DPP10-2010-001310

Abstract for an Invited Paper
for the DPP10 Meeting of
the American Physical Society

Subdominant Stable Eigenmodes in Plasma Microturbulenc

DAVID HATCH, University of Wisconsin - Madison

In gyrokinetic simulations, thousands of degrees of freedom for each perpendicular wavevector (corresponding to the resolution of the velocity space and parallel discretization) are available to contribute to the fluctuation spectrum. For wavevectors with a linear instability, the unstable eigenmode accounts for one of these degrees of freedom. Little has been known about the role of the remaining degrees of freedom in the turbulent dynamics. We use eigenmode analysis and proper orthogonal decomposition (POD) to demonstrate the excitation of a hierarchy of damped modes at the same spatial scales as the driving instabilities. The higher amplitude (low order) modes are weakly damped and exhibit smooth, large-scale structure in velocity space and in the direction parallel to the magnetic field. Lower amplitude (high order) modes are characterized by increasingly fine scale structure and, as a result, are highly dissipative. These modes are excited to exponentially decreasing (in mode number) amplitudes, yet in aggregate provide a potent energy sink. This leads to an overlap of the spatial scales of energy injection and peak dissipation, a feature that is in contrast with more traditional turbulent systems. In many cases, the high order modes exhibit equipartition in energy dissipation, i.e. the modes' increasing damping rates are balanced by decreasing amplitudes in such a way that on average each mode dissipates energy at the same rate. This motivates a novel statistical description of gyrokinetic turbulence. Finally, in electromagnetic simulations, a low order subdominant mode is characterized by micro-tearing parity: symmetric parallel mode structure for the magnetic vector potential. This damped mode is driven to high amplitude in the nonlinear state and thus offers a mechanism for the observed magnetic stochasticity even at very low values of beta.