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Search for the Missing L-mode Edge Transport and Possible Breakdown of Gyrokinetics[1]

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While GYRO simulations of typical core ($0 < r/a < 0.7$) DIII-D L-modes seems to be in good agreement with experiment, simulated low-k ($k_\theta \rho_s < 1$) transport and turbulence intensity is more than 5-fold lower than experimentally inferred levels in the near edge L-mode ($r/a = 0.7 - 0.95$) DIII-D shot 128913 [1]. Global edge slice GYRO simulations of this and the well-studied discharge 101391 [2] are presented here to document the shortfall. TGLF transport code simulations over a large L-mode database indicate this short fall is not atypical so that L-mode edges transit to H-like pedestal profiles contrary to experiment. High edge e-i collisionality stabilizes the TEM modes so that diffusivities (χ) decrease like $T^{7/2}/n$ to the cold edge. The very high magnetic shear and density gradients stabilize the ITG despite the very high temperature gradient drive and high q. High-k ETG can make-up for the shortfall in the electron but increases ion transport very little. Near L-edge transport is highly local. Focusing on local simulations at $r/a = 0.9$, the ion channel short fall can exceed 10-fold. An artificial 10-fold increase in collisionality is needed to reach the expected resistive g-mode scaling with χ increasing like $nT^{-1/2}$. Identical GYRO drift kinetic ion simulations (suppressing the gyroaverage) are close to experiment levels suggesting a possible breakdown of low-frequency gyrokinetics. Formulation of a nonlinear theory of 6D drift-cyclotron kinetics following the fast time scale of the gyrophase to test the breakdown of 5D gyrokinetics with reduced model simulations is presented.

[1] C. Holland, A.E. White, *et al.*, Phys. Plasmas **16**, 052301 (2009).
[2] R.E. Waltz, J. Candy, C.C. Petty, Phys. Plasmas **13**, 072304 (2006).

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