

# NONLINEAR STABILITY OF TWO-LAYER FLOWS

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**Abstract.**

We study the dynamics of two-layer, stratified shallow water flows. This is a model in which two scenarios for eventual mixing of stratified flows (shear-instability and internal breaking waves) are, in principle, possible. We find that unforced flows cannot reach the threshold of shear-instability, at least without breaking first. This is a fully nonlinear stability result for a model of stratified, sheared flow. Mathematically, for  $2 \times 2$  autonomous systems of mixed type, a criterium is found deciding whether the elliptic domain is reachable –smoothly– from hyperbolic initial conditions. If the characteristic fields depend smoothly on the system’s Riemann invariants, then the elliptic domain is unattainable. Otherwise, there are hyperbolic initial conditions that will lead to incursions into the elliptic domain, and the development of the associated instability.

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