Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Non-perturbative manipulation through a 3D microfluidic treadmill[1] JEREMIAS GONZALEZ, BIN LIU, UC Merced — Our capabilities of micromanipulation have evolved with advances in contact-free trapping techniques under various disciplines, such as optical, magnetic, and microfluidic traps. In these techniques, a microscale particle is held in place under compression due to electromagnetic or hydrodynamic forces. In this work, we present a trap-free design of a microfluidic "treadmill" (MFC), realized by a uniform flow along arbitrary directions in a 3D microfluidic device, which is composed of a central chamber and pairs of $x-$ and $y-$channels at different elevations. Through boundary element simulations, we demonstrate that 3D background flows along any direction can be generated in the middle of the chamber, controlled by a set of syringe pumps. By tuning the detailed geometry of the MFC, we show the optimized shape of the device that leads to minimized strain rate, allowing for manipulation of the suspended particles with negligible perturbations. We also show an experimental realization of the MFC device, using laser stereolithography. The $x-$, $y-$, and $z-$ manipulation modes are obtained independently by a syringe pump with push/pull mechanisms, and are compared with the above simulation results.

[1]The authors thank the support of National Science Foundation CREST: Center for Cellular and Biomolecular Machines at UC Merced (NSF-HRD-1547848).

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Date submitted: 13 Sep 2017 Electronic form version 1.4