Accurate treatment of lubrication forces between three spheres in viscous shear flow using a traction-corrected boundary element method

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Traditional boundary element methods cannot accurately resolve lubrication forces in the interstitial regions between nearly touching particles. In general, the interstitial tractions have been underestimated and the relative particle velocities have been overestimated resulting in significant errors in predicting particle trajectories. In order to accurately treat the lubrication force between nearly touching particles, a traction-corrected boundary element method (TC-BEM) for more than two particles is developed by combining the analytical asymptotic solution for the trations in the interstitial regions with the boundary element method. An adaptive remeshing algorithm is developed to provide appropriate meshes on surfaces of particles with close interactions to each other. The numerical method also employs an efficient parallelization scheme to make possible prediction of long-term behavior of particles suspended in an exterior flow. The results of the TC-BEM are benchmarked by comparing to analytical results for two particles in a linear shear flow and by considering the reversibility of three particles in circular Couette flow. It is shown that the TC-BEM developed here is able to correctly resolve the lubrication force between nearly touching particles, thus enabling the accurate analysis of the chaotic behavior of three spheres in nonlinear shear flow.