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Comparison of Electron Temperature Fluctuations and Profile Stiffness in Alcator C-Mod I-mode Plasmas with Nonlinear Gyrokinetic Simulations

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Experimentally measured core electron temperature fluctuations and perturbative electron thermal diffusivity in Alcator C-Mod I-mode plasmas are compared to gyrokinetic simulations using the GYRO code. I-mode plasmas are characterized by high energy confinement, similar to H-mode, but with L-mode-like particle confinement, making I-mode very favorable for reactors due to the natural absence of Edge Localized Modes (ELMs), but with no impurity accumulation [D.G. Whyte et al., Nucl. Fusion 50, 105005 (2010)]. Previous work has revealed that core electron temperature fluctuations measured with a Correlation Electron Cyclotron Emission (CECE) diagnostic are reduced in I-mode [A.E. White et al., Nucl. Fusion 54, 083019 (2014)]. Gyrokinetic simulations with the GYRO code underestimate this reduction in temperature fluctuations, but do predict stiffer temperature profiles [A.E. White et al., Phys. Plasmas 22, 056109 (2015)]. In this work, a new method of measuring perturbative thermal diffusivity (which is related to profile stiffness) [A.J. Creely et al., Nucl. Fusion 56, 036003 (2016)] is applied to these same I-mode plasmas in order to relate changes in temperature fluctuations to changes in perturbative thermal transport. Preliminary results with L-mode plasmas reveal that ion-scale simulations under-predict profile stiffness, but that multi-scale simulations agree quantitatively with experimental measurements.

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