Surfactant-coated interfaces in 2D Stokes Flow

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We present a new numerical method to compute the motion of a surfactant-coated interface of a bubble or drop in Stokes Flow. The surfactant concentration locally alters the surface tension and thus alters the interface motility. We consider the case of dilute insoluble surfactant whose own dynamics is now coupled to the interface one. The interface velocity is found by solving an integral equation whose analytic formulation is based on the complex variable theory of the biharmonic equation. The numerical method for solving the integral equation employs a fast-multipole based iterative solution, which requires only $O(N)$ operations, with $N$ being the number of points on the interface. The interface is described spectrally and we preserve equal spacing of the marker points on it. The surfactant concentration convection-diffusion equation in this equal arclength frame is solved using a semiimplicit time-integrating method to ease the CFL-type stability constraint to linear with respect to the mesh. The method is tested against known results and simple scenarios and we discuss interesting physical phenomena like surfactant cap formation, bursting instability and even bubble interaction. The roles of linear vs. nonlinear dependency of the surface tension to the surfactant concentration are also discussed.

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