Interactions between two close spheres in Stokes flow

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Abstract We investigate if two close spheres in a fluid flow at low-Reynolds-number can touch each other and interact mechanically. We outline how this problem relates to microhydrodynamics of suspensions. We measure the translational and rotational motion of a sphere, which settles in a silicon oil onto another, fixed sphere of the same size. We use simultaneously a video system and a laser interferometer coupled with encoders. We calculate the motion, assuming that the particles come into contact and that the mechanical interactions superpose with the gravitational and hydrodynamic forces. The experiment confirms the model and determines its parameters.

When spheres are tending to impact,
The question is: do they make contact?
When stick turns to slip,
The forces can dip;
And this is the tough nut that I've cracked.

1. Introduction

Theoretical description of structure and macroscopic properties of suspensions is based on the calculation of hydrodynamic interactions between particles immersed in a fluid (Felderhof 1990). Such interactions increase indefinitely with the decrease of the gap between the particle surfaces (Jeffrey & Onishi 1984). Therefore methods of numerical computations and values of the suspension transport coefficients are sensitive to the nature of other than hydrodynamic small-distance interactions, e.g. the existence of mechanical contact (Wilson & Davis 2000).