Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Analysis of pinching in deterministic particle separation[1]
SUMEDH RISBUD, MINGXIANG LUO, JOELLE FRECHETTE, GERMAN DRAZER, Johns Hopkins University — We investigate the problem of spherical particles vertically settling parallel to Y-axis (under gravity), through a pinching gap created by an obstacle (spherical or cylindrical, center at the origin) and a wall (normal to X axis), to uncover the physics governing microfluidic separation techniques such as deterministic lateral displacement and pinched flow fractionation: (1) theoretically, by linearly superimposing the resistances offered by the wall and the obstacle separately, (2) computationally, using the lattice Boltzmann method for particulate systems and (3) experimentally, by conducting macroscopic experiments. Both, theory and simulations, show that for a given initial separation between the particle centre and the Y-axis, presence of a wall pushes the particles closer to the obstacle, than its absence. Experimentally, this is expected to result in an early onset of the short-range repulsive forces caused by solid-solid contact. We indeed observe such an early onset, which we quantify by measuring the asymmetry in the trajectories of the spherical particles around the obstacle.

[1]This work is partially supported by the National Science Foundation Grant Nos. CBET- 0731032, CMMI-0748094, and CBET-0954840.

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Date submitted: 05 Aug 2011 Electronic form version 1.4