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Multiple bubble propagation modes in Hele-Shaw cells of variable depth ALICE THOMPSON, ANNE JUEL, ANDREW HAZEL, University of Manchester — Experimental investigations of long air bubbles displacing viscous oil in axially uniform rectangular channels have shown that symmetric partial occlusion of the cross-section can induce a variety of bubble morphologies, which may find practical application in microdevices. For sufficiently high steady flow rates, the bubbles switch from centred to asymmetric configurations,[1] and spatial oscillations can develop behind the tip in intermediate regimes.[2] We show that all observed morphologies are reproduced in a two-dimensional depth-averaged model, similar to that describing Saffman–Taylor fingering, but with a spatially varying channel height. The resulting equations are solved numerically, using the finite-element library `oomph-lib`[3] and we present the results of a bifurcation analysis that complements the existing experimental data. The qualitative agreement between 2D model and 3D experiments indicates that the complex behaviour arises solely from the enforced change in transverse curvature of the air-oil interface.

[1]de Lózar et al., *Phys. Fluids* **21**, 101702, (2009)
[2]Pailha et al., *Phys. Fluids* **24**, 021702, (2012)
[3]Heil & Hazel, *Lect. Notes Comput. Sci. Eng.* **53**, (2006)

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