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P1.1088 Edge stochastization and collisionality dependence of the L-H transition power threshold with applied n=3 resonant magnetic perturbations

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It is shown that stochastic edge magnetic field topology with applied resonant magnetic perturbations can explain the increased L-H power threshold with applied n=2 resonant magnetic perturbations (RMP) in low rotation, ITER-similar-shape plasmas in DIII-D (<ne>=1.5-5x10^19m^-3, Bt=1.9-2T, Ip=1.5 MA, q95~3.6). With RMP, the normalized L-H transition power threshold scales inversely with edge collisionality as PLH/PLH-08 ~ e*(=0.95)-0.5, where PLH-08 is the 2008 ITPA power threshold scaling (Martin scaling) [1]. The pertinent signatures of stochastic electron transport are a diminished L-mode Er well and E◊B shear, and increased edge toroidal rotation.
Spontaneous reversal (bifurcation) to a positive edge electric field can occur at high RMP strength. TRIP3D fieldline tracing calculations show a stochastic field line loss fraction of ~50% for > 0.97. A simple fluid theory [2], balancing stochastic radial electron flow and neoclassical ion flow, explains quantitatively the observed Er modifications, including the sign reversal at high RMP field, and the increased edge toroidal rotation (figure 1). This theory also predicts a more pronounced reduction of the Er well at low collisionality, consistent with experimental results. With RMP, increased turbulence levels are observed by BES, including modes propagating in electron diamagnetic drift direction (0.92<=rho<=0.97) and lower wavenumber ion-direction modes.
Matching the power balance ion thermal flux with TGLF/TGYRO requires 50-80% increase in a/LTi compared to a/LTi Carbon measured via impurity (Carbon) CER for > 0.85, but consistent within error margins with the main ion a/LTi from main ion CER [3]. Power balance electron thermal fluxes in the plasma edge are substantially under-predicted by TGLF within error limits for the measured a/LTe. These observations suggest that the increase in PLH with applied RMP results from increased L-mode electron and ion thermal power loss across the separatrix with simultaneously reduced E◊B shear due to stochastic radial electron flow and increased toroidal edge rotation.

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