Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Kelvin Modes with Nonlinear Critical Layers on a Vortex with a Continuous Velocity Profile SHERWIN MASLOWE, NILIMA NIGAM, McGill University — The short wave cooperative instability mechanism is of interest both scientifically and because of its pertinence to the aircraft trailing vortex problem. In the first quantitative investigation of this mechanism [Tsai & Widnall (1976)], the discontinuous Rankine vortex was employed. Recently, Sipp & Jacquin [Phys. Fluids (2003)] have shown, however, that for a continuous velocity profile the modes required for the "Widnall instabilities" would be damped. The damping is a consequence of viscosity being used to deal with the singular critical point that occurs in the linear, inviscid theory. An alternative approach that is, in fact, more appropriate at high Reynolds numbers is to restore nonlinear terms in a thin critical layer centered on the singular point. With such a nonlinear critical layer, we show that neutral modes exist that would be damped in the linear viscous theory. These modes are non-axisymmetric and the theory is similar mathematically to that for stratified shear flows, where it has been shown that nonlinear modes, not permitted in linear theory, can occur at Richardson numbers larger than 1/4.

Sherwin Maslowe
McGill University

Date submitted: 11 Aug 2005 Electronic form version 1.4