Distinguished Lecturers in Plasma Physics

The Division of Plasma Physics (DPP) of the American Physical Society is pleased to announce the Distinguished Lecturers in Plasma Physics for 2001- 2002. This Program is intended to share with the larger scientific community the most exciting recent advances in plasma physics.

Under the Plasma Travel Grant Program funded by the U.S. Department of Energy, the Lecturers are available for talks at U.S. colleges and universities for the academic year 2001- 2002. Their travel expenses will be supported by the grant; preference will be given to invitations from colleges and universities that do not have substantial programs in plasma physics.

The Lecturers may be invited by contacting them directly.

The following Distinguished Lecturers have been chosen by the DPP:

John Apruzese
Lecture Title: The Physics of Radiation Transport in Dense Laboratory Plasmas
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Palmyra Catravas
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Gurudas Ganguli
Lecture Title: Plasma Dynamics in the Earth's Auroral Region
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Martin Greenwald
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Chan Joshi
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Cynthia K. Phillips
Lecture Title: Wave Connections in Space and Fusion Laboratory Plasmas
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Lecture Descriptions are on the back...

Additional information about the Plasma Travel Grant Program can be obtained from the Chair of the DPP Education and Outreach Committee:

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Dr. John P. Apruzese

Lecture Title: The Physics of Radiation Transport in Dense Laboratory Plasmas

Radiation transport redistributes energy within a medium through the emission and absorption of photons. It is of great importance in influencing the structure and dynamics of stars and planetary atmospheres. It also significantly affects the emitted radiation and dynamics of dense laboratory plasmas, such as Z pinches, hohlraums, and laser-imploded capsules. The talk will first review the basic theory of radiation transport and its principal physical effects. Conditions for local thermodynamic equilibrium (LTE), radiative diffusion, formation of emission and absorption lines, and ladder ionization will be discussed. Computer animations drawn from detailed numerical calculations will be used to illustrate some of these topics. Manifestations of this rich and interesting physics in laboratory experiments will be presented. The conclusion of the talk will emphasize current challenges and issues.

Dr. Palma Catravas

Lecture Title: Radiation Sources and Diagnostics with Ultrashort Electron Bunches

The basic principles and design of radiation sources (transition radiation, Cerenkov radiation, radiation from periodic structures, etc) and radiation based diagnostics will be discussed, with emphasis on radiation from ultrashort electron bunches. Such bunches are currently under development using various production mechanisms, including laser-driven accelerators and inverse free electron lasers. Ultrashort electron bunches have the potential to produce high peak flux radiation sources which cover wavelength regimes where sources are currently not widely available (coherent THz/IR) and to produce ultrashort X-ray pulses (3-100 fs). While radiation from the electron bunch contains the full signature of the electron beam and/or plasma characteristics, the deconvolution of a single property of interest can be difficult due to a large number of contributing properties. Novel solutions to this problem will be described, using both incoherent radiation (such as fluctuational interferometry) and coherent radiation. Practical examples of the flux, brightness, coherence, spatial and spectral properties of radiation sources (OTR, DR, Thompson scattering, etc) based on laser wakefield accelerators will be discussed and compared with conventional sources.

Dr. Gurudas Ganguli

LectureTtitle: Plasma Dynamics in the Earth's Auroral Region

The earth is immersed in a vast sea of charged particles many of which have traveled almost 100 million miles from the Sun only to become trapped by the earth's magnetic field. This (solar) wind of charged particles, mostly electrons and protons, form what we call a plasma and surrounds the earth to create a region with unique properties called the ionosphere. The knowledge of physical processes in this plasma environment is not only of academic interest but critical for achieving a predictive capability of the near-earth space weather, which has obvious commercial and military importance. The auroral region of the earth's ionosphere, an annular region at high latitudes where the majestic northern lights (aurora borealis) occur, is an especially active region. It is characterized by a multitude of wave phenomena and wave-particle interactions. Even after decades of intense research, we have yet to understand the intricacies of the dynamics in this region. Detailed plasma processes associated with multi-scale auroral structures and fields are being observed with increasing resolution by modern in-situ spaceprobes. It is crucial to understand these fundamental processes, since they cumulatively determine the state of the near-earth plasma environment. This talk will focus on specific examples where plasma processes play a critical role in the auroral dynamics and discuss their cause and effect.

