Stationary sedimentation of non-Brownian suspensions: Stokesian dynamics simulations using Fast Hydro-Multipole Method

G. C. Abade[1] and B. Cichocki[2]

[1] Departamento de Engenharia Mecânica, Universidade de Brasília, 70910-900 Brasília, Brazil
[2] Institute of Theoretical Physics, University of Warsaw, Hoża 69, 00-681 Warsaw, Poland

Despite longstanding investigations a precise characterisation of the microstructure of a non-Brownian monodisperse suspension in the steadily sedimenting state is still an open problem. We address this problem by a careful numerical simulation of the dynamics occurring in the bulk of a sedimenting suspension. Our purpose is to investigate if a true *nonequilibrium* steady sedimentation state is attainable in computer simulations with periodic boundary conditions. Therefore, any influence of macroscopic boundary conditions or concentration gradients found in batch settling geometries has been neglected.

The fluid flow set up by the motion of the suspended particles is assumed to be described by the stationary Stokes equations of hydrodynamics. Many-body hydrodynamic interactions between particles are evaluated by the precise multipole method, corrected for lubrication effects. The method is encoded in the new FAST-HYDROMULTIPOLE, an accelerated version of the well-established HYDROMULTIPOLE program. In our higher-order multipole account, the essential effects associated with the nonvanishing of the divergence of the mobility matrix are considered. The motion of close spheres, when short-range lubrication forces dominate, is carefully solved.

The time evolution of dilute suspensions has been simulated and a nonequilibrium stationary state has been reached. With the complete neglect of Brownian motion, the sedimentation velocity and the configurational distribution of the particles in the nonequilibrium steady state differ measurably from their equilibrium counterparts. The simulated particle correlations in the steady state are in good agreement with theoretical calculations by Cichocki and Sadlej [Europhys. Lett. **72**, 936 (2005)].