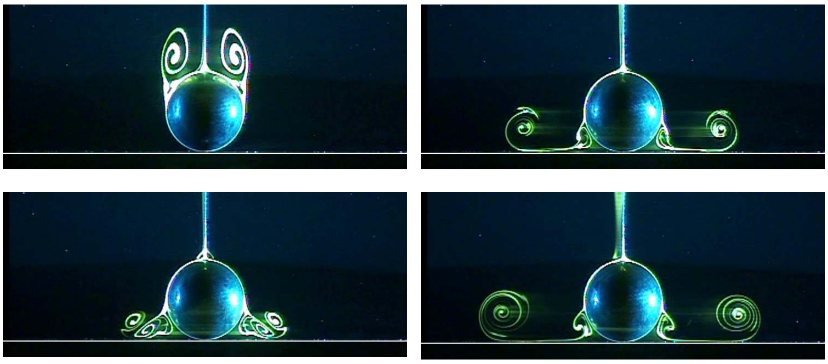

FIG. 1

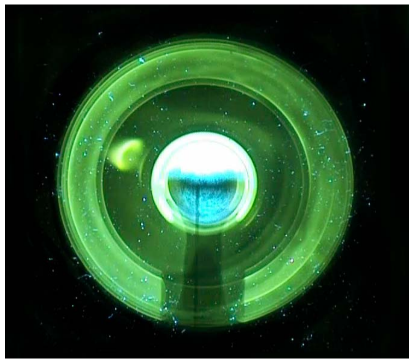

FIG. 2

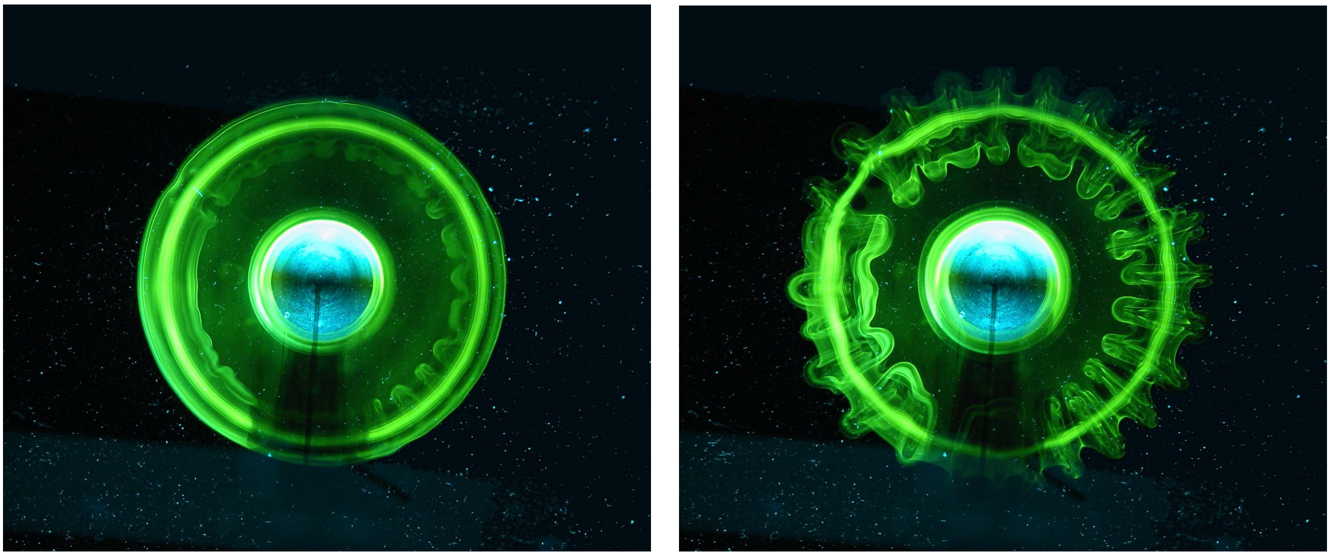

FIG. 3

Touchdown of a Sphere

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We show visualizations of the flow generated by the impact of a sphere onto a solid surface. The experiments were carried out in a water tank with a Plexiglas bottom, using a bronze sphere of diameter $D = 3/4$” attached to an inelastic string, whose vertical motion was imposed by a stepper motor. Visualization was achieved using fluorescent dye and laser light. The sphere was impulsively started from rest at a distance of $5D$ from the bottom surface. It moved downward with constant speed U until it hit the surface, where its motion was stopped. The main parameter characterizing this flow is the Reynolds number $Re = UD/\nu$ (ν: kinematic viscosity).

The sequence of images in Fig. 1 shows the flow structure for $Re = 800$, seen in a side view. Time t is counted from the impact, and the images correspond to $tU/D = 0$, 2, 5, and 20. Just before impact, an axisymmetric vortex ring is seen in wake of the sphere. For $t > 0$, this wake vortex continues its downward motion; it threads over the surface of the sphere, generating vorticity of the opposite sign, which rolls up into a secondary vortex ring. The wake vortex ring then encounters the surface and spreads out under the influence of its image, whereas the secondary ring is crushed between the surface and the wake vortex. The bottom view at $tU/D = 20$ in Fig. 2 shows that, during the entire sequence, the flow has remained perfectly axisymmetric. By this time, the fluid motion is very weak.

The two photographs in Fig. 3 show bottom views of the flow for $Re = 1500$, at $tU/D = 4.5$ and 9.0. At this higher Reynolds number the axisymmetric flow becomes unstable. The visualizations show that the initial perturbations do not appear on the main wake vortex, but on the secondary vortex ring which is periodically deformed with an azimuthal wave number $m = 24$. These perturbations then wrap around the main vortex leading to its deformation.