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Particle Migration and Sorting in Microbubble Streaming Flow[1]

SASCHA HILGENFELDT, RAQEEB THAMEEM, BHARGAV RALLABANDI, RUI YANG, Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — Ultrasonic driving of sessile semicylindrical bubbles results in powerful steady streaming flows that are robust over a wide range of driving frequencies. In a microchannel, this flow field pattern can be fine-tuned to achieve size-sensitive sorting and trapping of particles at scales much smaller than the bubble itself. The sorting process is passive and relies on large forces induced by the streaming flow that lead to particle migration across streamlines. While a thresholded size sorting can be understood from simple arguments about the steady streaming flow geometry, we show that more sophisticated size separation is achievable through a better understanding of the flow at short time scales. We present experimental data (high-speed videography) and theoretical analysis (asymptotic description of the flow fields) that show how particles undergo significant migration and separation on time scales ranging from milliseconds to microseconds, and on length scales of about 10μm. The highly tunable experimental set-up and the accurate analytical description of the flow field make this system an extremely fast and versatile device for applications ranging from flow cytometry to lab-on-a-chip micromanipulation.

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