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**Testing the High Turbulence Level Breakdown of Low-Frequency Gyrokinetics Against High-Frequency Cyclokinetic Simulations**[1]

ZHAO DENG, Peking University

Gyrokinetic simulations of L-mode near edge tokamak plasmas with the GYRO code underpredict both the transport and the turbulence levels by 5 to 10 fold [1], which suggest either some important mechanism is missing from current gyrokinetic codes like GYRO or the gyrokinetic approximation itself is breaking down. It is known that GYRO drift-kinetic simulations with gyro-averaging suppressed recover most of the missing transport [2]. With these motivations, we developed a flux tube nonlinear cyclokinetic [3] code rCYCLO with the parallel motion and variation suppressed. rCYCLO dynamically follows the high frequency ion gyro-phase motion (with no averaging) which is nonlinearly coupled into the low frequency drift-waves thereby interrupting and possibly suppressing the gyro-averaging. By comparison with the corresponding gyrokinetic simulations, we can test the conditions for the breakdown of gyrokinetics. rCYCLO nonlinearly couples $\nabla B$ driven ion temperature gradient (ITG) modes and collisional fluid electron drift modes to ion cyclotron (IC) modes. As required, rCYCLO cyclokinetic transport recovers gyrokinetics at high relative ion cyclotron frequency ($\Omega^*$) and low turbulence levels. However, because the IC modes are stable and act as a turbulence sink, we have found that at high turbulence levels and low-$\Omega^*$ cyclokinetic transport is lower (not higher) than gyrokinetic transport. Work is in progress with unstable IC modes to explore the possibility of driving cyclokinetic transport higher than gyrokinetic transport.

[1] C. Holland, A.E. White, et al., Phys. Plasmas **16**, 052301 (2009).
[2] R.E. Waltz, Bull. Am. Phys. Soc. **57**, 105 (2012).
[3] R.E. Waltz and Zhao Deng, Phys. Plasmas **20**, 012507 (2013).

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