Distinguished Lecturers in Plasma Physics

The Division of Plasma Physics of the American Physical Society is pleased to announce the Distinguished Lecturers in Plasma Physics for 2002-2003. This Program is intended to share with the larger scientific community exciting recent advances in plasma physics.

Under the Plasma Physics 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 2002-2003. Their travel expenses will be supported by the grant.

The Lecturers may be invited by contacting them directly.

The following Distinguished Lecturers have been chosen by the DPP:

Steve Allen
Lecturer's Title: Improving Tokamak Confinement with "Plasma Surgery" and "Plasma Floating"
Lawrence Livermore National Laboratory
email: allens@fusion.gat.com

R. Paul Drake
Lecturer's Title: Connecting laboratory experiments with astrophysical phenomena
University of Michigan
email: rpdrake@umich.edu

John Goree
Lecturer's Title: Making a plasma act like a crystal
University of Iowa
email: john-goree@uiowa.edu

Raffi Nazikian
Lecturer's Title: The Scientific Frontiers of Fusion Energy Science
Princeton Plasma Physics Laboratory
email: rnazikian@pppl.gov

John D. Sethian
Lecturer's Title: The Science and Technology of Electron Beam Pumped KrF Lasers for Fusion Energy
Naval Research Laboratory
email: sethian@this.nrl.navy.mil

John T. Slough
Lecturer's Title: Development of Compact Fusion Plasmas for Deep Space Exploration
University of Washington
email: slough@aa.washington.edu

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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Steve Allen
Lecturer's Title: Improving Tokamak Confinement with "Plasma Surgery" and "Plasma Floating"

The goal of Magnetic Fusion Energy is to sustain high temperature fusion reactions in a magnetic bottle. One design uses a doughnut-shaped device called the tokamak. Current tokamak research focuses on improving the confinement of the plasma by detailed shaping of the internal profiles (e.g. current, temperature) of the plasma with radio-frequency (RF) waves. Recent advances in diagnostic measurements of internal profiles, coupled with very-localized RF-driven current, has also enabled "plasma surgery" that stabilizes internal magneto-hydrodynamic instabilities, resulting in improved performance. However, even with effective magnetic confinement, there is localized exhaust heat from the core plasma which can damage the vessel walls and introduce impurities into the plasma. Recent advances have shown that a (visible and ultraviolet) radiating layer can effectively "float" the plasma away from the walls. This edge region is remarkably cold (a few eV) compared to the hot core plasma (several keV), and is a recombining plasma. Sophisticated numerical computer models are used to guide the experiments and develop an understanding of the basic physical processes. The US fusion program is currently developing a new "Burning Plasma" experimental plan with both national and international components; a progress report will be presented.

R. Paul Drake
Lecturer's Title: Connecting laboratory experiments with astrophysical phenomena

Modern high-energy-density facilities, which include lasers and Z pinches, are able to heat cubic millimeters of matter to millions of degrees. During the past decade, a community has emerged with a focus on the application of these facilities to problems posed by nature's own high-energy-density laboratories, such as exploding stars. Motivated by the questions posed by a recent supernova (SN 1987A), we have developed an approach through which laboratory work can impact our understanding of nature. We will review this approach as it has played out in the simulation of supernova explosions. During the next decade, further possibilities will be opened up as new facilities become available.

John Goree
Lecturer's Title: Making a plasma act like a crystal

In this interdisciplinary talk, it is explained how a dusty plasma is an ionized gas containing small particles of solid matter, which acquire a large negative electric charge. These particles repel one another, yet they are confined so that they can't escape, so as their motion is cooled, they arrange themselves in a lattice, similar to atoms in a crystalline lattice. This so-called "plasma crystal" behaves completely unlike other plasmas; in fact, it behaves like normal solid matter. In these lectures, experiments are described that show a melting/freezing phase transition and other kinds of solid-state behavior like phonons. What distinguishes a plasma crystal from normal solid matter is that the "atoms" are actually micron-size plastic microspheres, which are big enough to image directly, using a video camera as they move about. The presentation include videos, easily-understood photos and other audience-friendly images. An interdisciplinary approach is taken, drawing from the fields seismology, fluid mechanics, and condensed matter, as well as plasma physics. Results are shown from experiments performed in labs and on the International Space Station. Further information can be found at http://dusty.physics.uiowa.edu/~goree

