Theory of Head-on Droplet Collision:

Bouncing, Coalescence and Interface Evolution

Peng Zhang

Department of Mechanical and Aerospace Engineering

Princeton University, Princeton, New Jersey 08544

Droplet collision, coalescence, and bouncing are frequent events in dense sprays. A comprehensive theory was formulated to describe the dynamics of these processes for the head-on collision of two identical droplets. Specific interest was placed on predicting the coalescence and bouncing responses, including descriptions of the droplet deformation, the viscous loss through droplet internal motion, the dynamics and rarefied nature of the gas film between the colliding droplets, and the destruction and thereby merging of the colliding interfaces due to the van der Waals attractive force. The theoretical results agree well with previous experimental observations. Specifically, it is theoretically confirmed that as the impact inertial increases, collision of alkane droplets at one atmospheric pressure results in merging, bouncing and merging again, with the predicted merging Weber numbers agree well with the experimental data. Furthermore, the effects of ambient pressure and the rheological properties of the liquid were investigated. It is shown that while bouncing is absent for water droplets at atmospheric pressure, it occurs at higher pressures. Similarly, while bouncing is observed for alkane droplets at atmospheric pressure, it is absent at lower pressures.