DPP10-2010-000271

Abstract for an Invited Paper
for the DPP10 Meeting of
the American Physical Society

Core measurements of 3D effects in quasi-single-helicity plasmas in the MST RFP

WILLIAM BERGERSON, University of California, Los Angeles

As the current and temperature of RFP plasmas are increased, a spontaneous and self-organized transition can occur from the normal state involving multiple tearing modes of similar amplitude to a quasi-single-helicity state dominated by a single large mode. This dominant mode results in a 3D helical core plasma resembling a stellarator equilibrium, but with an axisymmetric boundary. We report on measurements of the internal magnetic field structure and confinement changes associated with this self-organized transition in MST plasmas. A unique, multi-chord FIR interferometer-polarimeter allows investigation of the magnetic equilibrium modifications and dynamical behavior of the dominant fluctuation associated with this transition. These measurements are made directly in the plasma core where the dominant mode is resonant. A helical shift in the magnetic axis by up to 10% of the plasma diameter is directly observed. Interferometry reveals a peaked density profile within the 3D helical structure, and the global particle confinement time becomes twice that of standard multi-helicity RFP plasmas. Hard-x-ray emission with photon energies exceeding 100 keV indicates that energetic electrons are also well confined. This suggests that the magnetic field is much less stochastic within the 3D structure, consistent with improved thermal particle confinement. Faraday rotation measurements of the current density and magnetic field fluctuations associated with the dominant mode reveal strong correlation, and the Hall dynamo emf, $\langle \tilde{J} \times \tilde{B} \rangle_{||}/n_e e$, is sustained for several ms. This is in sharp contrast to the short-lived (0.1 ms), impulsive dynamo in the sawtoothing multiple helicity state. The Hall dynamo emf reinforces the importance of two-fluid physics in magnetic self-organization.