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Many-particle hydrodynamic interactions in parallel-wall geometry: Cartesian-representation method

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This talk will describe the results of our theoretical and numerical studies of hydrodynamic interactions in a suspension of spherical particles confined between two parallel planar walls, under creeping-flow conditions. We propose an efficient algorithm for evaluating many-particle friction matrix in this system---no Stokesian-dynamics algorithm of this kind has been available so far. Our approach involves expanding the fluid velocity field in the wall-bounded suspension into spherical and Cartesian fundamental sets of Stokes flows. The spherical set is used to describe the interaction of the fluid with the particles and the Cartesian set to describe the interaction with the walls. At the core of our method are transformation relations between the spherical and Cartesian fundamental sets. Using the transformation formulas, we derive a system of linear equations for the force multipoles induced on the particle surfaces; the coefficients in these equations are given in terms of lateral Fourier integrals corresponding to the directions parallel to the walls. The force-multipole equations have been implemented in a numerical algorithm for the evaluation of the multiparticle friction matrix in the wall-bounded system. The algorithm involves subtraction of the particle--wall and particle--particle lubrication contributions to accelerate the convergence of the results with the spherical-harmonics order, and a subtraction of the single-wall contributions to accelerate the convergence of the Fourier integrals.