Doubly Degenerate Cahn-Hilliard Models of Surface Diffusion

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Motion by surface motion by surface diffusion is a type of surface-area-diminishing motion such that the enclosed volume is preserved and is important is many physical applications, including solid state de-wetting. In this talk I will describe a relatively recent diffuse interface model for surface diffusion, wherein the sharp-interface surface description is replaced by a diffuse interface, or boundary layer, with respect to some order parameter. One of the nice features of the new doubly degenerate Cahn-Hilliard (DDCH) model is that it permits a hyperbolic tangent description of the diffuse interfaces, in an asymptotic sense, but, at the same time, seems to support a maximum principle, meaning that the order parameter stays between two predetermined values. Furthermore, numerical simulations show that convergence to the sharp interface solutions for the DDCH model is faster than that of the standard regular Cahn-Hilliard (rCH) model. The downside is that the new DDCH model is singular and much more nonlinear than the rCH model, which makes numerical solution difficult, and it is still only first order accurate asymptotically. We will describe positivity-preserving numerical methods for the new model and review some existing numerical simulations and asymptotic analyses. We will also describe recent results on the rigorous Gamma convergence of the underlying diffuse interface energy.