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MULTIPHASE FLOWS WITH SURFACE TENSION AND CAPILLARITY

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ABSTRACT

Surface tension acts at the interface of two immiscible fluids, leading to the minimization of the contact area. This quantity is therefore of primary importance in a wide range of phenomena determining, for example, the shape, breakdown or coalescence of droplets or bubbles. Consequently, it is a crucial parameter for understanding, modelling and simulating the behaviour of a droplet on a solid surface, or a liquid against a wall, that play an important role in many natural or industrial processes.

Computationally, surface tension and capillarity present several challenges. Simulations must be stable, efficient, and accurate, avoiding parasitic currents and excessively constrained time steps. Additionnaly, an accurate coupling between fluid/solid mechanics problems and interface geometry is essential.

Fulfilling these criteria requires making several choices when elaborating the numerical strategy. First, different numerical strategies are available to describe moving (fluid-fluid or fluid-solid) interfaces, such as the Level-Set, Phase-Field, or Volume-Of-Fluid methods. However, the surface tension term depends on curvature, *i.e.* on second-order derivatives of the surface parametrization. Second, surface tension term is specified on a manifold of dimension 1 or 2 embedded into an ambiant space. This can be treated by transforming the surface term into a volume term via a smoothed Dirac delta function or by reconstructing the interface locally. Finally, at the interface, differences in materials properties, create discontinuities in the pressure gradient, while the pressure is discontinuous due to the curvature. Various strategies can address these discontinuities, including smoothing material properties, refining quadrature rules, adapting the mesh, or enriching approximation spaces (e.g., E-FEM, X-FEM).

This session will review recent advancements in computational mechanics for simulating flows involving surface tension. The mentioned points are not exhaustive, and contributions on related topics are welcome. Additionally, introducing a third phase, such as a solid substrate, adds complexity through capillarity and wetting phenomena at the triple junction.

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