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The transient journey and eventual fate of an air bubble travelling in a Hele-Shaw channel JACK KEELER, ALICE THOMPSON, ANDREW HAZEL, University of Manchester, GREGOIRE LEMOULT, Normandie Universite, GREGOIRE LA-LAY, ANTOINE GALLIARD, ANNE JUEL, University of Manchester, MANCHESTER CENTRE OF NONLINEAR DYNAMICS TEAM — Displacement flow in a Hele-Shaw channel is a canonical problem in fluid mechanics and is an archetypal example of a pattern-forming system. If an air-bubble is placed at the opposite end then it will propagate along the channel and change shape as it does so. Recent experimental results have shown that with the introduction of a depth-perturbation to the bottom of the channel the system exhibits regions of bistability, so that starting from an initially centered bubble a wide range of time-dependent outcomes are possible. For small flow-rates the bubble will settle towards a stable asymmetric state but for larger flow-rates the bubble shape will become increasingly deformed and a large range of transient phenomena is observed, including tip-splitting and oscillatory behaviour. In this talk, we attempt to understand the transition to disorder in this system for a bubble in Hele-Shaw channel by finding invariant solutions, in the form of steady states and periodic orbits, of the governing equations. Inspired by recent developments in the transition to turbulence in shear flow, and using dynamical systems theory, we discuss the idea, that when the flow-rate is large enough the bubble will transiently explore the stable manifolds of weakly unstable edge states of the system.

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