Press Release – New Insight for Plasma Turbulence : [wwlee@pppl.gov]

The U. S. Department of Energy (USDOE) has recently selected the "Center for Gyrokinetic Particle Simulation for Turbulent Transport in Burning Plasmas" to be part of the USDOE Scientific Discovery through Advanced Computing (SciDAC) Program. Dr. W. W. Lee of the Princeton Plasma Physics Laboratory (PPPL) at Princeton University is the head of this new national center, which includes strong collaborations with Columbia University, the University of Colorado, the University of Tennessee, and the University of California campuses at Irvine, Los Angeles, and Davis. This US-ITER-related project brings together leading experts in plasma simulation, theory, and computational sciences to address the grand scientific challenge of achieving better understanding of turbulent transport in fusion plasmas.

At the 2004 APS/DPP meeting, two invited papers, which are expected to have significant influence on future directions on plasma turbulence research, will be presented by members from the Center. The talks will focus on new results obtained from applications of the Global Gyrokinetic Toroidal Code (GTC), by following the dynamics of billions of plasma particles on the IBM SP Seaborg computer at the National Energy Research Supercomputing Center (NERSC) in Berkeley, CA. Very recent successful benchmarking tests of a new version of this code on the world's fastest supercomputer, the Earth Simulator Computer in Japan, have reached 3.7 trillion floating point operations per second. This holds great promise for accelerating the pace to new scientific discoveries in this key area of research.

Prof. Z. Lin of UC-Irvine [paper NI1.003] will address a subject of active current interest -- the question of whether electron temperature gradient (ETG) driven turbulence can contribute strongly to the anomalously large levels of transport observed in toroidal plasma experiments. Recent results from applications of the GTC code together with newly-developed nonlinear gyrokinetic theory indicate that the ETG instability saturates at low levels via a nonlinear toroidal coupling. As illustrated in Figure 1, it is found that while the lengths of the extended eddy structures ("streamers"), which characterize the ETG turbulence, scale with the device size, the actual radial distance of the electron diffusion is found to be much smaller. Both the fluctuation intensity and associated transport level are thus independent of the size of the streamers. When compared to earlier radially-local ("flux tube") simulation results, the present finding is that the electron heat conductivity is much smaller and is therefore not likely to be responsible for the large electron thermal transport in toroidal devices.

Dr. W. W. Lee of PPPL [paper FI1B.003] will report on important recent results dealing with the physics of steady state transport produced from the ion temperature gradient (ITG) driven instabilities. The key finding here is that appropriate treatment of the parallel acceleration dynamics produces much faster access to the steady state of the ITG turbulence when compared with conventional simulations. These new studies include the velocity space nonlinearity, which acts in concert with the zonal flow in the evolution of steady state turbulence.

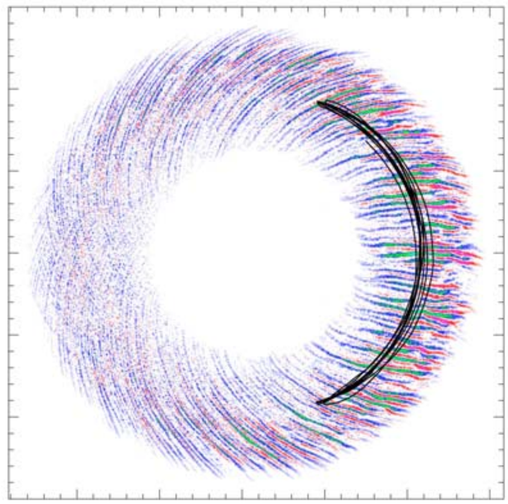

Figure 1. Tokamak plasma cross-section showing that streamers (color) of the perturbed fluctuations resulting from ETG turbulence have much larger radial extent than the actual electron particle diffusion (black).