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Simulations of rather rapid wetting phenomena

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要旨

Flows dominated by capillarity and wetting are important in many flows in nature and are of increasing interest in connection to microfluidic applications. Their accurate numerical simulation remains challenging. In this talk diffuse interface methods are used to simulate a few different flows showing for instance rapid dynamic wetting.

Diffuse interface models, for example the Cahn-Hilliard equations, coupled with the Navier-Stokes equations for fluid flow, provide a good description of many such cases. The Cahn-Hilliard equations can be formulated from a postulated free energy for a mixture. The result is a partial differential equation for a variable that can be interpreted as the fraction of oil, say, in an oil-water mixture.

Dynamic wetting near equilibrium is reasonably well described by classical models. In situations of very fast wetting far from equilibrium however, the dynamics of the contact line may be quite different. In direct simulations of recent experiments, we show that in order to correctly capture the dynamics of rapid wetting, it is crucial to account for non-equilibrium at the contact line, where the gas, liquid, and solid meet. In the context of the Cahn-Hilliard equations this can be captured conveniently by a time dependent term in the boundary condition at the solid surface. This arises naturally in the theory and is interpreted as allowing for the establishment of a local structure in the immediate vicinity of the contact line. A direct qualitative and quantitative match with experimental data of spontaneously wetting liquid droplets is found.

主催：　東京大学グローバルCOEプログラム「機械システム・イノベーション国際拠点」
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