


复旦大学数学科学学院

数学综合报告会

报告题目：Convergence analysis of a numerical scheme for the Cahn-Hilliard-Navier-Stokes system with dynamical boundary condition and its application to moving contact line problem

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地点：光华楼东主楼1801

报告摘要：

A finite difference numerical scheme is proposed and analyzed for the Cahn–Hilliard–Navier–Stokes system, combined with a dynamical boundary condition. Such a physical system has potential applications in the moving contact line problem. The boundary profile is governed by a lower-dimensional energy potential, coupled with a non-homogeneous boundary condition for the phase variable. In the numerical design, a convex-splitting approach is applied to the chemical potential in both bulk and surface levels, which leads to a highly coupled nonlinear system. A semi-implicit discretization is taken in the nonlinear fluid convection, as well as the coupled terms between the fluid motion and phase variable evolution. A careful finite difference approximation and convexity analysis reveals that such a numerical system could be represented as a non-symmetric and monotone mapping associated with the fluid convection. In turn, the unique solvability is valid based on the monotonicity argument. The total energy stability analysis is obtained through a careful summation-by-part calculation. In particular, an optimal rate convergence analysis is theoretically established in this work. The discrete mass conservation of the exact solution is required to preserve the mean-zero property of the error function. A combination of the Fourier projection and an auxiliary function is applied to overcome this difficulty. Furthermore, an approach of rough and refined error estimates concludes the desired convergence result. Some numerical results are presented in this article, which demonstrate the robustness of the proposed numerical scheme. In our knowledge, this work provides a theoretical proof of convergence analysis and error estimate for a numerical scheme to the moving contact line problem, for the first time in the literature.