Simulations of sheared suspensions using a fictitious domain method

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In this work, we have developed a fully Eulerian, Lagrange multiplier-free, fictitious domain approach to compute low Reynolds suspensions. Since lubrication forces between particles play an important role in the suspension rheology, they must be accounted properly in the model. The lubrication model consists in transposing the classical approach used in Stokesian Dynamics to our present direct numerical simulation. This lubrication model has also been adapted to account for solid boundaries such as walls. Finally, contact forces between particles are modeled using a classical Discrete Element Method (DEM) which is widely used in granular matter physics. The implementation of DEM in the fluid solver is such that it is tightly coupled with short-range lubrication forces since dense suspensions are predominantly controlled by both lubrication and contact forces (e.g., through particle roughness).
After some selected validations, we present some numerical results on the rheology of dense bounded sheared non-Brownian suspensions, including particle roughness and friction. Preliminary results show that both confinement and friction have a marked impact on the suspension rheology, especially on normal stresses, which could partially help understand discrepancies noted experimentally on those normal stresses.