Chaotic Neoclassical Separatrix Dissipation in Parametric Drift-Wave Decay

C.F. DRISCOLL, A.A. KABANTSEV, D.H.E. DUBIN, UCSD, YU.A. TSIDULKO, Budker Inst. Nucl. Phys. — Experiments and theory characterize a parametric decay instability between plasma drift waves when the standard nonlinear mode coupling is modified by chaotic dissipation on a separatrix. Experimentally, we utilize pure electron plasma columns with a central electrostatic “squeeze” barrier. We launch a large-amplitude $m_\theta = 2, k_z = 0$ dioctron mode, and observe it decay into an exponentially growing $m_\phi = 1, z$-anti-symmetric “Trapped Particle Diocotron Mode.” Measurements of the growth rates $\Gamma_1$ and relative mode phases $\Delta \Theta_{12}$ during exponentiation accurately characterize both the standard nonlinear coupling term and the enhanced dissipation due to chaotic neoclassical transport. Here, the $m = 2$ pump wave dynamically “ruffles” the separatrix, causing chaotic separatrix crossings. Similar enhancements are predicted and observed when the ruffle is static and the plasma drifts along the separatrix.2 This novel chaotic dissipation is essentially independent of collisionality, and may dominate in the low-collisionality regimes of toroidal fusion plasmas where trapped particles and separatrices are endemic.

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2Dubin, Kabantsev, Driscoll, Phys Plas 19, 056102 (2012).