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Role of Density Gradient Driven Trapped Electron Modes in the H-Mode Inner Core with Electron Heating[1]

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We present new experiments and nonlinear gyrokinetic simulations showing that density gradient driven TEM (DGTEM) turbulence dominates the inner core of H-Mode plasmas during strong electron heating. Thus α-heating may degrade inner core confinement in H-Mode plasmas with moderate density peaking. These DIII-D low torque quiescent H-mode experiments were designed to study DGTEM turbulence.[3] Gyrokinetic simulations using GYRO (and GENE) closely match not only particle, energy, and momentum fluxes, but also density fluctuation spectra, with and without ECH. Adding 3.4 MW ECH doubles T_e/T_i from 0.5 to 1.0, which halves the linear TEM critical density gradient, locally flattening the density profile. Density fluctuations from Doppler backscattering (DBS) intensify near ρ =0.3 during ECH, displaying a band of coherent fluctuations with adjacent toroidal mode numbers. GYRO closely reproduces the DBS spectrum and its change in shape and intensity with ECH, identifying these as coherent TEMs. Prior to ECH, parallel flow shear lowers the effective nonlinear DGTEM critical density gradient 50%, but is negligible during ECH, when transport displays extreme stiffness in the density gradient. GS2 predictions show the DGTEM can be suppressed, to avoid degradation with electron heating, by broadening the current density profile to attain $q_0 > q_{\min} > 1$. A related experiment in the same regime varied the electron temperature gradient in the outer half-radius ($\rho \sim 0.65$) using ECH, revealing spatially coherent 2D mode structures in the T_e fluctuations measured by ECE imaging. Fourier analysis with modulated ECH finds a threshold in T_e profile stiffness.

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[2]with K.H. Burrell, W. Guttenfelder, T.L. Rhodes, A.M. Dimits, R. Bravenec, B.A. Grierson, C. Holland, N.C. Luhmann Jr., A. Marinoni, G.R. McKee, T. Munsat, C.C. Petty, J.C. Rost, L. Schmitz, B. Tobias, G. Wang, S.E. Zemedkun, L. Zeng

[3]D. R. Ernst et al., 2014 IAEA Fusion Energy Conference, St. Petersburg, Russia, paper CN221-EX/2-3.