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# Multiscale cut-cell closures for hybrid computational architectures

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**Abstract**—Cut-cell methods [1]-[4] solve partial differential equations in domains with complex geometry by "cuts" within the cells of a background Cartesian mesh. The method has been successfully applied to Euler flow [1], [2], shallow-water flow [4], and extended to include effects from moving boundaries.

A persistent difficulty in cut-cell methods is the formation of small-volume cuts that severely limit allowable CFL number in explicit computations or lead to increased stiffness in implicit systems. Furthermore, there is significant interest in including additional physical effects at an interface as in the case of multiphase flow. This talk presents an approach that solves both the above problems by a multiscale approach suited to current developments in computer architecture. The base cut-cell method is solved on central processing units (CPUs). Fluxes and boundary conditions on cut cells are determined by a kinetic models running concurrently on graphics processing units (GPUs) or alternative vectorized co-processors. The kinetic models considered are lattice Boltzmann methods for Newtonian fluids and lattice Fokker-Planck methods for non-Newtonian methods. The concurrent kinetic models solved on GPUs envelop the regular Cartesian cells within the computational zone with a buffer zone of cut-cells. The overall computation proceeds at the CFL number set by stability considerations on the background Cartesian mesh.

## References

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