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A DIFFUSE-INTERFACE MODEL FOR CAPILLARITY-DRIVEN TWO-PHASE FLOW IN A THIN CHANNEL

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Models of binary-fluid flows can be distinguished into two main classes, viz. sharp-interface and diffuse-interface models. The numerical treatment of sharp-interface models generally proceeds via interface-tracking methods, while diffuse-interface models naturally lead to interface-capturing approaches. The implicit nature of this second type of method renders diffuse-interface methods particularly suitable for complex multi-phase flow problems with topological changes, in particular, moving contact lines [1, 2]. Moreover, provided with appropriate wetting boundary conditions, diffuse-interface models possess a thermodynamic structure in the sense that the dynamics of the flow and the motion of the contact line dissipate a convex (Helmholtz) free-energy functional [3].

In this presentation, we consider a three-dimensional phase-field model for two-phase pore-scale imbibition in a thin channel with full wetting behavior. The binary-fluid model is based on the quasi-incompressible Navier–Stokes–Cahn–Hiliard (NSCH) equations [3]. To exploit the thinness of the channel, we consider a tensor-product approximation space composed of high-order curvilinear elements in-the-plane and a single high-order element in the thickness direction. The numerical results are compared with experimental data.

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