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Thin-film flows without precursors RUBEN JUANES, LUIS CUETO-FELGUEROSO, MICHAEL SZULCZEWSKI, MIT — The flow of thin films over flat surfaces has been the subject of much theoretical, experimental and computational research. Under the lubrication approximation, the classical mathematical model for these flows takes the form of a nonlinear fourth-order PDE, where the fourth-order term models the effect of surface tension. This classical model, however, effectively assumes that the film is perfectly wetting to the substrate and, therefore, does not capture the partial wetting regime. Partial wetting is responsible for stopping the spread of a liquid puddle, and for pinning the contact line of a viscous liquid down an incline, controlling the morphology of the fingering pattern that ensues. Here, we extend our recent work on macroscopic phase-field modeling of two-phase flow in a capillary tube to thin-film flows with partial wetting. Our model naturally accounts for the dynamic contact angle at the contact line, and therefore permits modeling thin-film flows without invoking a precursor film, leading to compactly-supported solutions. We model the statics and dynamics of a liquid puddle, and the fingering behavior of flow down an incline. We compare model predictions with experiments of thin-film flows both on a horizontal plane and down an incline, for different contact angles.

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