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Smoothed Particle Hydrodynamics Continuous Boundary Force method for Navier-Stokes equations subject to a Robin boundary condition[1] WENXIAO PAN, JIE BAO, ALEXANDRE TARTAKOVSKY, Pacific Northwest National Laboratory — A Continuous Boundary Force (CBF) method was developed for implementing Robin (Navier) boundary condition (BC) that can describe no-slip or slip conditions (slip length from zero to infinity) at the fluid-solid interface. In the CBF method the Robin BC is replaced by a homogeneous Neumann BC and an additional volumetric source term in the governing momentum equation. The formulation is derived based on an approximation of the sharp boundary with a diffuse interface of finite thickness, across which the BC is reformulated by means of a smoothed characteristic function. The CBF method is easy to be implemented in Lagrangian particle-based methods. We first implemented it in smoothed particle hydrodynamics (SPH) to solve numerically the Navier-Stokes equations subject to spatial-independent or dependent Robin BC in two and three dimensions. The numerical accuracy and convergence is examined through comparisons with the corresponding finite difference or finite element solutions. The CBF method is further implemented in smoothed dissipative particle dynamics (SDPD), a mesoscale scheme, for modeling slip flows commonly existent in micro/nano channels and microfluidic devices.

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Wenxiao Pan
Pacific Northwest National Laboratory

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