Numerical simulations of vesicle dynamics by immersed boundary method

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In this talk, we would like to present a simple immersed boundary method to simulate the dynamics of 2D and 3D axisymmetric inextensible vesicles in Navier-Stokes flows. Instead of introducing a Lagrange's multiplier to enforce the vesicle inextensibility constraint, we modify the model by adopting a spring-like tension to make the vesicle boundary nearly inextensible so that solving for the unknown tension can be avoided. We also derive a new elastic force from the modified vesicle energy and obtain exactly the same form as the originally unmodified one. A series of numerical tests on the present schemes have been conducted to illustrate the applicability and reliability of the method. In particular, we study of viscosity and inertial effects on tank-treading to tumbling motion under shear flow. We also investigate the shapes of vesicles in Poiseuille flow to study the effects of the reduced volume, the confinement, and the mean flow velocity. The numerical results are shown to be in good agreement with those obtained in theory and experiments.