Numerical and modeling issues in fluid-grain simulations

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The direct simulation of immersed suspensions poses many difficulties. We shall mainly focus on two of them:

1) The domain occupied by the fluid is highly complicated and singular in quasi-contact situations, which makes it difficult (yet, not impossible) to generate meshes that are respectful of the geometry. Most methods therefore rely on a cartesian mesh that covers the whole mixture. Since this mesh does not fit to the boundary of particles, it degrades the quality of the velocity fields description. And this happens at the very location where dynamic interactions between the two phases take place. We shall present some attemps that have been made to overcome this difficulty, and propose a method based on a smooth extension of the velocity field within the particle, to recover good approximation properties in spite of the non boundary fitted mesh.

2) When grains get close to each other, the interstitial flow is poorly described by most direct methods (especially those that are based on a fixed mesh). Yet, the interaction between the two grains is driven by lubrication forces, and those forces can be shown to play, in some regimes, a very significant role in the overall behavior of the suspension.
We shall present a method to account for those lubrication forces, based on an asymptotic expansion in the interparticle distance: the "gluey contact" model.

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