Challenges in Study of Drop Impact onto Thin Immiscible Films

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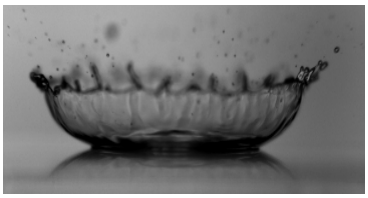
The process of drop impact onto a surface is ubiquitous in nature and industrial applications. In many instances, surfaces are covered with a thin liquid film. However, unlike drop impact onto dry surfaces, drop impact onto film covered surfaces are studied less, and even less so when the droplet and film liquids are immiscible, e.g. during the spray cooling or coating process, the target surface can be oil contaminated. When the liquid film is thick, the film is typically stable (does not rupture) during the impact process. However, this may not be always true, when the film is very thin (drop radius to film thickness ratio: $H^* << 0.1$). In this talk the results of our experimental study to understand the behaviour of the water drop impact onto a solid surface covered by an ultra-thin layer of oil will be discussed (see Fig.). Particular emphasis will be put on understanding the receding phase and answering the following two questions. First, weather the substrate wettability can affect the behaviour of the drop during the impact process? And second, how do the film thickness, viscosity and the drop impact Weber number affect the rebound behaviour? The observed (indirectly) encapsulation of droplet during impact process is also another intriguing observation that will be discussed in this talk. One of the important challenges in such study is to understand the dynamics of the fluid in the thin film and dissipation of energy. Our preliminary numerical efforts show how one fails with naive approaches to model this complex system. As such, there is a need for development of sophisticated numerical methods for understanding of the fluid behaviour in the film as well as film encapsulation.



Water Drop impact onto a thin oil film (top 5 cS; middle 20 cSt; bottom 100 cSt)