques are being broadly investigated for both in vitro and in vivo evaluations.

Participating in the field of terahertz technology since 1982 with researchers at the University of Massachusetts Lowell (UML), Giles has been investigating the applications of solid-state and laser-based terahertz sources for polarimetric imaging techniques. With the goal to develop and apply the technology in the frequency range of 0.1 to 3 terahertz, under the direction of Giles UML's BTTC has engineered and constructed measurement systems to investigate an ever-growing number of applications including the areas of medicine. Given preoperative in vitro and in vivo approaches to cancer screening are requisite to addressing the cancer care pathway, BTTC researchers have been investigating intrinsic contrast reflection imaging techniques to differentiate cancerous and healthy tissue, evaluating the advantages of characterization techniques such as polarimetric sensing. A summary of the research initiatives and findings of UML's Biomedical Terahertz Technology Center (BTTC) will be presented along with the foundation of material characterization methods and polarimetric system design considerations for biomedical applications.

Speaker: Dr. Li Fang

Department of Physics, The Ohio State University

"Imaging photoinduced particle fragmentation: Mass spectroscopy using x-ray sources and tabletop ultrafast lasers"

Monday, November 12, 2018

Abstract: Photoionization and the consequent fragmentation of the charged particles are ultrafast response of atomic and molecular systems to the absorption of

photoenergies. These photo-interaction phenomena reveal electronic and chemical bond properties of the systems and can be strongly dependent on the wavelength of the light source. Time-of-flight mass spectroscopy has been a widely used tool for not only identifying chemical constituents but also investigating the kinetics and pathways of the photo-induced fragmentation. I will present studies concerning photo-induced fragmentation of molecules and van der Waals clusters using photon sources of different types, including tabletop ultrafast near-infrared and XUV lasers and light sources of large scales such as synchrotron light sources and free electron lasers. In these works, Time-of-flight spectroscopy was used to probe the momentum space of the dynamic process of molecular and cluster breaking-up.

Speaker: Jiangming Yao, Ph.D.

NSCL/FRIB at Michigan State University

"Beyond mean-field approaches for nuclear physics"

Monday, November 19, 2018

Abstract: The self-consistent mean-field approaches have achieved a great success in describing the bulky properties of atomic nuclei with an acceptable computation cost. Because of spontaneous symmetry breaking, these approaches, however, cannot be applied directly to describe nuclear spectroscopy. Moreover, atomic nucleus is a quantum system and generally has a large fluctuation in collective coordinates, the description of which is beyond the mean-field approximation. In this talk, I will introduce the implementation of quantum-number projection and generator coordinate method into covariant density functional theory to overcome the above issues and then present its applications to nuclear low-energy collective excitations, nuclear matrix elements of neutrinoless double beta decay and strangeness physics. In the last part of my talk, I will introduce the project on the implementation of two-nucleon plus three-nucleon interactions from chiral effective field theory into the beyond mean-field approach for medium-mass deformed nuclei with the technique of multi-reference in-medium similarity renormalization group.

Speaker: Edward Brown, Professor of Physics and Astronomy

Michigan State University and National Superconducting Cyclotron Laboratory

"Accreting Neutron Stars and the Physics of Dense Matter"

Monday, November 26, 2018

Abstract: Neutron stars are composed of the densest observable matter in nature and occupy the intellectual frontier between astrophysics, nuclear physics, and, now, gravitational physics. Current and planned nuclear experiments on heavy nuclei and observations of neutron stars in both electromagnetic and gravitational waves will be exploring the nature of dense matter from complimentary approaches. Many observed neutron stars accrete hydrogen- and helium-rich matter from a companion star. During the slow compression to nuclear density the accreted matter is transmuted from being proton-rich to being proton-poor. These reactions affect many observable phenomena — from energetic explosions on the neutron star's surface to cooling of the surface layers — that in turn inform us about the nature of the deep interior of the neutron star. In this talk, I shall describe what recent astronomical observations and nuclear physics experiments are telling us about the nature of matter at nuclear densities.

Speaker: Dr. Benjamin Saliwanchik

Postdoctoral Associate in the Department of Physics at Yale

"The Universe in 60 Minutes"

Monday, February 4, 2019

Abstract: Modern cosmology is in the midst of a renaissance, over the last generation we have mapped previously unexplored epochs of the universe's history, advanced cosmology to a precision science, and made revolutionary discoveries about the contents and evolution of the universe, from the earliest fractions of a second to implications for the distant future. We have discovered that the universe is a strange place, mostly composed of unfamiliar and exotic forms of matter and energy. Most of the mass of the universe is dark matter, rather than the normal baryonic matter of stars and planets. The universe is also expanding at an accelerating rate, which we posit to be caused by a mysterious energy creatively called dark energy, which may be a cosmological constant. This talk will provide a broad overview of our current picture of the universe, its constituent elements, its origin and evolution, and how they have been observed and measured. It will

conclude with a summary of the open questions in cosmology, including cosmic inflation and the nature of dark energy, and descriptions of some of the cutting edge experiments seeking to continue expanding our knowledge into these undiscovered areas.

Speaker: Patricia Sievert

Director of Northern Illinois University's STEM Outreach program

"An Outreach Story: starting and growing an outreach program (with and without grant funding)"

Monday, February 25, 2019

Abstract: Pati Sievert will share her journey from recent physics master's grad with no outreach experience but loads of enthusiasm to Director of Northern Illinois University's STEM Outreach program with four additional full-time employees. She is also a member of the leadership team of a broader collaboration, NIU STEAM, employing a total of fifteen people and serving over 50,000 people per year. She'll share the call that got her into every 5th and 8th grade classroom in the second largest school district in Illinois, how she got kids to drag their parents into the physics department for an "open house" that grew exponentially over the next four years, and why you should consider a summer program. Along the way, she'll share examples of other successful physics outreach models, how to connect with people committed to physics outreach across the country, and where to find grants to get started. Find out how her first $10,000 grant from the American Physical Society for the World Year of Physics in 2005 launched what continues to be a major outreach initiative.

Speaker: Remco Zegers, Ph.D.

Michigan State University, National Superconducting Cyclotron Laboratory

"Core-collapse supernovae and the role of electron captures in late-stage stellar evolution"

Monday, April 1, 2019

Abstract: Core-collapse supernovae are amongst the most energetic events in the universe we know and contribute to nucleosynthesis and galactic chemical evolution. Our understanding of how massive stars evolve into supernovae has improved significantly through observations and sophisticated and multi-dimensional models that contain a wide variety of physics inputs. Still, there are important open questions that require further improvement of these inputs.

One important ingredient for simulations of late stellar evolution are electron captures on light and medium heavy nuclei. Although one must largely rely on theoretical models for estimating electron capture rates, these models must be benchmarked and guided by experimental data. The best way to do this is by using so-called charge-exchange reactions, from which the nuclear structure information needed to estimate electron-capture rates can be deduced. Performing charge-exchange experiments with the goal to constrain the electron capture rates in core collapse supernovae and other astrophysical phenomena is one of the main goals of the charge-exchange group at NSCL. The presentation will focus on the interplay between the astrophysical, theoretical, and experimental efforts necessary to improve our understanding of core-collapse supernovae and the experimental efforts to constrain the electron captures rates.