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An experimental study of the crater evolution by impact of a drop onto a fluctuating shallow pool

N. P. van Hinsberg*, I. V. Roisman and C. Tropea
Chair of Fluid Mechanics and Aerodynamics
Technische Universität Darmstadt
64287 Darmstadt, Germany

Abstract

Splashing of drops on liquid layers is encountered frequently in nature, agriculture, and has also a great relevance in many technical applications. Many coatings of solid substrates, however, are achieved by means of sprays, for example spray painting. In this context, the impact of a single drop onto a smooth and horizontal solid surface has often been used as the simplest system simulating the spraying process. However, sprays impacting onto a substrate create on it a thin, moving and fluctuating film. To build a bridge between single drop impacts onto a film and spray impact onto a moving liquid film, a single drop impacting onto an oscillating film is investigated.

The specific objective of the present study is to understand the phenomena occurring during impact of a single drop onto a shallow, oscillating film of the same liquid, by changing various input parameters, like the liquid properties, the film depth, the drop impact velocity and the film oscillation frequency and amplitude. A particular aspect of interest is the evolution of a cavity formed after impact, primarily the expansion and the contraction phases as well as the typical time to reach maximum cavity diameter and cavity depth.

The results of these experiments are compared to the measurements of a drop impact onto a steady film, under the same conditions. This comparison reveals whether the oscillating film has any influence on the cavity formed after impact.

The results show that for all liquids, film heights and Weber numbers, the cavity penetrates the liquid film with constant velocity and reaches the bottom of the film faster when the film is oscillating. When the drop impacts onto the bottom or the top of a surface wave, almost no differences are found with respect to the results for a steady, non-moving film, i.e. the crater evolves in a symmetrical way. In case of a drop impact onto an inclined, receding or advancing wave, the growth and receding phase of the cavity in radial direction are either slower or faster, resulting in a lower or higher maximum diameter respectively, compared to the impact onto a steady film. Furthermore, the cavity evolves in an asymmetric way, resulting in a sharply inclined jet after cavity collapse.

Key words: single drop impact, oscillating film, cavity shape

*nvanhinsberg@sla.tu-darmstadt.de