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Fluid displacement under elastic membranes: Dynamics and interfacial instabilities[1] TALAL AL-HOUSSEINY, IVAN CHRISTOV, Princeton University, ANNE JUEL, University of Manchester, HOWARD STONE, Princeton University — The spreading of fluids under a flexible membrane is a feature of many systems such as the lateral intrusion of magma under a terrestrial crust, or when blood spreads underneath the skin giving the signature color of bruises. In this work, we investigate the displacement of a viscous fluid by a gas underneath an elastic membrane. We consider a radial Hele-Shaw cell where the upper plate is an elastic sheet. The dynamics of the interface between the injected gas and the displaced fluid are fundamentally modified by the presence of an elastic boundary, which leads to the suppression of viscous fingering below a critical flow rate. We demonstrate theoretically the mechanism of suppression and find the corresponding critical flow rate. In addition, we study the dynamics of a stable (circular) interface propagating underneath an elastic membrane and derive the scaling laws for both the position of the interface and the shape of the elastic membrane. Our theoretical findings agree very well with the experimental results of D. Pihler-Puzovic et al. (PRL 2012).

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