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Falling drops skating on a film of air

SHMUEL RUBINSTEIN, Dept. of Physics of Complex Systems, Weizmann Institute of Science

When a raindrop hits a window, the surface immediately becomes wet as the water spreads. Indeed, this common observation of a drop impacting a surface is ubiquitous in our everyday experience. I will show that the impact of a drop on a surface is a much richer, more complex phenomenon than our simple experience may suggests: To completely wet the surface the drop must first expel all the air beneath it; however, this does not happened instantaneously. Instead, a very thin film of air, only a few tens of nanometers thick, remains trapped between the falling drop and the surface as the fluid spreads. The thin film of air serves to lubricate the drop enabling the fluid to skate laterally outward at strikingly high velocities. Simultaneously, the wetting fluid spreads inward at a much slower velocity, trapping a bubble of air within the drop. However, these events occur at diminutive length scales and fleeting time scales; therefore, to visualize them we develop new imaging modalities that are sensitive to the behavior right at the surface and that have time resolution superior to even the very fastest cameras. These imaging techniques reveal that the ultimate wetting of the surface occurs through a completely new mechanism, the breakup of the thin film of air through a spinodal like dewetting process that breaks the cylindrical symmetry of the impact and drives an anomalously rapid spreading of a wetting front. These results are in accord with recent theoretical predictions and challenge the prevailing paradigm in which contact between the liquid and solid occurs immediately, and spreading is dominated by the dynamics of a single contact line.