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Density-Gradient-Driven trapped-electron-modes in improved-confinement RFP plasmas[1]

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Short wavelength density fluctuations in improved-confinement MST plasmas exhibit multiple features characteristic of the trapped-electron-mode (TEM), strong evidence that drift wave turbulence emerges in RFP plasmas when transport associated with MHD tearing is reduced. Core transport in the RFP is normally governed by magnetic stochasticity stemming from long wavelength tearing modes that arise from current profile peaking. Using inductive control, the tearing modes are reduced and global confinement is increased to values expected for a comparable tokamak plasma. The improved confinement is associated with a large increase in the pressure gradient that can destabilize drift waves. The measured density fluctuations have frequencies >50 kHz, wavenumbers k_phi*rho_s<0.14, and propagate in the electron drift direction. Their spectral emergence coincides with a sharp decrease in fluctuations associated with global tearing modes. Their amplitude increases with the local density gradient, and they exhibit a density-gradient threshold at R/L_n~15, higher than in tokamak plasmas by ~R/a. the GENE code, modified for RFP equilibria, predicts the onset of microinstability for these strong-gradient plasma conditions. The density-gradient-driven TEM is the dominant instability in the region where the measured density fluctuations are largest, and the experimental threshold-gradient is close to the predicted critical gradient for linear stability. While nonlinear analysis shows a large Dimits shift associated with predicted strong zonal flows, the inclusion of residual magnetic fluctuations causes a collapse of the zonal flows and an increase in the predicted transport to a level close to the experimentally measured heat flux. Similar circumstances could occur in the edge region of tokamak plasmas when resonant magnetic perturbations are applied for the control of ELMs.

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