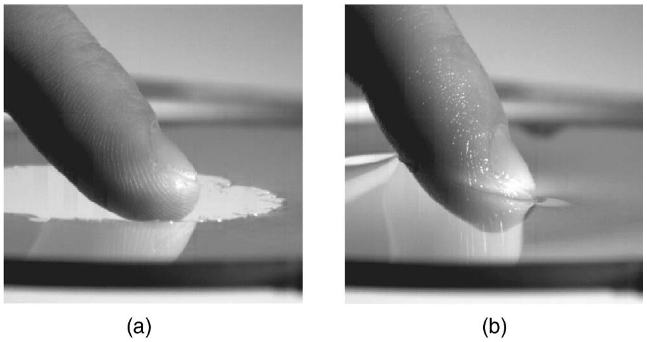

FIG. 1.

Impact, puncturing, and the self-healing of soap films

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The easiest way to puncture and break a soap film is to use your dry finger [Fig. 1(a)]; the created hole in the film then grows at a constant velocity.[1] Wetting your finger with the soap solution allows you to deform the two-dimensional liquid film significantly without breaking it [Fig. 1(b)], as is familiar to all of us from simple demonstrations in science museums.

We experimented with releasing either liquid droplets or rigid spheres, from a specific height, onto soap films. In the case of liquid droplets, when the height of the fall is small enough, the droplet deforms the soap film. The initial kinetic energy of the droplet is partially converted into potential energy of deformation of the film, which then acts like a liquid trampoline: the droplet bounces off the film [Fig. 2(a)]. When the deformation of the film is too large, the shape holding the droplet becomes unstable, and the droplet continues its journey to the ground, whereas the liquid film relaxes back to its initial state and heals itself [Fig. 2(b)]. This result may seem quite surprising if one recalls that the critical size for opening a hole in a soap film without breaking it is expected to be of the order of the thickness of the film (i.e., a few micrometers).[2] The soap film self-heals, even when a table-tennis ball passes through it (Fig. 3).

When we drop rigid spheres, bouncing is not observed, but the sphere gets entrapped in the film instead (Fig. 4). For example, we consider the motion of a sphere through a set of parallel soap films. As the sphere descends, it encounters films that act as fragile barriers, which absorb part of the initial kinetic energy and self-heal following passage of the sphere. The sphere is finally caught in the sixth film. This experiment should be useful for studying the energy absorption of foams.

[1]A. Dupré, Ann. Chem. Phys. **11**, 194 (1867).
[2]G. I. Taylor and D. H. Michael, "On making holes in a sheet of fluid," J. Fluid Mech. **58**, 625 (1973).

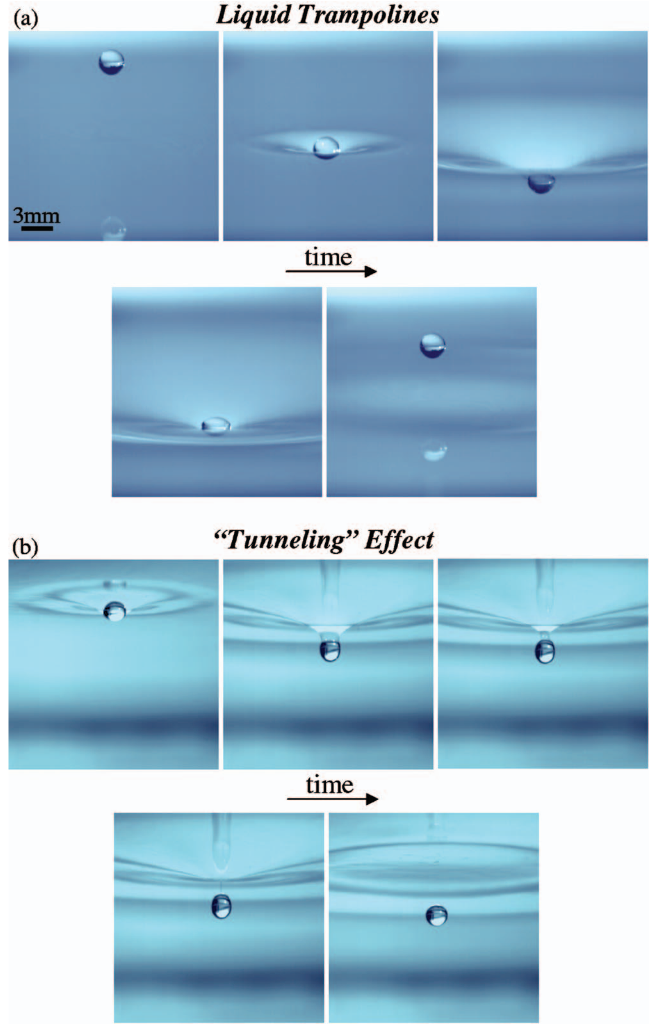

FIG. 2.

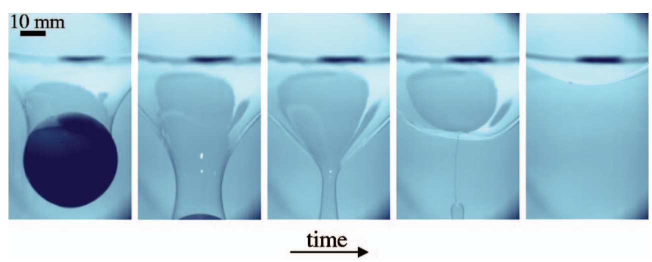

FIG. 3.

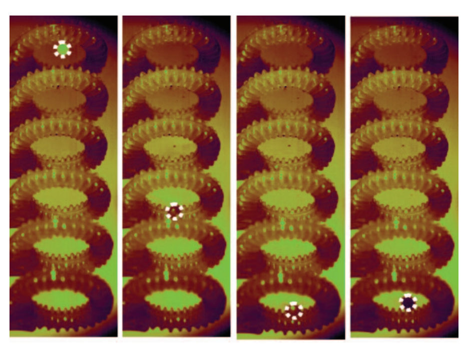

FIG. 4.

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