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TH/P2-10: Microtearing Mode Fluctuations in Reversed Field Pinch Plasmas

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Improved confinement scenarios in RFP plasmas that reduce global tearing modes are expected to lead to plasmas where confinement is limited by microturbulence driven by gradients of pressure, density, and temperature. Because enhanced confinement regimes in MST yield temperature profiles with core gradients near the critical threshold for temperature-gradient driven instability, a linear analysis of temperature-gradient driven micro-instabilities in MST-like RFP equilibria is undertaken using toroidal gyrokinetics for beta values ranging from 0 to 10%. These simulations show that when the ratio of minor radius to temperature gradient scale length is greater than 3 - 4, MST plasmas are unstable to ITG at low beta and unstable to microtearing at high beta ˜10%. The beta at which microtearing dominates ITG is 5%, with ITG becoming completely stable just above 10%. Theory shows that the higher critical beta for ITG stabilization, relative to tokamaks, is associated with the shorter scale lengths for magnetic curvature. At the MST-relevant beta of 10% the microtearing mode growth rate peaks at a poloidal wavenumber of = 1.4 inverse gyroradii. However, instability is strong even for low wavenumbers, where there is a growth rate 2-3 times that of ITG at its maximal wavenumber for zero beta. The growth rate remains large even for very low collisionality, with indications that different microtearing branches are associated with low and moderate collisionalities. With these growth rate values significant transport is expected. MST has several diagnostics that will access microturbulence spatial scales, including FIR interferometry/scattering, fast Thomson scattering, heavy ion beam probe, and material probes. Work is underway to prepare these diagnostics for electrostatic and magnetic turbulence measurements for model validation in high-performance plasmas.

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