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Liquid spreading in the partial wetting regime AMIR A. PAHLAVAN, MICHAEL CHEN, LUIS CUETO-FELGUEROSO, GARETH H. MCKINLEY, RUBEN JUANES, Massachusetts Institute of Technology — The flow of thin films over flat surfaces has been the subject of much theoretical, experimental and computational research [D. Bonn et al., Rev. Mod. Phys., 2009]. Using 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 [e.g. H. E. Huppert, Nature, 1982]. This classical model effectively assumes that the film is perfectly wetting to the substrate, whereas partial wetting is responsible for stopping the spread of a liquid puddle. Here, we present experiments of (large-volume) liquid spreading over a flat horizontal substrate in the partial wetting regime, and characterize the four spreading regimes that we observe. We develop a macroscopic phase-field model of thin-film flows that naturally accounts for the dynamic contact angle. Our model therefore permits describing thin-film flows without invoking a precursor film, leading to compactly-supported solutions that reproduce the spreading dynamics and the static equilibrium configuration observed in the experiments.

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