Dr. Martin Greenwald

Lecture Title: Turbulence, Transport and Confinement in Fusion Plasmas

To make use of fusion as a practical energy source, we have had to learn how to confine hot plasmas with magnetic fields. This has turned out to be a much more difficult and much more interesting problem than anyone could have guessed. Driven by the free energy of the system, plasmas in magnetic confinement experiments exhibit strong turbulence, chaotic behavio which carries particles and energy out of the system. The study of turbulence is perhaps the greatest challenge left in classical physics. Still, significant progress has been made in recent years. Experimental methods which reduce turbulence to insignificant levels, have been discovered and exploited. Comparisons of experimental data to t heoretical and computer models provide important insights and are guiding researchers to improvements in both models and experimental techniques. This talk will survey recent work in this important field.

Professor Chan Joshi

Lecture Title: High Energy Density Science with Ultra-relativistic Electron Beams

An intense, high-energy electron or positron beam can have focused intensities rivaling those of today's most powerful lasers. For example, the 5 ps (FWHM), 50 GeV beam at the Stanford Linear Accelerator Center at 1 kA and focused to a 3 micron rms spot size gives intensities of > 10^20 W/cm^2 at a repetition rate of 10 Hz. Unlike a ps or fs laser pulse, the particle beam can readily bore through several mm of steel due to the rigidity of its flux component. However, the same particle beam can be manipulated quite strongly by a plasma that is a million times less dense than air! This is because of the incredibly strong collective fields induced in the plasma by the Coulomb force of the beam. The collective fields in turn react back onto the beam leading to many clearly-observable phenomena. The beam can be: (1) deflected leading focusing, defocusing, or even steering of the beam; (2) undulated causing the emission of spontaneous betatron x-ray radiation and; (3) accelerated or de-accelerated by the plasma fields. Using the 28.5 GeV electron and positron beams from the SLAC linac we have carried out a series of experiments that demonstrate clearly the above mentioned effects. The results are compared with theoretical predictions and 3D, one-to-one PIC code simulations using the code OSIRIS. These phenomena may have practical application in future technologies including optical elements in particle beam lines, synchrotron light sources, and ultra-high gradient accelerators.

Professor Mark E. Koepke

Lecture Title: Interrelated Experiments in Laboratory and Space Plasma Physics

Many advances in understanding space plasma phenomena, such as plasma-wave generation and propagation, plasma acceleration, and magnetic reconnection, have been linked to insight derived from theoretical modeling and/or laboratory experiments. This talk will review advances for which laboratory experiments played an important role and will describe how the interpretation of the space plasma data was influenced by one or more laboratory experiments. The space-motivation of laboratory investigations and the scaling of laboratory plasma parameters to space plasma conditions will be discussed. Examples demonstrating how laboratory experiments develop physical insight, benchmark theoretical models, discover unexpected behavior, establish observational signatures, and pioneer diagnostic methods for the space community will be presented. A primary objective of the talk is to articulate the overlapping scientific issues that are addressable in space and lab experiments. A secondary objective is to convey the wide range of laboratory and space plasma experiments involved in this interdisciplinary alliance.

Dr. Cynthia K. Phillips

Lecture Title: Wave Connections in Space and Fusion Laboratory Plasmas

Over 99% of the observable universe exists as a plasma in which collective long range electromagnetic interactions among a multitude of charged particles dominate over short range inter-particle interactions. A wide variety of phenomena ranging from radio-wave communications, magnetospheric disturbances, distance determination to astrophysical objects such as pulsars, and control of magnetically confined laboratory plasmas for fusion energy research are all dependent on the existence of waves in plasmas. In plasmas, the nuclear fusion reactions that fuel the sun can occur naturally. This presentation will begin with an introduction to the key physics challenges that must be met in order to realize the potential of controlled thermonuclear fusion as a clean, abundant energy source here on earth. Attention will then be focused on the dynamics and utilization of electromagnetic waves for auxiliary control of magnetically confined fusion plasmas. The specific process of mode conversion, in which the propagation of one particular wave can lead to excitation of another due to localized inhomogeneities in the plasma, will be introduced. This process is fundamental to understanding one of the most successful methods developed for the heating of fusion-relevant plasmas, as well as to providing the mechanism for propagation of waves between the earth's magnetosphere and ionosphere.