# A Cartesian Discontinuous Galerkin Solver with Immersed Boundaries

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The discontinuous Galerkin (DG) method has received considerable attention in research community for its high convergence order/accuracy, its computational efficiency and its conservation properties. While DG is traditionally used on body-fitted meshes, its combination with Cartesian mesh and immersed boundaries is appealing for simulating fluid related problems with a priori unknown, complex or moving boundaries. On one hand, the method allows to achieve the high accuracy required to properly resolve solution features around complex geometries. On the other hand, the inherent efficiency of the method, which stems from its locality, can be highly optimized; the use of Cartesian meshes allows for significant computational efficiency gains both at the level of the variational form and the computation of the cut elements.

Among the many methods developed since the seminal work of Peskin, the cut-cell approach modifies locally the discretization scheme to account for immersed boundaries. Using a level-set function to capture the geometry on the Cartesian background mesh, the main challenge remains in developing accurate but efficient integration algorithms for implicitly cut elements and boundaries. Another difficulty deals with the treatment of slender elements resulting from cuts, requiring cell-agglomeration strategies (B. Müller, S. Krämer-Eis, F. Kummer and M. Oberlack, “A high-order discontinuous Galerkin method for compressible flows with immersed boundaries”, in *Int. J. Numer. Meth. Engng.*, vol. 110, pp. 3-30, 2017) to conserve the method’s stability.

This work will first present the implementation optimization of DG on Cartesian meshes and then, a cut-cell approach using high-order quadrature rules on implicitly cut elements created using Algoim library (R.I. Saye, “High-order quadrature methods for implicitly defined surfaces and volumes in hyperrectangles, in *SIAM Journal on Scientific Computing*, vol. 37(2), pp. A993-A1019, 2015). The immersed boundary approach will at last be compared to body-fitted computations on selected fluid dynamics problems.