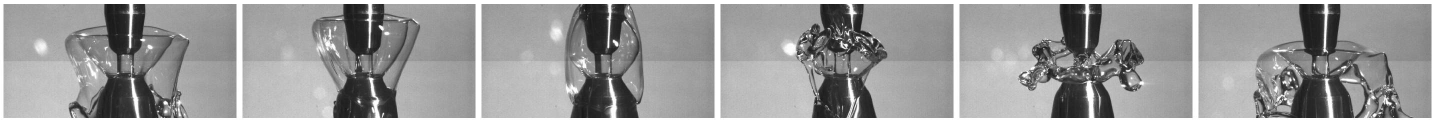

FIG 1

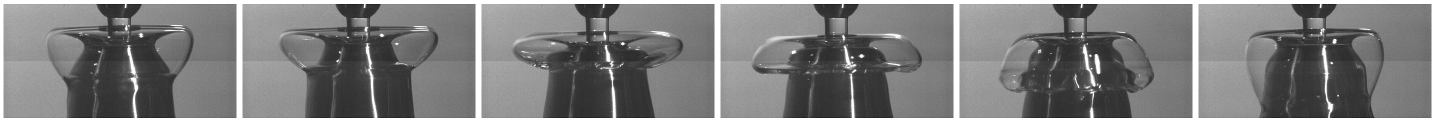

FIG 2

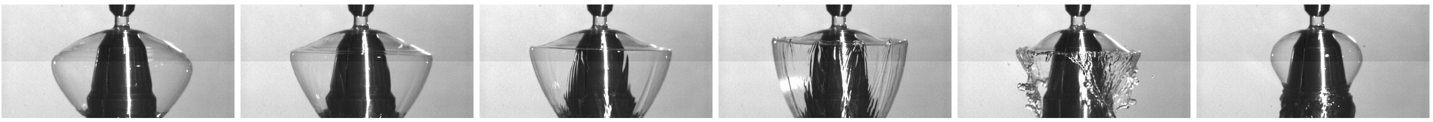

FIG 3

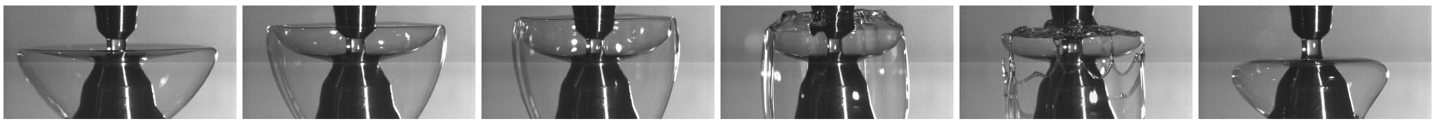

FIG 4

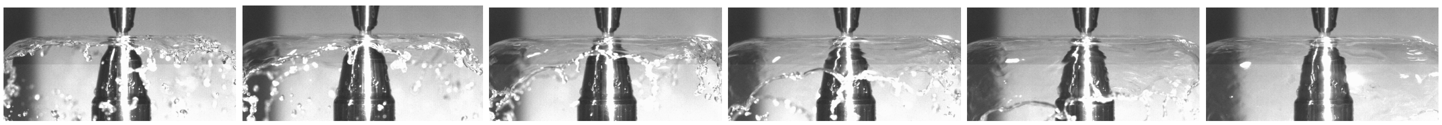

FIG 5

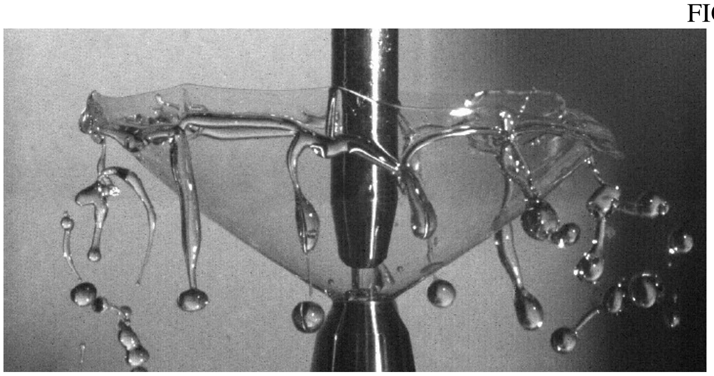

FIG 6

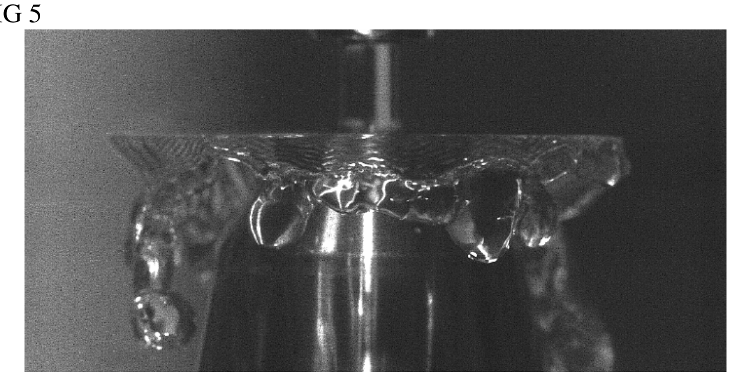

FIG 7

Water Bell and Sheet Instabilities

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We examine several instabilities that may arise when a vertically descending fluid jet impacts a solid surface. Fluid is expelled radially in a thin sheet until either closing into a bell or breaking into droplets via the Rayleigh-Plateau instability[1-3]. In our study, glycerol-water solutions with viscosities of 1-60 cS were pumped at flow rates of 10-70 cc/s through source nozzles with radii of 1-4 mm. The fluid impacted the center of a circular steel plate with a diameter of 11 mm. An adjustable lip surrounded the plate and controlled the takeoff angle.

In Figure 1, we see the evolution of a water bell generated with a large takeoff angle. The bell's volume decreases with time and thus positive perturbations in pressure are amplified. Clanet[4] derived a critical angle above which this instability occurs, causing a periodic rupture and regeneration of the bell. In Figure 2, we observe a water bell that oscillates without breaking. Its volume decreases until a critical pressure is reached at which point the bell expands to compensate accordingly. Figures 3 and 4 indicate the transient behavior brought on by a sudden decrease in flux on a steady water bell. After the bell breaks, a smaller one is formed. As was reported by Hopwood[5], a water bell may destabilize following a flux decrease and form a momentary cusp. In Figure 5, we see the influence of surfactant on the stability of a fluid sheet. The sheet first expands, and then closes into a bell.

Our investigation revealed that a range of angles exists wherein a conical sheet will possess quasi-steady cusps along its upper edge (Fig. 6). At low viscosity, both cusps and capillary waves are present (Fig. 7). Such flows are generated with steady source conditions.

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[4]Clanet C., "Dynamics and stability of water bells." *J. Fluid Mech.* **430**, 111-147 (2001).
[5]Hopwood, F.L., "Water Bells." *Proc. Phys. Soc. B*, **65**, 2 (1952).