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Staggered finite volumes methods on general meshes

mardi 24 octobre 2023 16:00 (30 minutes)

We consider the discretization of incompressible Navier-Stokes equations. It is well known that staggered discretizations such as the MAC scheme are robust in practice [1]. In particular, they mitigate efficiently potential spurious modes that are commonly encountered with collocated meshes. However, such discretizations are restricted to Cartesian meshes which are rather limited in practice.

PolyMAC schemes were developed at the CEA in order to generalize MAC schemes to general polyhedral meshes. Up to now, three versions were developed [2]. In this talk, we will first describe how all three discretizations are built and which difficulties each of them meets. Then, we present a benchmark of problems inspired by the conferences FVCA [3] to compare the three PolyMAC versions.

The last panel of our presentation will be dedicated to the resolution of the linear systems resulting from the discretizations. Those systems which often present a complicated structure are challenging to solve by classical iterative solvers and can prove a bottleneck for the numerical simulation as a whole. We present a new algebraic approach to solve saddle-point systems arising from the PolyMAC discretizations and show that they are more robust that classical approaches.

[1] F.H. Harlow, J.E. Welch, Numerical Calculation of Time-Dependent Viscous Incompressible FLow of Fluid with Free Surface, The Physics of Fluids, 8, 1965.
[2] P.-L. Bacq, A. Gerschenfeld, M. Ndjinga, PolyMAC: Staggered Finite Volume Methods on General Meshes for Incompressible Navier-Stokes Problems, Finite Volume for Complex Applications X, 2023.
[3] F. Boyer, P. Omnes, Benchmark Proposal for the FVCA 8 Conference; Finite Volume Methods for the Stokes and Navier-Stokes Equations, Finite Volumes for Complex Applications VIII - Methods and Theoretical Aspects, 2017.

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