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Simulation of Multi-Fluid System: Understanding Drop Impact

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Multi-fluid systems play an important role in many natural and industrial processes such as rising bubbles in bubble column reactors, boiling, ink jet printing, painting, biological systems, rain drop impact phenomenon etc to mention few. Albeit the existence of a number of experimental, theoretical analysis and numerical studies on multiphase flows, a full understanding of the behavior of multi-fluid system is still lacking. Various numerical techniques, such as the volume of fluid method (VOF), level set method (LS), coupled level set and volume of fluid method (CLSVOF), front tracking method (FT) etc. are deployed to solve these multi-fluid systems. We have used the CLSVOF method to investigate the partial coalescence phenomena during drop impact on liquid-liquid interface.

Our study deals with the understanding of drop dynamics during partial coalescence. When a drop of liquid 1 falls through liquid 2 to eventually hit the liquid 2-liquid 1 interface, its initial impact on the interface can produce daughter droplets of liquid 1. In some cases, a partial coalescence cascade governed by self-similar capillary-inertial dynamics is observed, where the fall of the secondary droplets in turn continues to produce further daughter droplets. Whenever the horizontal momentum in the liquid column, formed due impact of primary drop, is more than the vertical momentum, secondary drop is formed. A transition regime from partial to complete coalescence is defined based on oscillation of the neck radius.

The transition between coalescence and splashing proceeds via a number of intermediate steps, such as thick and thin jet formation and gas-bubble entrapment. We perform simulations to determine the conditions under which bubble entrapment and jet formation occur.