Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Numerical study of nonlinear interactions in suspensions of ideally polarizable spheres under electrophoresis JAE SUNG PARK, DAVID SAINTILLAN, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — We investigate the dynamics in a suspension of interacting ideally polarizable spheres undergoing electrophoresis using theory and numerical simulations. In addition to the classical linear electrophoretic motion of the particles, it is shown that two types of nonlinear electrokinetic phenomena may also occur and result in relative motions. First, when several particles are present and field gradients are created, nonzero dielectrophoretic forces (DEP) may arise due to Maxwell stresses in the fluid. In addition, if the particles can polarize under the action of the applied field, induced-charge electrophoresis (ICEP) occurs and may induce relative motions through hydrodynamic interactions. These two nonlinear effects are first analyzed in the prototypical case of two equal-sized spheres using asymptotic methods and are predicted to result in particle pairings. Based on this analysis, numerical simulations of full-scale particle suspensions undergoing DEP and ICEP with periodic boundary conditions are also performed using a fast Smooth Particle-Mesh Ewald (SPME) algorithm. The simulations confirm that pairing dynamics occur, and results are presented on the suspension microstructure, velocity statistics and particle hydrodynamic diffusion.

Jae Sung Park
Department of Mechanical Science and Engineering,
University of Illinois at Urbana-Champaign

Date submitted: 28 Jul 2009 Electronic form version 1.4