A fast and accurate integral equation method for particles in viscous flow using QBX.

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The flow around rigid particles sedimenting in a viscous fluid can be described using the Stokes equations. Solving these equations using a double-layer boundary integral formulation gives a well-conditioned problem which can be solved to high accuracy, provided that a suitable quadrature method is used for computing the singular and nearly singular integrals arising in the formulation. We present the development of such a method, specifically adapted for the case where the particles are rigid spheroids. The method is based on the quadrature by expansion (QBX) method [2], which uses surrogate local expansions of the layer potential to evaluate it to very high accuracy both on and off the particle surfaces.

We combine our new quadrature method with an existing boundary integral method for periodic particle suspensions, which uses FFT-based fast Ewald summation for computing triply-periodic layer potentials in $\mathcal{O}(N \log N)$ time [1]. The result is a fast method for computing the flow of periodic particle suspensions to very high accuracy. To validate our method and demonstrate its capabilities, we apply it to both static particle configurations and systems of freely sedimenting particles.

References

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