Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Self-diffusiophoresis in the strongly advecting regime GARETH ALEXANDER, University of Pennslyvania, ANDREA LIU, University of Pennsylvania — Certain forms of biological motility, such as actin-based propulsion and chromosomal translocation in certain bacteria, have recently been proposed to have their physical origins in the phenomenon of self-diffusiophoresis. In diffusiophoresis, a particle in a fluid with an inhomogeneous concentration of solute will move along the concentration gradient with a well-defined velocity due to surface interactions with the solute. If the particle has the means of generating the concentration gradient itself–by catalyzing a chemical reaction on one side of its surface, for example–then self-diffusiophoresis serves as a mechanism of self-propulsion. Until now, self-diffusiophoresis has been studied under conditions of rapid diffusion, or small Péclet number, where the effects of advection on the solute dispersion can be neglected. However, in the biological examples of interest, the Péclet number is high. We present an analysis of the large Péclet number limit, where diffusion is slow and advection by the fluid flow is the primary means of solute dispersal. The resulting motion is still described in terms of a slip velocity generated in a thin boundary layer, but with a different origin, arising not from diffusion but from local outward flow to carry away the solute together with fluid continuity. A simple model is developed on this basis, contrasted with the rapid diffusion regime, and applied to provide insight into relevant biological processes.

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Date submitted: 19 Nov 2010 Electronic form version 1.4