数学与系统科学研究院

计算数学所学术报告

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报告题目：

An ALE-FEM of higher order for flows with surfactants

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上午 10:00-11:00

报告地点：　　数学院南楼七层

702 会议室

Abstract:

The convective transport of surfactants induced by the flow field generates a local accumulation resulting in a non-uniform concentration of surfactants at the liquid-fluid-interface. The appearing Marangoni forces may lead to a destabilization of the interface with essential consequences for the flow structure. This is a complex process whose tailored use in applications requires a fundamental understanding of the mutual interplay.

We propose a finite element method for the flow of two immiscible incompressible fluids in the presence of surfactants in a bounded domain $\Omega\subset\mathbb{R}^d$, $d=2,3$. We assume that a liquid droplet filling $\Omega_1(t)$ is completely surrounded by another liquid filling the domain $\Omega_2(t)=\Omega\backslash \Omega_1(t)$, $t\in [0,T]$. The distribution of the surfactant on the interface

$\Gamma_F(t)=\partial\Omega_1(t)\cap\partial\Omega_2(t)$ influen ces the surface tension and thus the dynamic of the flow. The mathematical model consists of the time-dependent incompressible Navier-Stokes equations in each phase, completed by an initial condition, the kinematic and force balancing conditions at the interface $\Gamma_F(t)$. On the fixed (in time) boundary $\partial\Omega$ we impose homogeneous Dirichlet type boundary conditions. Finally, we add equations describing the surfactant transport.

The finite element method is based on the ALE (arbitrary Langrangian-Eulerian) method \cite{GT12,GHHT} on a moving, interface aligned grid. This interface tracking method allows for an accurate incorporation of surface tension and Marangoni forces and and accurate handling of the surface equation of convection diffusion type. The coupled bulk-surface pde for the surfactant concentrations is solved following the approaches in \cite{DE05,ER13} but with higher order isoparametric elements. Numerical test examples show the potential of the proposed discretization technique.

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