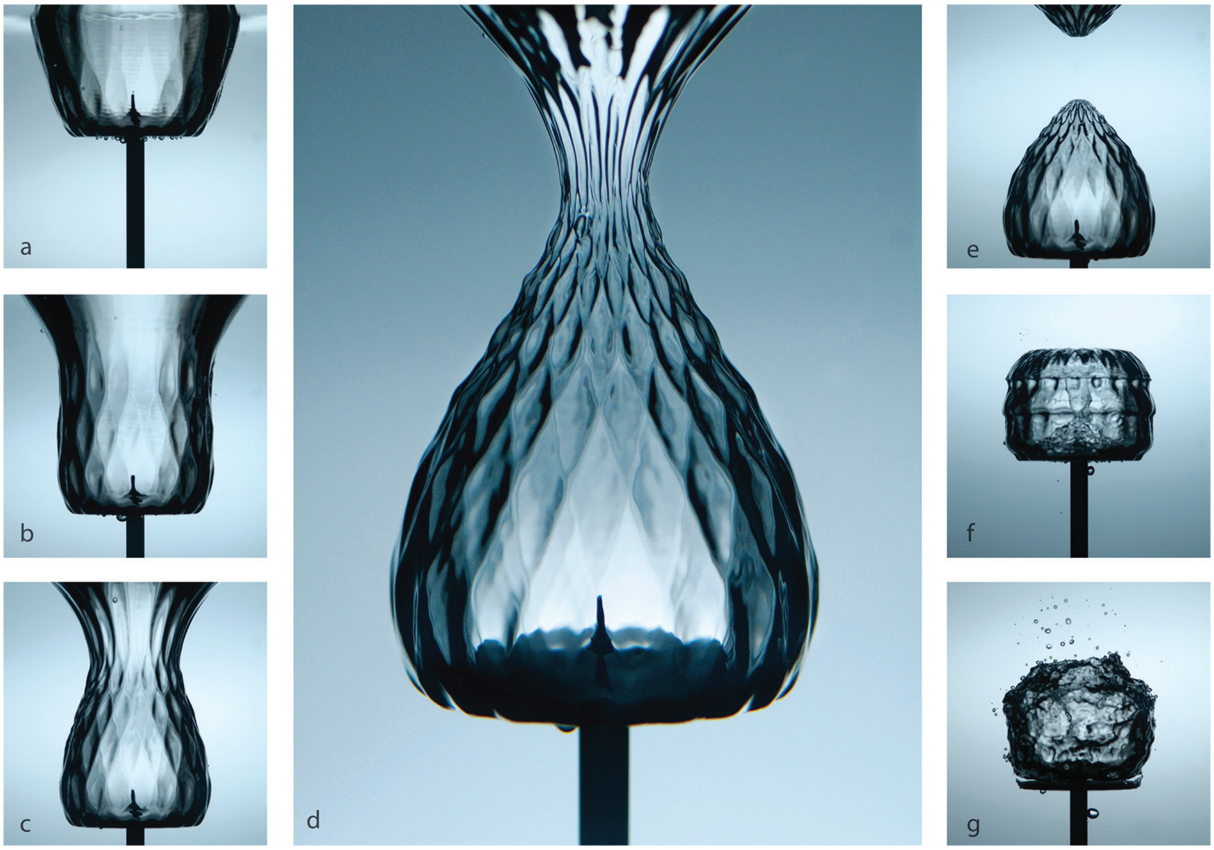


FIG. 1. (Color) Seven snapshots of a cavity created when a round disk with an $m = 20$ azimuthal disturbance (shaped like a 20-petal daisy) impacts a water surface with velocity $v = 1$ m/s. Clearly, the 2% initial disturbance is retained until the very end, and is seen to oscillate several times during expansion and collapse. The diamond-shaped structure of the cavity near pinch-off (d), resembling the skin of a pineapple, reflects the history of these oscillations. (*Time after impact: a: 33 ms, b: 77 ms, c: 95 ms, d: 104 ms, e: 107 ms, f: 125 ms, g: 200 ms.)*

# Non-axisymmetric impact creates pineapple-shaped cavity

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We impact a disk on a free water surface at a controlled speed of 1 m/s. The disk is round, with a superimposed mode-20 azimuthal disturbance. The mean disk radius is 20 mm and the amplitude of the disturbance is 0.4 mm. Initially, very close to the disk, the free surface is forced to match the shape of the disk. During the void expansion and subsequent collapse, however, the interface displays rich dynamics, resulting eventually in a pineapple-shaped cavity.

If we made a cut-through of the cavity at one specific depth, we would observe an oscillating behavior of the water-air interface just like a standing wave coupled to the fast decreasing mean radius of the cavity. The amplitude of this oscillation remains constant, while the frequency diverges towards the pinch-off—following the prediction made by linear stability analysis of a disconnecting air bubble.[1] Since the absolute amplitude remains constant while the mean radius of the cavity goes to zero, the relative amplitude grows strongly towards the pinch-off; the disturbance thus becomes much more pronounced closer to the pinch-off (e.g., compare Fig. 1(b) with 1(c)).

Since the radial flow in this system is much larger than the axial flow, we can approximate each horizontal layer of fluid as being decoupled from the vertical direction. It is, therefore, possible to solve the system at each layer by combining the radial dynamics of an axisymmetric cavity[2] with the model for the oscillations.[1] This was done by Enríquez *et al.*,[3] resulting in an almost perfect reproduction of the full pineapple-shaped cavity.

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