Migration of a solid and arbitrarily-shaped particle near a plane slipping wall

A. Sellier
LadHyx. Ecole polytechnique, 91128 Palaiseau Cédex, France
e-mail: sellier@ladhyx.polytechnique.fr

N. Ghalia
Laboratory of Engineering Mathematics, Polytechnic School of Tunisia
BP 743, La Marsa, Tunisia
e-mail: nejibaghalia@yahoo.fr

F. Feuillebois
LIMSI - CNRS, BP 133, 91403 Orsay Cédex, France
e-mail: Francois.Feuillebois@limsi.fr

Particle-wall interactions play a key role when investigating the macroscopic properties (effective viscosity,...) of dilute and bounded suspensions. For a liquid flow with velocity $\mathbf{u}$ above the $x_3 = 0$ plane slipping wall Navier [1] proposed his famous conditions

$$\mathbf{u}.\mathbf{e}_3 = 0, \;\; \mathbf{u}.\mathbf{e}_1 = \lambda \frac{\partial \mathbf{u}.\mathbf{e}_1}{\partial x_3} \text{ and } \mathbf{u}.\mathbf{e}_2 = \lambda \frac{\partial \mathbf{u}.\mathbf{e}_2}{\partial x_3} \text{ at } x_3 = 0 \tag{1}$$

where $\lambda \geq 0$ denotes the wall slip length. For instance, the above relations received experimental support for a nonwetting fluid-solid interface in [2]. The effect of the slip length λ on the migration of a solid *sphere* has been examined in the literature using two different approaches:

(i) The so-called bipolar coordinates method (see, for instance, [3-5]).

(ii) The boundary-integral technique in [6].

Unfortunately and to the authors very best knowledge, there is no available work dealing with the challenging case of a *non-spherical* particle. This work therefore presents a boundary-integral apporach (different from the one employed in [6]) resting on the establishment and use of a new Green tensor which complies with (1) and valid by essence for arbitrarily-shaped solid particles. Both benchmarks against [3-5] for a sphere and new results for a solid and ellipsoidal particle will be discussed.

References

[1] C. L. M. H. Navier Mémoire sur les lois du mouvement des fluides. *Mémoire de l'Académie Royale des Sciences de l'Institut de France*, **VI**, 389-440 (1823).

[2] J. Baudry, E. Charlaix, A. Tonck and D. Mazuyer Experimental evidence for a large slip effect at a nonwetting fluid-solid interface. *Langmuir*, **17**, 5232-5236 (2001).

[3] M. E. O'Neill and B. S. Bhatt Slow motion of a solid sphere in the presence of a naturally permeable surface. *Q. J. Mech. Appl. Math.,* **44**, 91-104 (1991).

[4] A.M.J Davis, M.T. Kezirian and H. Brenner On the Stokes-Einstein model of surface diffusion along solid surfaces: Slip boundary conditions *J.Colloid Interface Sci.,* **1065**, 129-140 (1994).

[5] F. Feuillebois, H. Loussaief and L. Pasol Particles in Creeping Flow Near a Slip Wall. *CP1186, Applications of Mathematics in Technical and Natural Sciences* Editors M. D. Todorov and C.I. Christov. American Institute of Physics, 3-14 (2009).

[6] H. Luo and C. Pozrikidis Effect of slip on the motion of a spherical particle in infinite flow and near a plane wall. *J. Eng. Math.*, **62(1)**, 1-21. (2008).