Raffi Nazikian
Lecturer's Title: The Scientific Frontiers of Fusion Energy Science
Bringing the stars down to earth is one of the great scientific challenges of the 21st century. The controlled fusion of hydrogen into helium represents an essentially inexhaustible source of energy for mankind and remarkable progress has been made in the last half century in attaining that goal. Recent progress in the field is reviewed in the areas of configuration science, fundamental scientific understanding of the processes limiting fusion performance, and the development of sensors and actuators for feedback control of the plasma state. Prospects for a next step fusion device are discussed.

John D. Sethian
Lecturer's Title: The Science and Technology of Electron Beam Pumped KrF Lasers for Fusion Energy

Electron beam pumped krypton fluoride (KrF) lasers are an attractive driver for inertial fusion energy. They have demonstrated very high beam quality, which is essential for reducing imprint in direct drive targets. Their short wavelength (248 nm) mitigates the growth of plasma instabilities. And they have the potential to meet the fusion needs for repetition rate, efficiency, and cost. This talk reviews the development of e-beam pumped KrF lasers. It will include a description of the fundamental physics and technology, as well as the challenges in developing a fusion system. Although KrF laser development is a multi-disciplinary endeavor, this talk will emphasize areas of interest to plasma physicists: electron beams, KrF kinetics, and pulsed power. It will describe the electron beam propagation experiments, the supporting 3D parallel PIC codes, and how these have been used to design systems for maximum electron energy deposition into the laser gas. KrF kinetics modeling will be discussed. These newly developed time dependent codes can predict the output of several experiments operating under significantly different conditions. Finally, the talk will discuss the development of the pulsed power needed to drive the electron beams. The presentation will be cast in context of the large, single shot KrF lasers built in the 1990s such as Nike (NRL-US), Ashura (Japan), and Titania (UK), as well as the Electra 700 J, 5 Hz rep-rate laser that is currently under development at NRL.

John T. Slough
Lecturer's Title: Development of Compact Fusion Plasmas for Deep Space Exploration

Fusion is most likely the only energy source where there are large and available quantities of fuel, and which can also provide the prodigious power required for human exploration of deep space. The difficulty however for most nuclear fusion propulsion concepts is the large complexity and mass associated with the confinement systems, which render them inappropriate for use in space. One is led to consider fusion plasmas that are very compact, yet can still provide the requisite energy confinement to yield a sufficient energy gain from fusion. In this talk, the basic power and mass requirements for various deep space missions will be reviewed, as well as how some of the more promising fusion plasma systems address these requirements. Various candidate magnetic confinement systems such as the magnetic dipole, mirror, and spherical torus will be presented. Of the magnetic fusion reactor embodiments developed so far, it appears that the compact toroidal plasmoid commonly referred to as a Field Reversed Configuration (FRC) shows the most promise as a compact fusion plasma for space propulsion. The advantage of the FRC for propulsion stems from the simplicity of the configuration. The FRC has no coil threading the plasma toroid, and toroidal plasma currents provide for the entire confining poloidal magnetic field. Formed in an open ended solenoidal coil, the compact toroidal plasma is self-contained, and can be (and has been) accelerated to high velocity by external magnetic field coils. The physics of these compact toroidal plasmas will be discussed as well as the results from recent experiments. The observed confinement scaling for these plasmoids points toward a high energy density reactor plasma that can be as small as a football. A description of such a compact fusion reactor, along with a point design for a rapid manned mission to Mars will complete the talk.