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Propagation of a finite bubble in a Hele-Shaw channel of variable depth[1] ANNE JUEL, ANDRES FRANCO-GOMEZ, ALICE THOMPSON, ANDREW HAZEL, Manchester Centre for Nonlinear Dynamics, University of Manchester, UK — We study the propagation of finite bubbles in a Hele-Shaw channel, where a centred rail is introduced to provide a small axially-uniform depth constriction. We demonstrate experimentally that this channel geometry can be used as a passive sorting device. Single air bubbles carried within silicone oil are generally transported on one side of the rail. However, for flow rates marginally larger than a critical value, a narrow band of bubble sizes on the order of the rail width can propagate over the rail, while bubbles of other sizes segregate to the side of the rail. The width of this band of bubble sizes increases with flow rate and the size of the most stable bubble can be tuned by varying the rail width. We present a depth-averaged theory which reveals that the mechanism relies on a non-trivial interaction between capillary and viscous forces that is fully dynamic, rather than being a simple modification of capillary static solutions. In contrast, for larger bubbles and sufficiently large imposed flow rates, we find that initially centred bubbles do not converge onto a steady mode of propagation. Instead they transiently explore weakly unstable steady modes, an evolution which results in their break-up and eventual settling into a steady state of changed topology.

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