FIG. 1. Vortex wakes behind a flexible loop. (a) Wake structure after the stationary loop. (b) Wake structure after the oscillating loop.

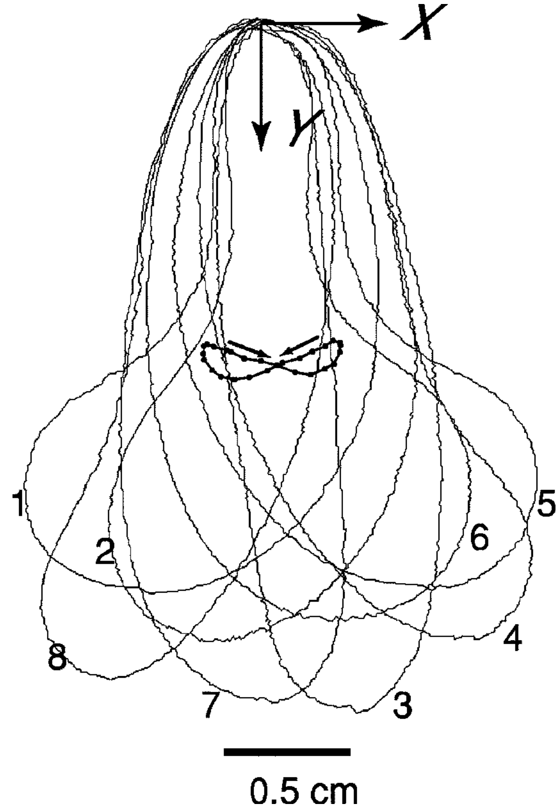

FIG. 2. Snapshots of the oscillating loop over its period. The figure eight inside shows the trajectory of the loop center of mass.

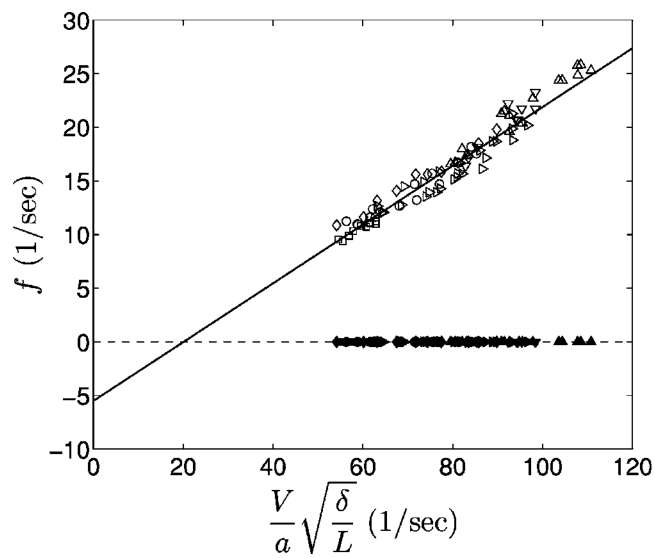

FIG. 3. The loop oscillation frequency plotted against a rescaled velocity.

The dynamics of a flexible loop in a quasi-two-dimensional flow

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A vortex street forms in the wake of a deformable body wetted into a quasi-two-dimensional soap film flow. A loop of thin rubber is supported by a solid wire that is introduced normally into the film. Flow structures are visualized using interference patterns from monochromatic illumination (low-pressure sodium lamps; $\lambda = 585$ nm). A high-speed camera records the dynamics at 1000 fps and an LDV records flow velocities.

We observe a bistability of stationary and oscillatory states of the loop over a range of flow velocities (1.5–2.5 m/s).

Figures 1(a) and 1(b) show the wake structures behind a 5 cm loop immersed in a 2.2 m/s flow. In Fig. 1(a), the loop is stationary and its wake is the classical von Kármán vortex street. Figure 1(b) shows an oscillatory state in which the loop sheds two vortex dipoles within each oscillation period, generating the so-called 2P (two pair) vortex wake. Figure 2 shows 8 snapshots of the loop, at 6 ms intervals and flow speed 2.2 m/s, over the oscillation period (52 ms). The figure also shows the path taken by the centroid of the loop.

By using several loops of different length, we find a linear relationship between the frequency of the oscillating loop (f) and a rescaled velocity (Fig. 3), where δ is the film thickness, a is the cross-sectional diameter of the loop, and L is the loop circumference.

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