# IMMERSED BOUNDARY METHODS FOR RIGID-PARTICLE SUSPENSIONS

BRENNAN SPRINKLE, AMNEET BHALLA, ALEKSANDAR DONEV, AND NEELESH A. PATANKAR

Abstract. We introduce new numerical methods for simulating the dynamics of passive and active Brownian colloidal suspensions of arbitrary shape in fully confined domains, such as periodic suspensions or suspensions confined in slit and square channels. We develop a rigid-body immersed boundary method for suspensions of freely-moving passive or active rigid particles at zero Reynolds number. We demonstrate that our preconditioned iterative solver for the coupled fluid and rigid body equations converges in a bounded number of iterations regardless of the system size. In our approach, each iteration only requires a few cycles of a geometric multigrid solver for the Poisson equation, and an application of the block-diagonal preconditioner, leading to linear scaling with the number of particles. We generate Brownian increments using fluctuating hydrodynamics, which adds no additional computational cost or complexity aside from generating a random stochastic stress. We design a Split–Euler–Maruyama (SEM) scheme that correctly captures the stochastic drift terms in the overdamped equations of Brownian Dynamics. We use our numerical method to study the formation and motion of kinks in a periodic quasi–2D colloidal lattice confined to a tight slit channel and driven over a commensurate substrate potential.

**Keywords**: immersed boundary methods; Brownian dynamics; Brownian suspensions

Courant Institute of Mathematical Sciences, New York University, New York NY, USA
*E-mail address*: bs162@nyu.edu

Department of Mechanical Engineering, San Diego State University, San Diego CA, USA
*E-mail address*: asbhalla@sdsu.edu

Courant Institute of Mathematical Sciences, New York University, New York NY, USA
*E-mail address*: donev@courant.nyu.edu

McCormick School of Engineering, Northwestern University, Evanston IL, USA
*E-mail address*: n-patankar@northwestern.edu