Rotation induced L to H mode transition of a cylindrical plasma column

J. E. Maggs, T. A. Carter

Department of Physics and Astronomy, University of California, Los Angeles

The outer region of the plasma column of the LAPD is rotated in a controlled fashion by biasing a section of the vacuum chamber wall positive with respect to the cathode. The plasma column of the LAPD device at UCLA is 17.5 m in length and 60 cm in diameter. A uniform, 400 Gauss axial magnetic field is used in these experiments. Cross-field ion current due to ion-neutral collisions provides the torque to spin up the plasma. In the non-rotating plasma column, cross-field particle transport is measured to proceed at the Bohm diffusion rate. Rotation, above a threshold voltage, suppresses cross-field transport from Bohm to classical rates, leading to steeper radial density gradients. Suppression of radial particle transport is global and not isolated to the region of flow shear. Physics of the transition threshold appears to be tied to radial penetration of the cross-field flow from near the chamber wall to the plasma edge. Once the flow has penetrated to the plasma edge, the observed shearing rate already exceeds the local value of the drift frequency. Measurements of the two-dimensional turbulent cross-correlation function show that the radial correlation length decreases only slightly. However, the azimuthal correlation length is observed to increase dramatically. While the turbulent amplitude does decrease during biasing, the decrease is confined to the low-frequency portion of the spectrum. A dramatic change is observed in the cross-phase between density and azimuthal electric field fluctuations during biasing. As the bias threshold is reached, the cross-phase term approaches zero and then reverses sign as the bias is raised further, indicating inward turbulent particle flux. However, these measurements of inward flux are not consistent with transport modeling.