CONTACT: Saralyn Stewart
Cell phone: (512) 694-2320

FOR IMMEDIATE RELEASE
Oct. 14, 2005

Keeping the fire burning in a fusion reactor

Simulating the behavior of alpha particles and Alfvén waves in fusion reactors

DENVER, Colorado, Oct. 24, 2005 – In research with important implications for the development of the International Thermonuclear Experimental Reactor (ITER), recent experiments on the DIII-D fusion facility at General Atomics in La Jolla, California, and on the National Spherical Torus Experiment (NSTX) at the Princeton Plasma Physics Laboratory in Princeton, New Jersey, have simulated the behavior of alpha particles and Alfvén waves expected in the plasma of a fusion reactor.

An alpha particle is an ion, a type of electrically charged particle. An Alfvén wave is a traveling oscillation of the plasma and the magnetic field. The waves propagate at the Alfvén speed (approximately one per-cent of the speed of light), which increases with the strength of the magnetic field. In the magnetic fields used to contain a fusion reaction, these oscillations can cause instabilities that drain power from the reactor.

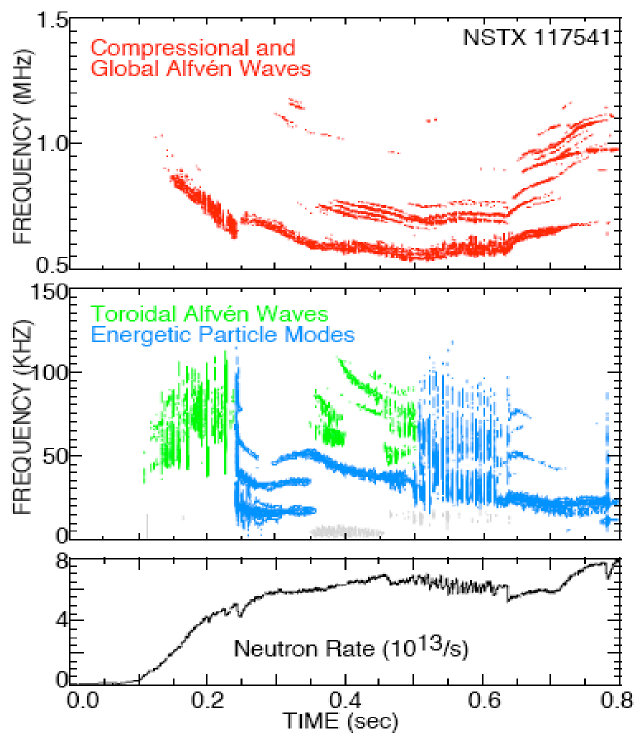

Figure 1. The frequency of different types of Alfvén instabilities observed in NSTX. When the modes occur in discrete bursts, the mode-induced loss of energetic particles is easily detectable, as indicated by drops in the neutron emission.

Because of its modest magnetic field, NSTX is the first U.S. fusion research device to routinely operate with a large population of fast ions whose velocity is higher than the Alfvén speed (super-Alfvénic), a condition also expected in ITER. The fast ions in NSTX are introduced by high-power beams of neutral deuterium atoms and move much faster than the background plasma ions. Recent experiments on NSTX have revealed an unexpectedly rich spectrum of waves, corresponding to different instabilities, excited by the super-Alfvénic ions. These instabilities are often observed to act in unison to “kick out” the energetic ions whenever a large burst of Alfvén waves is detected (see

Figure 1). Careful measurements of these multiple waves and fast ions are continuing to improve the understanding of how waves interact with large populations of fast ions.

In experiments complimentary to those on NSTX, researchers working on the DIII-D device, which operates at a higher magnetic field, have discovered a vast number of short-scale Alfvén waves, also similar to those expected in ITER. These waves have escaped detection in the past because they have been hidden in the core of the plasma where measurements were not possible until recently. The measurements are taken with new diagnostic tools—including lasers, microwaves, and atomic spectroscopy—that can look directly into the plasma core.

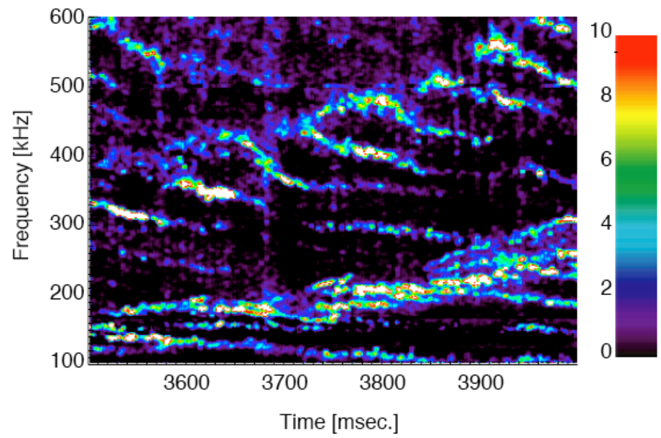

Figure 2. Bands of short-scale Alfvén waves are seen in the spectrum of core density fluctuations in the DIII-D tokamak.

Measurements of these instabilities, or modes, using a Far Infra Red (FIR) scattering system developed by researchers at UCLA (see Figure 2) show many modes that may also occur in ITER, chirping up and down in frequencies. One of the surprising theoretical implications of the discoveries on DIII-D is that, due to the short length of these Alfvén waves, they can be strongly excited not only by energetic ions but also by the much more slowly moving thermal particles in the plasma.

NSTX and DIII-D researchers can now address whether super Alfvénic ions interacting with short-scale Alfvén waves can lead to loss of energetic particles in ITER and how these Alfvén waves might affect thermal plasma particles.

Work supported by U.S. Department of Energy–Office of Fusion Energy Sciences.

Contacts

Eric Fredrickson, PPPL, (609) 243-2945, **efredrickson@pppl.gov**
Gerrit Kramer, PPPL, (609) 243-2326, **gkramer@pppl.gov**
Martin Peng, PPPL, (609) 243-2305, cell (609) 933-2976, **mpeng@pppl.gov**
Raffi Nazikian, PPPL, (609) 243-3504, **rnazikian@pppl.gov**

[QI1.00005] Collective fast ion instability-induced losses in NSTX
Abstract: **http://meetings.aps.org/Meeting/DPP05/Event/35716**
October 27, 2005
Thursday, 11:30 am–12:00 pm
Invited Session QI1: Wave and Particle Interactions
Adam's Mark Hotel - Plaza Ballroom ABC

[QI1.00006] Interpretation of Core Localized Alfven Eigenmodes in DIII-D and JET Reversed Magnetic Shear Plasmas
Abstract: **http://meetings.aps.org/Meeting/DPP05/Event/35717**
October 27, 2005
Thursday, 12:00–12:30 pm
Invited Session QI1: Wave and Particle Interactions
Adam's Mark Hotel - Plaza Ballroom ABC