Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Drag and diffusion coefficient of a spherical particle attached to a fluid interface STEFFEN HARDT, AARON DOERR, Center of Smart Interfaces, TU Darmstadt, HASSAN MASOUD, Department of Mechanical Engineering, University of Nevada, HOWARD STONE, Department of Mechanical and Aerospace Engineering, Princeton University — We consider a spherical particle attached to the interface between two immiscible fluids of large viscosity contrast. The degree of immersion in the two fluids is determined by the contact angle. For small enough particles and significant contact-angle hysteresis, it can be assumed that the three-phase contact line is pinned at the particle surface. We study the movement of such particles along the fluid interface for the case of small Reynolds and capillary numbers. We solve the Stokes equation based on two geometric perturbation expansions around contact angles of 90 degrees and 180 degrees, the latter corresponding to a particle completely immersed in the less viscous phase. Based on the Lorentz Reciprocity Theorem we obtain expressions for the drag coefficient of an interfacial particle which are analogs of the well-known Stokes drag coefficient for a particle moving in an unbounded medium. Interpolation of the two results gives a relationship which approximates the drag coefficient quite accurately over the entire range of contact angles. A comparison with previously published numerical results for contact angles below 90 degrees shows good agreement. Using the fluctuation-dissipation theorem, we also obtain expressions for the diffusion constant of a small particle attached to a fluid interface.

Steffen Hardt
Center of Smart Interfaces, TU Darmstadt

Date submitted: 17 Jul 2015 Electronic form version 1.4