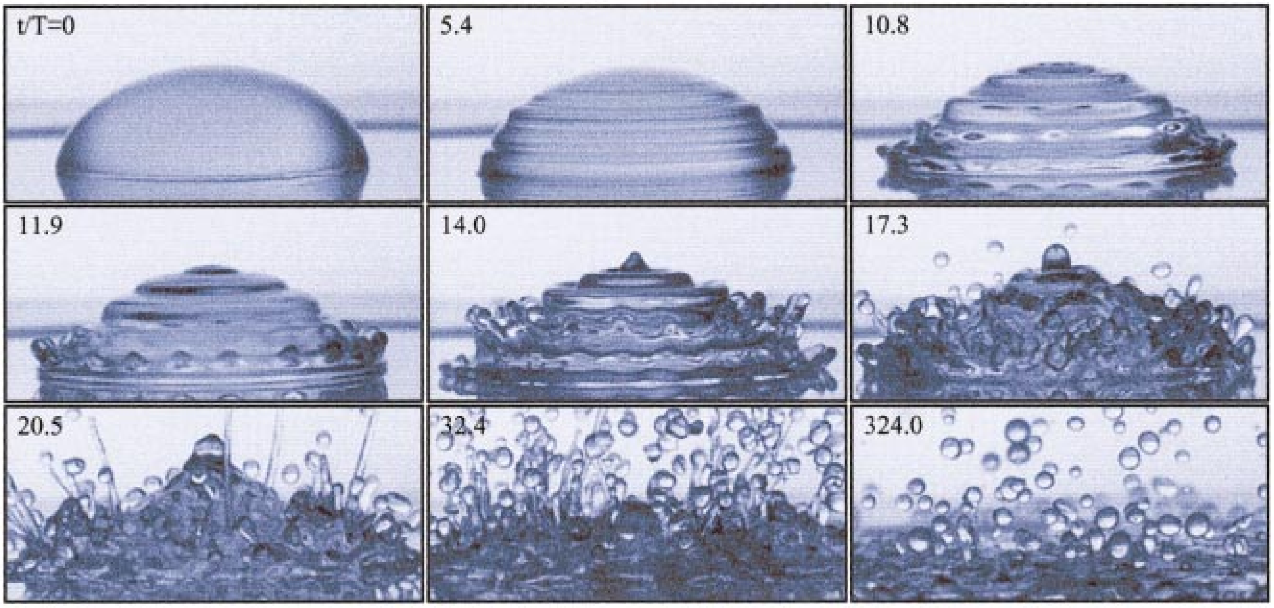

FIG. 1. Rapid atomization of a 0.1 ml water droplet forced by stepped actuation at 1080 Hz. The frame rate is 2000 fps.

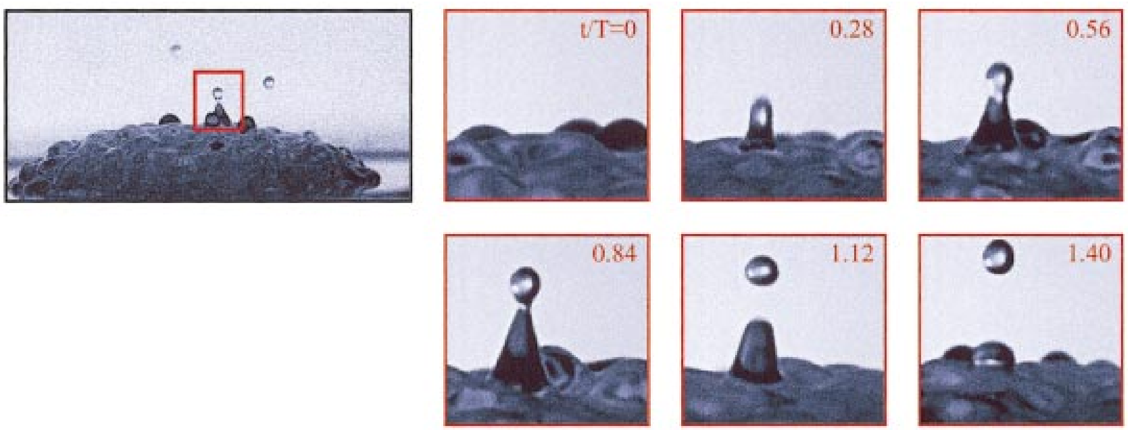

FIG. 2. A single ejection from the free surface of a 0.1 ml water droplet forced by slowly ramped actuation at 840 Hz. The sequence of zoomed-in images is recorded at 3000 fps.

Vibration-Induced Droplet Atomization

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The atomization of a liquid droplet placed on a round vibrating diaphragm is investigated experimentally. The diaphragm is driven in its fundamental axisymmetric mode at or near resonance by a smaller piezoceramic actuator disk that is bonded at the center of the diaphragm and operates in its radial (shearing) mode. Figure 1 is a sequence of high-speed video images that show a 10 mm diameter droplet being atomized within 400 ms. The droplet surface undergoes a hierarchy of instabilities that lead to the formation of surface waves and the atomization or bursting is a result of the rapid ejection of small secondary droplets from the crests of these waves. The atomization is triggered along the circumference of the primary droplet near the contact line by a strong azimuthal instability. The evolution and rate of ejection of these secondary droplets depend on the coupled dynamics of the primary droplet and the vibrating diaphragm.

A single secondary-droplet-ejection event is shown in Fig. 2. These events are apparently initiated by the interplay of the spatial modes on the highly contorted surface of the primary droplet. The vertical motion of the liquid spike is preceded and directly initiated by the collapse of a free-surface crater or depression. The secondary droplet separates from the liquid spike by a capillary pinch-off mechanism. If it has enough momentum it will then be ejected from the primary droplet.

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