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Nonlinear Evolution of Instabilities due to Drag and Large Effective Scattering[1] JEFF LESTZ, University of California, Irvine, VINICIUS DUARTE, NIKOLAI GORELENKOV, ROSCOE WHITE, Princeton Plasma Physics Lab — Energetic-particle-driven instabilities exhibit a broad range of nonlinear behavior in fusion plasmas, including steady state solutions, frequency chirping, bursting, chaos, etc. The role of drag in chirping has been explored extensively, but its effect on the more ubiquitous steady state solutions has not been thoroughly investigated. The electrostatic bump on tail problem is studied analytically in order to determine the effect of drag on steady state solutions near marginal stability ($1 - \gamma_d/\gamma_L \ll 1$) when effective collisions are large ($\nu_{eff} \gg \gamma$). A new analytic solution is derived in this common tokamak regime, demonstrating that drag increases the saturation amplitude and introduces a shift in the oscillation frequency by modulating the saturated wave envelope. Remarkably, a quasilinear diffusion equation for δf naturally emerges from the nonlinear system when $\nu_{eff} \gg \gamma$, even for a single, isolated resonance. Due to a broken symmetry, drag shifts the wave-particle resonance lines and can even split them into many new sidebands. Excellent agreement is found between all analytic results and 1D Vlasov simulations. Methods for future experimental validation of these fundamental plasma physics predictions are discussed.

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