Abstract Submitted
for the DPP07 Meeting of
The American Physical Society

Decoupling of ion and electron heat transport via scale separation

FRANK JENKO, Max-Planck-Institut, TOBIAS GOERLER, TERRY RHODES, STAN KAYE — Traditionally, turbulent transport is thought to be carried mainly by long-wavelength modes with $k_{\perp}\rho_i \sim 0.2$. While this seems to be generally true for the ion heat channel, there is experimental evidence that the electron heat fluxes behave differently – both in transport barriers and beyond. Here, we will examine the spectral properties of heat transport in nonlinear gyrokinetic simulations with the Gene code, focussing on contributions from shorter wavelengths than the ones mentioned above. Some simulations treat both ion and electron space-time scales fully self-consistently and are therefore very challenging from a computational point of view, requiring of the order of 100,000 CPU-hours or more. In pure ITG and TEM turbulence, the heat fluxes exhibit clear peaks around $k_{\perp}\rho_i \sim 0.2$, and fall off quickly for higher wavenumbers. However, in cases for which TE/ITG modes and ETG modes coexist, the spectral properties may change completely. Now, a wide range of wavenumbers, from ion scales all the way to electron scales, can contribute to the overall electron heat transport. This implies that the latter is dominated by high-wavenumber TEMs and ETG modes, while the direct contribution from ITG modes is relatively small. Applications to recent experiments at both DIII-D and NSTX will be discussed. Here, the concept of scale separation turns out to be crucial for the interpretation of experimental data.

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Date submitted: 20 Jul 2007