

Ranging from rain droplets falling in a thunderstorm, to the generation of droplets in crop spraying, to the production of personalized medicine via inkjet printing, the creation of droplets in a reliable controllable manner has become an increasingly useful ability in the modern world. In all of these processes droplets often form from the breakup of jets of fluid times emanating from a nozzle and depending on the process it can be desirable to form a monodisperse distribution of droplets of a specific size or be able to predict and limit the range of the drop size distribution. In crop spraying the creation of small droplets, satellite drops, can allow these droplets to be carried away on the wind spreading contamination and in pharmaceutical applications these small droplets can result in the loss of the active ingredient and deliver imprecise dosages. In order to predict and help eliminate satellite drop formation simulations are used to model the drop formation process for an arbitrary number of droplets including satellite drops where the creation and subsequent evolution may be tracked. In instances where satellite drops may be unavoidable a parametric study is done on their stability establishing regimes when sub-satellite drops may form where the effects of viscoelasticity are also briefly considered.

In addition to studying the process of drop breakup, one must also consider the dynamics involved when two droplets meet and coalesce into a single entity which may occur in drop emulsions or sprays altering the size distribution of drops. While the study of drop breakup is well studied and the physics well established, drop coalescence is a much younger field with conflicting results from theory, experiments and simulations. Simulations are used to reconcile the findings to date in research for both the limiting cases of coalescing droplets in air and coalescing bubbles in a fluid where experiments and theory have contradictory findings. Built upon this basis an extension to viscous drops coalescing in a viscous fluid is explored, which can be found at the heart of emulsion systems being used in many industries including cosmetics, food, and pharmaceutical. Current theory is validated for the case of highly viscous emulsion systems and simulations are generalized to the coalesce of drops in a secondary fluid of non zero inertia where a new regime in coalescence dynamics is discovered.