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ACCURATE DISCRETIZATION OF DIFFUSION IN THE LS-STAG CUT-CELL METHOD USING DIAMOND CELL TECHNIQUES

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The LS-STAG method [2] is a Cartesian method for incompressible flow computations in irregular geometries which aims at discretizing accurately the flow equations in the cut-cells, *i.e.* cells of complex polyhedral shape formed by the intersection of the Cartesian mesh with the immersed boundary. The LS-STAG method has recently been extend to heat transfer computations in 2D and 3D extruded geometries. An issue encountered in 2D heat transfer is related to the discretization of heat diffusion in the cut-cells. In effect, due to the non-orthogonality of the cut-cells, the use of 2-point formulas for computing cell-face fluxes proves to be inaccurate.

A way to improve the accuracy is to compute the whole temperature gradient at the cut-cell faces, thus decomposing the flux as an orthogonal contribution (using a standard 2-point formula) and non-orthogonal correction (using data at cell vertices). The temperature at cut-cell vertices are then interpolated from cell-centered data and boundary conditions. This gradient reconstruction technique is commonly denominated “secondary gradients" [5] in the CFD community and “diamond cell method" [3] in the applied mathematics community.

The diamond cell method is first implemented in the LS-STAG code for 2D heat transfer problems using various interpolation schemes (inverse distance weighting, least-squares, Delaunay triangulation). The accuracy of the discretization is firmly assessed on a series of benchmark problems (Taylor-Couette flow, natural convection from a cylinder in an enclosure [4]) by inspecting the formal order of accuracy and the heat flux distribution at the immersed boundary.

Finally, the diamond cell technique is employed for enhancing the accuracy of the velocity gradients in 3D extruded geometries. Comparison with body-fitted CFD codes will be provided in terms of accuracy and computer resources (wall time, memory usage) for benchmark flows past circular cylinder [1].

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