Skating on a Thin Film of Air: Drops Impacting on a Surface

John Kolinski
Harvard University

Drops impacting on a surface are ubiquitous in our everyday experience. This impact is understood within a commonly accepted hydrodynamic picture: it is initiated by a rapid shock and a subsequent ejection of a sheet leading to beautiful splashing patterns. However, this picture ignores the essential role of the air that is trapped between the impacting drop and the surface. Here we describe a new imaging modality that is sensitive to the behaviour right at the surface. We show that a very thin film of air, only a few tens of nanometers thick, remains trapped between the falling drop and the surface as the drop spreads. The thin film of air serves to lubricate the drop enabling the fluid to skate on the air film laterally outward at surprisingly high velocities, consistent with theoretical predictions. Eventually this thin film of air must break down as the fluid wets the surface. We suggest that this occurs in a spinodal-like fashion, and causes a very rapid spreading of a wetting front outwards; simultaneously the wetting fluid spreads inward much more slowly, trapping a bubble of air within the drop. Our results show that the dynamics of impacting drops are much more complex than previously thought and exhibit a rich array of unexpected phenomena that require rethinking classical paradigms.