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Linear non-normality as the cause of nonlinear instability in LAPD BRETT FRIEDMAN, TROY CARTER, UCLA, MAXIM UMANSKY, LLNL — A BOUT++ simulation using a Braginskii fluid model reproduces drift-wave turbulence in LAPD with high qualitative and quantitative agreement. The turbulent fluctuations in the simulation sustain themselves through a nonlinear instability mechanism that injects energy into $k_{||}=0$ fluctuations despite the fact that all of the linear eigenmodes at $k_{||}=0$ are stable [1]. The reason for this is the high non-orthogonality of the eigenmodes caused by the non-normality of the linear operator, which is common in fluid and plasma models that contain equilibrium gradients [2]. While individual stable eigenmodes must decay when acted upon by their linear operator, the sum of the eigenmodes may grow transiently with initial algebraic time dependence. This transient growth can inject energy into the system, and the nonlinearities can remix the eigenmode amplitudes to self-sustain the growth. Such a mechanism also acts in subcritical neutral fluid turbulence, and the self-sustainment process is quite similar [3], indicating the universality of this nonlinear instability.

[1] Friedman et al., Phys. Plasmas, 19, 2012.
[2] Camargo et al., Phys. Rev. E, 58 (1998).
[3] Trefethen et al., Science, 261 (1993).

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