Nonlinear interactions between toroidal Alfven eigenmode and microturbulence

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Our nonlinear global gyrokinetic simulations have uncovered multi-scale interactions between the macro-scale magnetohydrodynamic (MHD) mode, driven by energetic particles, and micro-scale turbulence. This highlights the importance of understanding these interactions for the confinement of burning plasmas. Specifically, we examine the nonlinear interactions between the toroidal Alfven eigenmode (TAE), driven by energetic particles, and the microturbulence driven by the ion-temperature gradient (ITG) in tokamak plasmas using the GKNET code.

We discovered that changes in the heat transport of thermal ions are characterized by the ratio of the growth rate of TAE to that of microturbulence. Transport was reduced when gamma_TAE/gamma_Turb exceeded 0.5. The physical mechanism for this reduction is the shearing of microturbulence eddies by the vortex flow associated with the TAE. This transition is reminiscent of the well-known bifurcation in transport barrier formation, where ExB flow shearing plays a crucial role.

Our new finding on the TAE-turbulence interaction significantly impacts the realization of high-performance burning plasmas, which necessitate the simultaneous reduction of both energetic particle transport and bulk plasma transport.

References

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