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Two-Dimensional Viscous Exchange Flows GARY P. MATSON, ANDREW J. HOGG, University of Bristol — We consider two fluids that are confined in a horizontal, two dimensional channel of fixed height and are initially separated by a thin, vertical lock. The lock gate is instantaneously removed and due to the density difference between the two fluids, the denser fluid slumps under the less dense fluid. We analyse this motion theoretically and experimentally. On the assumption of lubrication theory, a similarity solution is constructed for the height profile of the interface and the two points at which the interface contacts the upper and lower boundary are found numerically. We show that the rate of advance of one fluid into the other is proportional to $\sqrt{\Delta\rho g d^3 t/\mu}$, where $\Delta\rho$ is the density difference between the two fluids, g is gravity, d is the height of the channel, μ is the viscosity of one of the fluids and t is the time since release. The constant of proportionality is found to depend only on the ratio of the fluid viscosities, r. Asymptotic methods are used to study the regimes $r \to 0$ and $r \to \infty$ with results agreeing remarkably well with the numerical solutions. Experimental results within the regime $r \sim 1$ also compare favourably with theoretical predictions.

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