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Waves on vorticity discontinuities

The two-dimensional incompressible Euler equations have solutions for vorticity discontinuities (planar analogs of vortex patches) that separate two half-spaces with constant but distinct vorticities. Vorticity discontinuities are linearly stable but support unidirectional waves that propagate along the discontinuity and decay exponentially into the interior of the fluid. The linearized frequency of these waves is independent of their wave numbers, which leads to interesting and unusual weakly nonlinear, nondispersive dynamics for discontinuities with small slope. In particular, we formulate contour dynamics equations for the motion of vorticity discontinuities before they filament, and prove that a quadratically nonlinear Burgers-Hilbert equation provides an asymptotic description of the motion of small-slope vorticity discontinuities on cubically nonlinear time-scales. This is joint work with Joseph Biello, Ryan Moreno-Vasquez, Jingyang Shu, and Qingtian Zhang.