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Transitional inertialess instabilities in driven multilayer channel flows[1] EVANGELOS PAPAEFTHYMIOU[2], DEMETRIOS PAPAGEORGIOU, Imperial College London — We study the nonlinear stability of viscous, immiscible multilayer flows in channels driven both by a pressure gradient and/or gravity in a slightly inclined channel. Three fluid phases are present with two internal interfaces. Novel weakly nonlinear models of coupled evolution equations are derived and we concentrate on inertialess flows with stably stratified fluids, with and without surface tension. These are 2×2 systems of second-order semilinear parabolic PDEs that can exhibit inertialess instabilities due to resonances between the interfaces - mathematically this is manifested by a transition from hyperbolic to elliptic behavior of the nonlinear flux functions. We consider flows that are linearly stable (i.e the nonlinear fluxes are hyperbolic initially) and use the theory of nonlinear systems of conservation laws to obtain a criterion (which can be verified easily) that can predict nonlinear stability or instability (i.e. nonlinear fluxes encounter ellipticity as they evolve spatiotemporally) at large times. In the former case the solution decays asymptotically to its base state, and in the latter nonlinear traveling waves emerge.

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