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Multi-Channel Validation of Nonlinear Gyrokinetic Simulations in Alcator C-Mod I-mode Plasmas[1]

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New multi-channel validation of nonlinear gyrokinetic simulations (GYRO) is carried out for I-mode plasmas on Alcator C-Mod, utilizing heat fluxes, profile stiffness, and density and temperature fluctuations. I-mode plasmas are characterized by high energy confinement, similar to H-mode, but with L-mode-like particle confinement, making them favorable for reactors due to natural absence of ELMs, but without impurity accumulation [Whyte NF 2010]. At C-Mod, I-mode plasmas have been obtained across a wide range of plasma currents (Ip = 0.55-1.2MA) and magnetic fields (Bt = 2.8-8.0T). I-mode is also actively studied at ASDEX Upgrade, DIII-D and other tokamaks [Hubbard NF 2016]. Open questions remain regarding core transport in I-mode compared to L and H-mode, making validation studies in I-mode of great interest. Previous work at C-Mod found that ITG/TEM-scale GYRO simulations can match both electron and ion heat fluxes within error bars in I-mode [White PoP 2015], suggesting that multi-scale, cross-scale coupling effects [Howard PoP 2016] may be less important in I-mode than in L-mode. Adding the constraint of experimental perturbative heat diffusivity, however, revealed that ITG/TEM scale simulations do not adequately capture the high profile stiffness in I-mode [Creely NF 2016]. These results motivated more comprehensive comparisons of gyrokinetic simulations with I-mode plasmas. This talk expands upon past I-mode GYRO validation work to simultaneously constrain nonlinear gyrokinetic simulations with experimental electron and ion heat fluxes, electron temperature fluctuations measured with Correlation ECE, density fluctuations measured with Phase Contrast Imaging and reflectometry, and the temperature profile stiffness measured using partial sawtooth heat pulses.

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