Analysis and Control Problems for Fluid Flow Models Coupled with Cahn-Hilliard Equation

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Abstract

Diffuse interface models provide an effective framework for describing the interface between fluids, which are represented as thin layers of finite thickness. In this talk, we consider a Cahn-Hilliard Brinkman system which describes the dynamics of phase separation of binary fluids in a porous media. We first investigate the wellposedness results of the nonlocal system with a practically relevant singular potential and variable mobility. Further regularity and continuous dependence results are established, which form a basis to study the optimal control problem for the system. We also examine the long-time behaviour of the system, establishing the separation property and convergence to equilibrium under suitable assumptions on the mobility and potential.

We next consider a pointwise tracking optimal control of the Cahn-Hilliard Navier-Stokes (CHNS) system, where the cost functional involves pointwise evaluations of the phase variable. The pointwise tracking term poses additional analytical challenges due to the low regularity of source terms in the adjoint system. We address the wellposeness of the adjoint system through the transposition method. Finally, we discuss the approximate controllability of the Cahn-Hilliard (CH) equation with targets prescribed at finitely many spatial points. We study this problem for both distributional and pointwise controls.