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# Mixing in high aspect ratio Rayleigh-Taylor flow

**S. B. Dalziel** (1), M. D. Patterson (1), C. P. Caulfield (2,1)
(1) DAMTP, (2) BP Institute, University of Cambridge (c.p.caulfield@bpi.cam.ac.uk)

Quantitative time dependent measurements of irreversible mixing caused by the development of a Raleigh-Taylor instability (RTI) on an initially unstable two-layer stratification of miscible fluids are taken from a series of laboratory experiments. The experiments are conducted by overturning a stable stratification in a high-aspect ratio (40:1) tank with square cross-section (200*50*50cm), and are observed until the flow is quiescent. The effects of both Atwood number and vertical wall roughness on the time-dependent flow evolution is investigated. Using a light attenuation technique in conjunction with the available potential energy framework due to Winters et al, we obtain detailed time-dependent measures of the irreversible mixing, and its efficiency during flow evolution.

We find that the flow passes through four distinct phases. During the initial phase the classical growth of instability that develops on the interface soon becomes modified by the lateral constraints of the high aspect ratio geometry. In the second phase, which is associated with large amounts of mixing and the most intense fluid motions, there is a rapid descent of dense fluid towards the base of the tank and ascent of light fluid towards the top. Although the third phase of flow evolution, (which starts once the interfaces have reached the full tank extent) typically has a somewhat slower rate of mixing, the flow still exhibits strong turbulent motions for a substantial period of time. Ultimately however, the intensity of the turbulence decays sufficiently for the flow to enter its final diffusive phase, as the flow approaches its final, quiescent state. During the turbulent phases, the turbulent mixing is highly efficient, with almost precisely half the potential energy lost from the flow leading to irreversible mixing, with the other half being lost to dissipation. There is little dependence on either wall roughness or Atwood number, and the ultimate flow state is typically very close to being completely well-mixed in all cases.