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Inviscid Damping of Vortex Asymmetries by a Critical Layer Flux[1] C.F. DRISCOLL, A.A. KABANTSEV, C.Y. CHIM, T.M. O'NEIL, UCSD —
Experiments and theory characterize a novel regime of near-inviscid 2D vortex symmetrization, wherein a weak flux through the critical layer causes algebraic (rather than exponential) damping of azimuthal asymmetries. This is distinct from exponential critical-layer damping (or spiral wind-up), where the damping may cease once the critical-layer vorticity is trapped in cats-eyes.[2] Here, weak viscosity causes slow vortex expansion and negligible direct azimuthal-shear damping; but when the weak expansion flux reaches the critical layer, previously un-damped Kelvin waves are rapidly damped to zero. Pure electron plasma experiments have quantitatively characterized this novel damping for $m_\theta = 1$ and $m_\theta = 2$ waves, obtaining wave amplitudes varying as $A(t) = A_0 - \gamma\, t$. A simple analysis of critical-layer dynamics agrees well with experiments for $m_\theta = 1$ waves (with a bounding wall); but suggests a $\gamma\, t^{2/3}$ dependence for $m_\theta = 2$ due to the critical-layer width scaling with wave amplitude. Simulations suggest that weak diffusion may obviate this discordant time exponent of 2/3.

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[2]D.A. Schecter et al., Phys. Fluids **12**, 2397 (2000).

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