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A three-layer Hele-Shaw problem driven by a sink

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We investigate a sink-driven three-layer flow in a radial Hele-Shaw cell performing numerical simulations. The three fluids are of different viscosities with one fluid occupying an annulus-like domain, forming two interfaces with the other two fluids. Using a boundary integral method and a semi-implicit time stepping scheme, we alleviate the numerical stiffness in updating the interfaces and achieve spectral accuracy in space. The interaction between the two interfaces introduces novel dynamics leading to rich pattern formation phenomena, manifested by two typical events: either one of the two interfaces reaches the sink faster than the other (cusp-like morphology) or they touch each other (interface merging). In particular, the inner interface can be wrapped by the other to have both scenarios. We find that multiple parameters contribute to the dynamics including the width of annular region, the location of the sink, and the mobilities of the fluids.

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References

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