Direct Numerical Simulation of Bubbles with Adaptive Mesh Refinement with Distributed Algorithms

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This talk presents the implementation of the simulation of two-phase flows in conditions of water-cooled nuclear reactors, at the scale of individual bubbles. To achieve that, we study several models for Thermal-Hydraulic flows and we focus on a technique for the capture of the thin interface between liquid and vapour phases. We thus review some possible techniques for Adaptive Mesh Refinement (AMR) and provide algorithmic and computational tools adapted to patch-based AMR, which aim is to locally improve the precision in regions of interest. More precisely, we introduce a patch-covering algorithm designed with balanced parallel computing in mind. This approach lets us finely capture changes located at the interface, as we show for advection test cases as well as for models with hyperbolic-elliptic coupling. The computations we present also include the simulation of the incompressible Navier-Stokes system, which models the shape changes of the interface between two non-miscible fluids. We highlight two canonical test cases: the (one-phase) lid-driven cavity as well as the Rayleigh-Taylor instability.