Computational Droplet Dynamics

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Droplet dynamics plays a significant role in a large range of industrial and natural processes. The impact of rain drops on soil is an important part of the process of soil erosion with consequences for agriculture as well as irrigation. Many industrial processes rely on the use of sprays, e.g. in painting or spray cooling. There is a need for a better understanding of the process of droplet impact, break-up and coalescence. The mathematical and numerical modelling of the multi-fluid Navier-Stokes equations provides one approach to further study the range of fluid dynamical phenomena associated with multi-fluid flows.

The multi-fluid process does not involve heat transfer or phase change but rather the complex interaction of multiple immiscible fluid dynamical interfaces. Currently, there exist a range of methods for the modelling of multiply interacting interfaces in processes such as droplet impact on solid/liquid surfaces or droplet break-up. The older multi-field approaches emphasised an averaging approach to treat various engineering processes such as bubbly flows in pipes but were not able to study these processes in any detail. More recently Eulerian, Lagrangian and Eulerian-Lagrangian methods which track the propagation of individual fluid interfaces have become possible. Typically, these methods concentrated on a one-fluid approach rather treating two or more separate fluids as in the older approaches.

In the one-fluid approach, two or more fluids, as well as their mutual interfaces, are treated as a single fluid with discontinuously varying material properties across the fluid-fluid interfaces. The interface itself is “tracked” in various ways including advecting a marker function which locates the interface implicitly, so-called volume tracking: e.g. early volume of fluid and marker-and-cell methods; or explicitly, also called surface tracking: e.g. level-sets and front tracking.

This seminar will discuss one of these approaches, the marker-particle method, a combination of Eulerian field and Lagrangian particle tracking which allows the tracking of embedded fluid interfaces without some of the inherent weaknesses of the other techniques. It examines in some detail why the method works as well as its strengths and weaknesses and some of the research that still needs to be done to resolve the associated difficulties involved in the embedding of Lagrangian markers within an Eulerian grid.