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Controlling particle trajectories using oscillating microbubbles
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In many applications of microfluidics and biotechnology, such as cytometry and drug delivery, it is vital to manipulate the trajectories of microparticles such as vesicles or cells. On this small scale, inertial or gravitational effects are often too weak to exploit. We propose a mechanism to selectively trap and direct particles based on their size in creeping transport flows ($Re \ll 1$). We employ Rayleigh-Nyborg-Westervelt (RNW) streaming generated by an oscillating microbubble, which in turn generates a streaming flow component around the mobile particles. The result is an attractive interaction that draws the particle closer to the bubble. The impenetrability of the bubble interface destroys time-reversal symmetry and forces the particles onto either narrow trajectory bundles or well-defined closed trajectories, where they are trapped. The effect is dependent on particle size and thus allows for the passive focusing and sorting of selected sizes, on scales much smaller than the geometry of the microfluidic device. The device could eliminate the need for complicated microchannel designs with external magnetic or electric fields in applications such as particle focusing and size-based sorting.

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