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Forces on particles in microstreaming flows[1] SASCHA HILGENFELDT, BHARGAV RALLABANDI, RAQEEB THAMEEM, Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — In various microfluidic applications, vortical steady streaming from ultrasonically driven microbubbles is used in concert with a pressure-driven channel flow to manipulate objects. While a quantitative theory of this boundary-induced streaming is available, little work has been devoted to a fundamental understanding of the forces exerted on microparticles in boundary streaming flows, even though the differential action of such forces is central to applications like size-sensitive sorting. Contrary to other microfluidic sorting devices, the forces in bubble microstreaming act over millisecond times and micron length scales, without the need for accumulated deflections over long distances. Accordingly, we develop a theory of hydrodynamic forces on the fast time scale of bubble oscillation using the lubrication approximation, showing for the first time how particle displacements are rectified near moving boundaries over multiple oscillations in parallel with the generation of the steady streaming flow. The dependence of particle migration on particle size and the flow parameters is compared with experimental data. The theory is applicable to boundary streaming phenomena in general and demonstrates how particles can be sorted very quickly and without compromising device throughput.

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