Instabilities in blisters
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Fingering instabilities in blisters
Growth of complex interfacial patterns at the interface of air and a viscous fluid in the narrow gap between two parallel plates is an archetypical problem of pattern formation. We find a surprisingly effective means of suppressing this instability by replacing one of the plates with an elastic membrane. For sufficiently large driving flow rate, a fingering instability can arise that is reminiscent of a printer’s instability. The amplitude of the interfacial deformation saturates as the interface expands radially by contrast with the rigid Hele-Shaw cell, where fingers growth is unbounded, and successive tip-splittings results in a highly branched pattern. We show how the introduction of wall elasticity in a radial Hele-Shaw cell can weaken or even suppress the fingering instability, by allowing changes in cell confinement through the flow-induced deflection of the boundary. We further circumvent the inherent time dependence of the circular blister geometry by exploring viscous fingering patterns forming on a steadily propagating interface in a compliant rectangular channel. We show that induced axial and transverse depth gradients foster novel pattern formation. Moreover, the steady propagation of the interface allows us to elucidate the nonlinear selection of the fingering pattern.