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MHD modeling of DIII-D QH-mode discharges and comparison to observations[1]

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MHD modeling of DIII-D QH-mode discharges and comparison to observations Nonlinear NIMROD simulations, initialized from a reconstruction of a DIII-D QH-mode discharge with broadband MHD, saturate into a turbulent state, but do not saturate when flow is not included. This is consistent with the experimental results of the quiescent regime observed on DIII-D with broadband MHD activity [Garofalo et al, PoP (2015) and refs. within]. These ELM-free discharges have the normalized pedestal-plasma confinement necessary for burning-plasma operation on ITER. Relative to QH-mode operation with more coherent MHD activity, operation with broadband MHD tends to occur at higher densities and lower rotation and thus may be more relevant to ITER. The nonlinear NIMROD simulations require highly accurate equilibrium reconstructions. Our equilibrium reconstructions include the scrape-off-layer profiles and the measured toroidal and poloidal rotation profiles. The simulation develops into a saturated turbulent state and the n=1 and 2 modes become dominant through an inverse cascade. Each toroidal mode in the range of n=1-5 is dominant at a different time. The perturbations are advected and sheared apart in the counter-clockwise direction consistent with the direction of the poloidal flow inside the LCFS. Work towards validation through comparison to magnetic coil and Doppler reflectometry measurements is presented. Consistent with experimental observations during QH-mode, the simulated state leads to large particle transport relative to the thermal transport. Analysis shows that the phase of the density and temperature perturbations differ resulting in greater convective particle transport relative to the convective thermal transport.

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