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Flow Curvature Induced Inertial Forces on Particles in Oscillatory Flows SIDDHANSH AGARWAL, FAN KIAT CHAN, MATTIA GAZZOLA, SASCHA HILGENFELDT, University of Illinois at Urbana-Champaign — Oscillatory flow is a very effective way of exploiting inertia in a typical low Re setting. Localized oscillating objects such as a volumetrically pulsating bubble have been used to efficiently induce migration of micron-scale objects in microfluidic devices. In this work, we describe a new kind of attractive inertial force that is generically present in this situation and induced by the curvature tensor of the flow field, while not relying on contrasts of density or compressibility. In the spirit of Oseen's and Saffman's formalisms, we present a simple uniformly valid expression for the force that interpolates accurately between the two limits of purely viscous (inner) and inviscid (outer) solutions. The particle dynamics is ultimately reduced to an overdamped equation of motion that is simple to use and quantitatively accurate. Extensive direct numerical simulations of the Navier-Stokes equations show excellent quantitative agreement with theory throughout the entire parameter range. Comparison is also made with experiments showcasing the predictive power of our theory and its practical relevance for object manipulation in microfluidics.

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