

FIG. 1. A water drop (0.1 ml) forced by a slowly ramped vibration at 903 Hz: (a) unforced, (b) axisymmetric waves, (c) coupling of the axisymmetric and azimuthal waves, (d) complex pre-ejection state, (e) ejection onset, and (f) atomization.

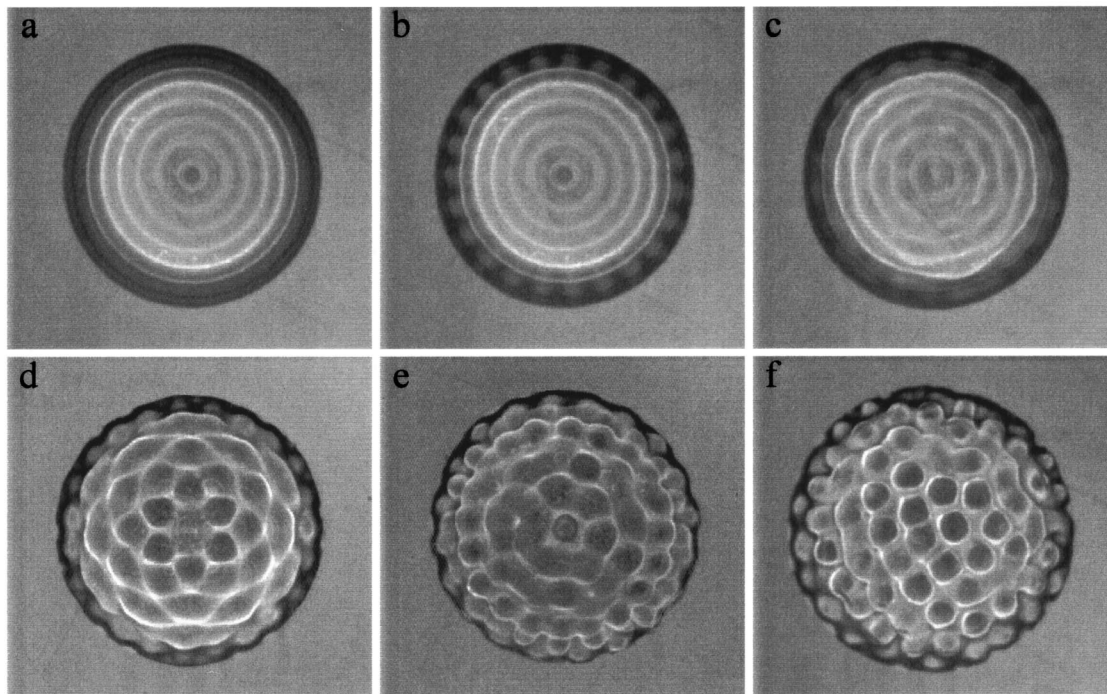


FIG. 2. The transition modes of a water drop (0.1 ml) forced at 903 Hz: (a) axisymmetric waves, (b) azimuthal waves, (c) azimuthal breakdown, (d) lattice pattern, (e) lattice breakdown, and (f) the pre-ejection mode.

Mode Shapes of a Sessile Drop in Forced Vibration

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Earlier work has shown that a sessile drop forced by a vibrating diaphragm undergoes several transitions prior to ultimate atomization.¹ The present work focuses on the evolution of waves on the drop surface (Fig. 1). At low forcing amplitudes, axisymmetric waves are induced by the motion of the contact line [Fig. 1(b)]. As the forcing amplitude is increased, an azimuthal instability appears along the contact line of the drop and couples with the existing axisymmetric

waves [Fig. 1(c)]. A further increase in the forcing amplitude results in complex free-surface waves [Fig. 1(d)] and ultimately leads to the ejection of secondary droplets [Fig. 1(e)] and atomization [Fig. 1(f)]. The free surface (and internal) motions that are associated with these transitions result in radial spreading of the drop.

A closer look at the drop free surface (Fig. 2) reveals that the forced drop undergoes three primary transitions, namely, from axisymmetric to azimuthal waves [Fig. 2(b)], then to a newly observed lattice-like pattern [Fig. 2(d)] having a six-fold symmetry, and then to a chaotic state that is the precursor to ejection and atomization [Fig. 2(f)].

¹B. Vukasinovic, A. Glezer, and M. K. Smith, "Vibration-induced droplet atomization," *Phys. Fluids* **12**, S12 (2000).