Abstract Submitted for the MAR16 Meeting of The American Physical Society

Simulating Electrophoresis with Discrete Charge and Drag<sup>1</sup> AARON J. MOWITZ, THOMAS A. WITTEN, University of Chicago — A charged asymmetric rigid cluster of colloidal particles in saline solution can respond in exotic ways to an electric field: it may spin or move transversely. These distinctive motions arise from the drag force of the neutralizing countercharge surrounding the cluster. Because of this drag, calculating the motion of arbitrary asymmetric objects with nonuniform charge is impractical by conventional methods. Here we present a new method of simulating electrophoresis, in which we replace the continuous object and the surrounding countercharge with discrete point-draggers, called Stokeslets. The balance of forces imposes a linear, self-consistent relation among the drag and Coulomb forces on the Stokeslets, which allows us to easily determine the object's motion via matrix inversion. By explicitly enforcing charge+countercharge neutrality, the simulation recovers the distinctive features of electrophoretic motion to few-percent accuracy using as few as 1000 Stokeslets. In particular, for uniformly charged objects, we observe the characteristic Smoluchowski independence of mobility on object size and shape. We then discuss electrophoretic motion of asymmetric objects, where our simulation method is particularly advantageous.

<sup>1</sup>This work is supported by a grant from the US-Israel Binational Science Foundation

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Date submitted: 04 Nov 2015

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