Mixing Efficiency of Non-chaotic Drop Oscillation on the Basis of Finite Time Lyapunov Exponent

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We study the mixing efficiency of a sessile drop oscillation on a flat surface induced by time-periodic wettability change. A full numerical simulation based on the volume of fluid method shows a distinctive frequency dependence of shape modes, which are quite well matched with the resonance frequency predicted by linear analysis. It also shows that there exists an internal net flow field during simple regular shape oscillations. The driving mechanism of the net flow field can be explained in terms of the Stokes drift, where the surface wave propagates from the contact line to the apex of drop. A massless and non-interacting particle tracing based on the net flow field shows that even regular drop oscillation dramatically enhances the mixing efficiency, which is quantified with the finite time Lyapunov exponent (FTLE). The frequency dependence of FTLE is carefully examined comparing with those of oscillation amplitudes.