Gyrokinetic Simulation of Heat Transport in a Magnetized Temperature Ring

R.D. Sydora[1], B. Van Compernolle[2], J.E. Maggs[2] and G.J. Morales[2]
[1]*Department of Physics, University of Alberta, Canada*
[2]*Department of Physics and Astronomy, University of California, Los Angeles, USA*

3D electromagnetic gyrokinetic particle simulations of drift-Alfven fluctuations and thermal transport have been carried out using plasma conditions similar to those in the recent off-axis heat source experiment performed in the Large Plasma Device (LAPD) at UCLA. The novel heat source resulted in a long, hollow cylindrical temperature filament of elevated temperature embedded in a colder plasma. The electron heat transport and associated drift wave fluctuations have been characterized experimentally as a function of heating power. It has been observed that as the heating power is increased, the radial temperature profiles steepen until a threshold is reached, whereby drift waves grow and cause a rapid collapse. Then the drift wave activity disappears and the profile slowly recovers with the process repeating.

The gyrokinetic simulations, in cylindrical geometry, are initialized using the same parameters as experiment, including the radial and axial extent of the hollow cylindrical filament. The inner diameter of the ring is taken to be approximately four times its width. The steepness of the electron temperature gradient was mainly determined by the ratio of the peak temperature in the ring to the background temperature. Above a certain temperature gradient threshold, drift-Alfven fluctuations were excited and induced a rapid thermal collapse of the ring on time scales consistent with experiment. The spatio-temporal pattern of the electrostatic potential, density, and magnetic fluctuations arising from parallel currents, have been characterized in the linear and nonlinear regimes. In the linear regime the eigenmodes consist of a spectrum of low to moderate poloidal mode numbers (m) and low axial mode numbers (n). The reverse temperature gradient across the ring results in oppositely-directed diamagnetic drifts with finite-m and for sufficiently small ring radii, the radial extent of the eigenmodes produces an interference pattern that enhances the transport and therefore hastens the collapse. The detailed physical processes and saturation dynamics along with comparison to experiments will be presented.

This work is supported by the Natural Science and Engineering Research Council (NSERC), Canada and is also performed at the Basic Plasma Science Facility, supported by DOE/NSF.