IITB-Monash Research Academy

An Indian-Australian research partnership

Project title: *Computer simulations of surface impact and breakup of drops of dilute polymer solutions*

Project number: IMURA0066

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Research Academy theme: *Advanced computational engineering, simulation and manufacture*

The research problem

Liquid drops splattering after striking a surface is a common, everyday experience that is nevertheless of considerable importance in applications such as inkjet printing, agricultural spraying, etc. In many situations, it is necessary to reduce or eliminate splattering, and this is often achieved by adding small amounts of polymeric additives. However, we do not understand this ability of polymers to reduce splatter well enough to be able to "design" fluids with just the right amount of stickiness. Computer simulations of the process of drop impact and splattering have been hampered by the lack of an efficient numerical method that can simultaneously handle all the complexities of gravity, surface tension, fluid flow, surface wettability, *and* polymer elasticity.

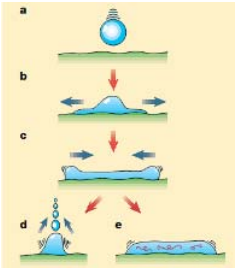

Fig.: The process of drop impact: (a–c) The drop flattens after striking a surface, and after reaching a maximum radius, begins to retract. (d) In drops of pure water, the retraction is fast enough to result in ejection of satellite drops, leading to wastage. (e) Adding very small amounts of polymer can completely eliminate retraction and breakup (image from Klein, *Nature*, 405, 6788:745, 2000).

Project aims

Our central goals are to firstly devise and test a new numerical technique that will be suitable for complex free-surface problems involving breakup of the polymeric viscoelastic liquids into droplets, and then apply this technique to develop a detailed predictive understanding of drop impact.

Expected outcomes

The numerical technique proposed is a hybrid method combining the "Lattice Boltzmann" (LB) technique for simulations of Newtonian fluids with the recent Brownian Configuration Fields (BCF) method for handling polymer solutions. Such a technique will be of considerable value in a range of other problems involving complex flows of polymer solutions. This Project will also explore for the first time, and in considerable detail, the effect of polymer viscoelasticity on drop impact and breakup. The sophisticated models used to describe the polymer's contribution to fluid stresses will allow us to study the influence of intrapolymer hydrodynamic interactions, and other interesting behaviour such as "coil-stretch hysteresis", in a complex, real-world application.

This Project is an ideal stepping-stone for a rewarding academic or industrial career in advanced computer simulations, and will provide in-depth training in numerical methods, modern simulation techniques, fluid mechanics, polymer physics and statistical mechanics.