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RESEARCH FIELD
Mathematics - Numerical analysis - Simulation / Engineering science

TITLE
Staggered scheme for the Navier-Stokes equations with general meshes

ABSTRACT
Staggered scheme for the Navier-Stokes equations with general meshes

Context

The simulation of Navier-Stokes equations requires accurate and robust numerical methods taking into account diffusion operators, gradient and convection terms. Operational approaches have shown their effectiveness ([6], [8]) on simplexes. However, in some modelisations or some codes (TrioCFD [2bis], Flica5 [2ter]), it can be useful to improve locally the precision of solutions by means of an error estimator or to take into account general meshes.

Recall that we are interested here in staggered schemes. This means that the pressure is calculated at the center of the meshes and the velocities on the edges (or faces) of the mesh. Naturally accurate methods with low Mach number are obtained [5].

New schemes ([2], [3], [4]) have recently been presented in this context and have shown their robustness and accuracy. However, these discretizations can be very expensive in memory and in computation time compared to MAC schemes on regular meshes ([5], [7], [10]).

Description of the method

We are interested in the "gradient" methods described in [4]. Some of them are based on a variational formulation with unknowns of pressure at the centers of the meshes and unknowns of velocity vector on the edges (or the faces) of the cells. This approach has shown its effectiveness, particularly in terms of robustness in [1]. Note also that an algorithm with the same degrees of freedom as MAC methods has been proposed in [5] and gives promising results.

The idea would be to combine these two approaches, namely the "gradient" method with the same degrees of freedom as the MAC methods. At first, we will focus on finding MAC schemes on regular meshes. Fundamental questions must be considered in the case of general meshes: stability, consistency, conditioning of the system to be reversed, numerical locking. We can also try to improve the precision as described in [6] and [8] using the methods presented in [9] to discretize the pressure gradients.

During this thesis, we will take the time to solve the basic problems of this method (first and second year), both on the theoretical aspects and on the computer implementation. This can be done in TrioCFD or Trust development environments. We will then look at representative applications of the community ([1]).

Bibliography


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