Is the Adabatic Ion Approximation Valid for Electron-Temperature-Gradient Turbulence Simulations?*

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Gyrokinetic simulations of electron-temperature-gradient-driven turbulence normally rely upon an adiabatic ion (AI) approximation for numerical tractability. GYRO simulations using the AI approximation show that, in some regions of parameter space, simulations give rise to unbounded levels of turbulence. Such a result cannot be physical, suggesting a breakdown of the model equations. More expensive simulations which include the correct nonadiabatic ion response, on the other hand, are well-behaved and give rise to physically sensible levels of electron heat transport. We explore this topic in detail, departing from a low-shear, low-transport ETG-AI test case and moving to the high-transport regime. We remark that the low-shear departure point has been the subject of a previous benchmark effort [1], for which four codes (GYRO, GS2, PG3EQ and GENE) are in mutual agreement.

[1] W. Nevins, *et al.,* Bull. Am. Phys. Soc. **50**, 180 (2005), APS invited paper KI14.