Droplets that Roll Uphill

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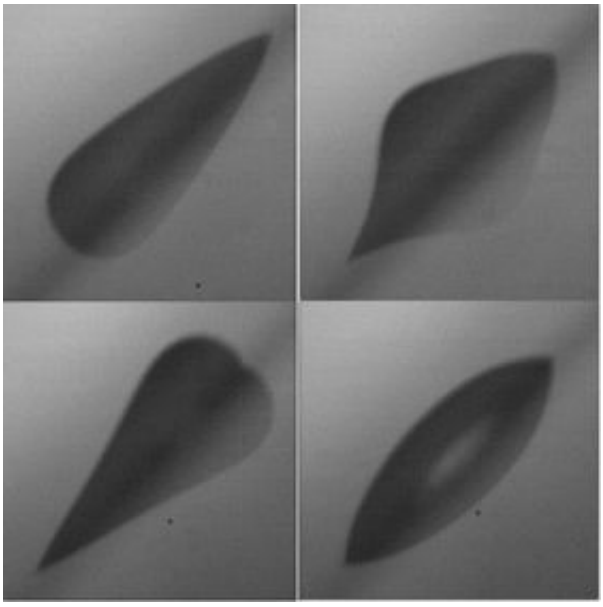

Droplets of a glycerol-water mixture defy gravity to climb up hill, provided the surface under them is shaken in the right way. The discovery may lead to new methods to manipulate microscopic amounts of fluids. Credit: P. Brunet, J. Eggers, and R.D. Deegan

A recent experiment conducted by physicists at University of Bristol in the United Kingdom has shown that liquid drops can defy gravity. Droplets of liquid on an inclined plate that is shaken up and down can travel uphill rather than sliding down. In fact, if the plate vibrates at the right rate, the droplets will always travel counter-intuitively up the incline.

The reason has to do with pushing and pulling. As the plate rises, it pushes the droplet upward, and as it falls, it pulls the droplet down. Inertia would have the droplet slide down as the plate moved upward. Similarly, the droplet would climb up the incline as the plate drops, resisting the rapid downward acceleration.

However, the forces that hold the droplet to the plate are stronger as the plate rises. During the time that the droplet would be moving downhill, it is stuck more firmly to the plate. Therefore, the droplet gains more ground moving up the incline as the plate falls than it loses as the plate rises. Overall, the droplets travel uphill.

If the vibration doesn't apply enough force to the droplet, it will just sit still on the inclined plate. As the force increases, the droplet will begin to slide. Increasing the forces further, the droplet sits still again. Turn up the force on the droplet a little more, and it starts to climb.

Since the droplet must withstand a fair amount of force, alternately pushing and pulling, the fluid has to be somewhat thick or viscous. Pure water droplets will break apart before the forces are strong enough to cause them to climb. On the other end, the drops move very slowly if the fluid is too thick. Nevertheless, this method for moving droplets using vibrations may prove useful in the manipulation of microscopic fluids.

Citation: P. Brunet, J. Eggers, and R.D. Deegan, *Physical Review Letters*, forthcoming article

Source: American Physical Society