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Linear and nonlinear instability and ligament dynamics in 3D laminar two-layer liquid/liquid flows[1] LENNON Ó NÁRAIGH, University College Dublin, PRASHANT VALLURI, The University of Edinburgh, DAVID SCOTT, IAIN BETHUNE, Edinburgh Parallel Computing Centre, The University of Edinburgh, PETER SPELT, Département Mécanique, Université de Lyon 1 and Laboratoire de Mécanique des Fluides & d'Acoustique (LMFA), CNRS, Ecole Centrale Lyon — We consider the linear and nonlinear stability of two-phase density-matched but viscosity contrasted fluids subject to laminar Poiseuille flow in a channel, paying particular attention to the formation of three-dimensional waves. The Orr–Sommerfeld–Squire analysis is used along with DNS of the 3D two-phase Navier–Stokes equations using our newly launched TPLS Solver (http://edin.ac/10cRKzS). For the parameter regimes considered, we demonstrate the existence of two distinct mechanisms whereby 3D waves enter the system, and dominate at late time. There exists a direct route, whereby 3D waves are amplified by the standard linear mechanism; for certain parameter classes, such waves grow at a rate less than but comparable to that of most-dangerous two-dimensional mode. Additionally, there is a weakly nonlinear route, whereby a purely spanwise wave couples to a streamwise mode and grows exponentially. We demonstrate these mechanisms in isolation and in concert. Consideration is also given to the ultimate state of these waves: persistent three-dimensional nonlinear waves are stretched and distorted by the base flow, thereby producing regimes of ligaments, "sheets," or "interfacial turbulence."

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