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Universal instability, non-modal amplification, and subcritical turbulence MATT LANDREMAN, University of Maryland, GABRIEL G. PLUNK, Max Planck Institute for Plasma Physics, THOMAS M. ANTONSEN JR., WILLIAM DORLAND, University of Maryland — The "universal instability" has been discounted since studies in 1978 found this drift wave to be absolutely stable for nonzero magnetic shear. We challenge this finding and demonstrate a variety of interesting behaviors in this sheared slab system: (1) The 1978 work was limited to $k\rho < 1$, but we show in gyrokinetics the linear mode with shear can be absolutely unstable for $k\rho > 1$ even with no temperature gradients, no trapped particles, and no magnetic curvature [1]. (2) Even if the system is linearly stable, significant transient linear amplification can occur [2]. Flow shear is unnecessary for this growth, in contrast to Navier-Stokes linear transients. (3) Turbulence can be sustained even if all linear eigenmodes are decaying [2], as seen previously in fluid models [3-4] and which we demonstrate kinetically. We generalize a Navier-Stokes proof [5] that transient linear amplification is required for sustained turbulence. While unstable eigenmodes are not necessary for sustained turbulence, a modified eigenvalue problem does provide a necessary condition [2].

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[2] Landreman et al J Plasma Phys 81, 905810501 (2015).
[3] Scott, PRL 65, 3289 (1990).
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Matt Landreman
University of Maryland

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