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Multiple instabilities in layered stratified plane Couette flow C.P. CAULFIELD, BP Institute & DAMTP, University of Cambridge, T.S. EAVES, DAMTP, University of Cambridge — We consider the linear stability and nonlinear evolution of a Boussinesq fluid consisting of three layers with density $\rho_a - \Delta\rho/2$, ρ_a and $\rho_a + \Delta\rho/2$ of equal depth $d/3$ in a 2D channel where the horizontal boundaries are driven at a constant relative velocity ΔU. Unlike unstratified flow, we demonstrate that for all $Ri_b = g\Delta\rho d/(\rho_a \Delta U)^2 > 0$, and for sufficiently large $Re = \Delta U d/(4\nu)$, this flow is linearly unstable to normal mode disturbances of the form first considered by Taylor (1931). These instabilities, associated with a coupling between Doppler-shifted internal waves on the density interfaces, have a growth rate (maximised across wavenumber and Ri_b) which is a non-monotonic function of Re. Through 2D simulation, we explore the nonlinear evolution of these primary instabilities at various Re, demonstrating that the primary instabilities grow to finite amplitude as vortices in the intermediate fluid layer before rapidly breaking down, modifying the mean flow to become susceptible to strong and long-lived secondary instabilities of Holmboe (1962) type, associated with vortices now localised in the top and bottom layers.

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