Numerical Study of Incompressible Fluid Dynamics with non-Uniform Density by the Immersed Boundary Method

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abstract

We apply the immersed boundary (IB) method to the dynamics of an incompressible fluid with a non-uniform density. The immersed boundary (IB) method is a generally useful computational method for problems in which elastic materials interact with a viscous incompressible fluid. In order to take into account both the inertial and gravitational effects of the elastic materials with mass, we have proposed a simple way to give mass to the elastic boundary and showed that the method can be applied to many problems for which the boundary mass is important [Y.Kim and C.S.Peskin, Phys.Fluids, 19(5), 053103 (2007)].

Incompressible fluid motion with a non-uniform density has been extensively explored both experimentally and computationally. In this talk, I introduce the new extension of the IB method, which is called the penalty IB method, and show that the pIB method is a robust and efficient numerical tool for the simulation of fluids with variable density by showing computation results of some example problems: the falling of a heavier fluid surrounded by a lighter fluid and the Rayleigh-Taylor instabilities in 2D and 3D, and the dynamic stabilization of the Rayleigh-Taylor instability.