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Rectified inertial forces in oscillatory flows: theory, simulation, experiment SIDDHANSH AGARWAL, FAN KIAT CHAN, MATTIA GAZZOLA, SASCHA HILGENFELDT, University of Illinois - Urbana Champaign — While the long-time effects of oscillatory interface motion on fluid elements are well understood (leading to rectified flow known as steady streaming), the rectification of forces on particles in such flows is much less understood, and of immediate practical relevance. In previous work, we analytically described physical effects leading to steady forces of particle attraction to or repulsion from the interface in a setting where streaming is negligible and for weak viscous effects. Here we present results from direct numerical simulations of the Navier-Stokes equations quantifying rectification forces on spherical particles in a wider range of situations. The outcomes suggest an improved version of the theory that more generally and systematically takes into account inertial forces on particles in oscillatory flows, revealing the dependence of these inertial forces on the strength of background flow gradients as well as on the particle size and density contrast. Comparison is also made with experiments using oscillating microbubbles. The improved fundamental understanding of attractive/repulsive forces manipulating microparticles benefits experimental design in many applications.

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