An immersed boundary method for the simulation of interfacial flows with insoluble surfactant

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Abstract

In this talk, an immersed boundary method is proposed for the simulation of two-dimensional fluid interfaces with insoluble surfactant. The governing equations are written in an usual immersed boundary formulation where a mixture of Eulerian flow and Lagrangian interfacial variables are used and the linkage between these two set of variables is provided by the Dirac delta function. The immersed boundary force comes from the surface tension which is affected by the distribution of surfactant along the interface. By tracking the interface in a Lagrangian manner, a simplified surfactant transport equation is derived. The numerical method involves solving the Navier-Stokes equations on a staggered grid by a semi-implicit pressure increment projection method where the immersed interfacial forces are calculated at the beginning of each time step. Once the velocity value and interfacial configurations are obtained, surfactant concentration is updated using the transport equation. Moreover, a new symmetric discretization for the surfactant concentration equation is proposed that ensures the surfactant mass conservation numerically. The effect of surfactant on drop deformation in a shear flow is investigated in detail.