8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

APPLICATION OF THE CHIMERA METHOD FOR THE SIMULATION OF THE FLOW AROUND A FIXED SPHERE IN A TUBE

T. Deloze, Y. Hoarau and J. Dusek

Institut de Mécanique des Fluides et des Solides de Strasbourg
UMR 7507 - Universit Louis Pasteur/ CNRS
2 rue Boussingault - 67000 STRASBOURG - France
hoarau@imfs.u-strasbg.fr

Key Words: *Chimera, overset grid, confined sphere.*

ABSTRACT

In a recent work in our groups we studied the scenario of transition to chaos of a free falling sphere under gravity. We showed a natural lateral displacement of the falling sphere. Other studies by Zeng and al [1] showed that a fixed sphere placed in a flow very closed to a wall is submitted to a ground effect. Previously Segré and Silberberg [2] showed experimentally small particules in a poiseuille flow reach an equilibrium position.
Many question remains and this study will try to answer them : what is the effect of the 6 degrees of liberty on a falling sphere in a tube? What is the influence of the boundary layers? What is the scenario of the transition to turbulence?
In this congress we would like to present the first results of this work : the implementation of a chimera methodology in the NSMB solver. The chimera overset scheme provides a simple solution for simulations of flow past complex geometries or moving geometries. This method was developped by Benek and al [3] and then many studies were done using this technique.

The chimera method consist in solving the equation on overlapping grids. The main difficulty is a communication between the overset blocks. The global conservation is very difficult to enforce because the borders of overlaped regions are arbitrarily. We use a first-order interpolation for link data from one block to another. Setting up these interpolated values on the overlapping block can be done in two ways : in the first method, called ”switch method”, the interpolated values are just imposed. In the second method, a combination of the interpolated values and the local values (coming from the resolution of the Navier-Stokes equation) is applied (Fujii [4]). These two methods have been implemented in the NSMB code which solves the Navier-Stokes equations for steady or unsteady compressible flow. This solver is a multi-block, parallel, finite volume solver based on structured grids. A large choice of time ans space discretisation as well as many turbulence models is available

We used the chimera method to simulate the flow past a 2D and a 3D cylinder as well as the flow past a sphere. We compare our results to the literature. The first results on the cylinder and on the sphere are consistent with the previous results and validate the implementation of the chimera method.

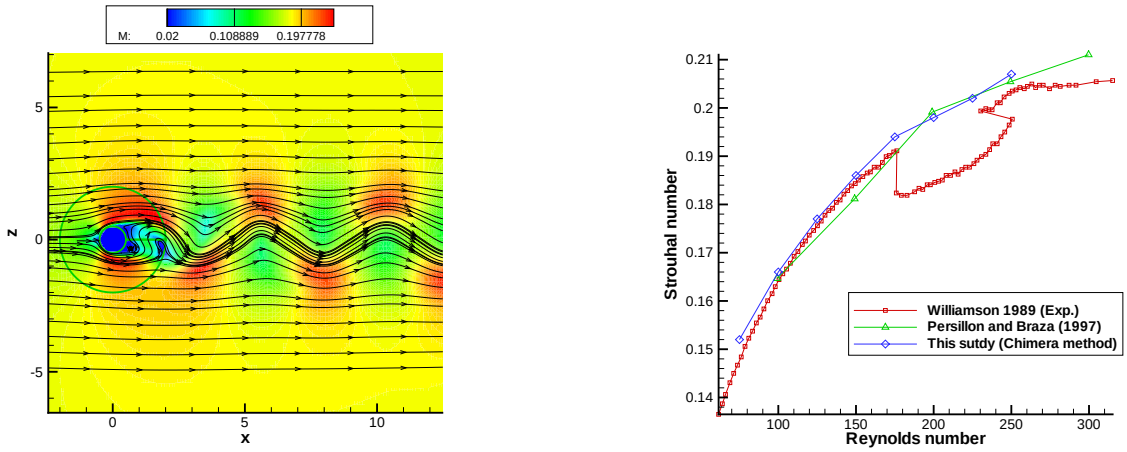

Figure 1: Isovalues of Mach number for Re=150 (left) and Strouhal number versus Reynolds number (right) for cylinder

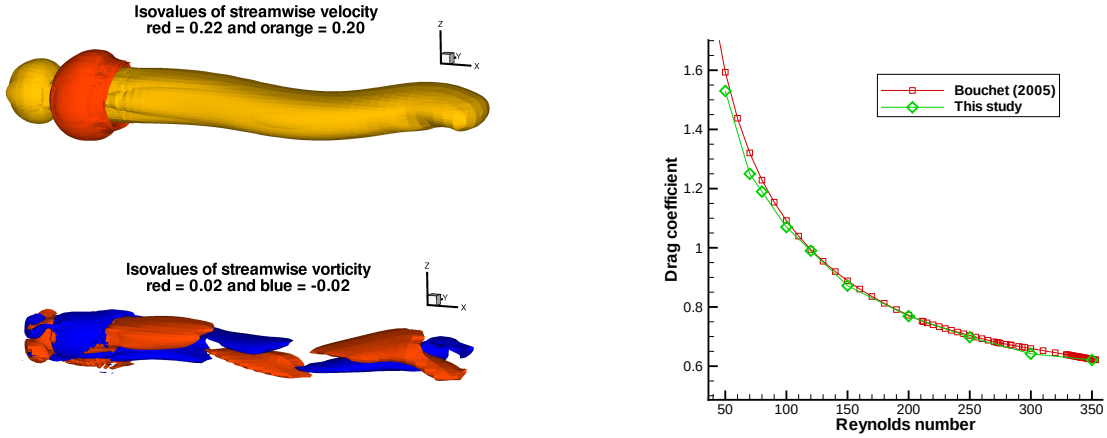

Figure 2: Isovalues of velocity (left and top) and of vorticity (left and bottom) for re=350 and drag coefficient versus Reynolds number (right) for the sphere compared to Bouchet and al [6]

REFERENCES

[1] L. Zeng, S. Balachandar and P. Fischer. "Wall-induced forces on a rigid sphere at finite Reynolds number". *J. of Fluid Mech.*, Vol. **536**, 1-25, 2005.

[2] G. Segré and A. Silberberg. "Behaviour of macroscopic rigid sphere in Poiseuille flow, Part I". *J. of Fluid Mech.*, Vol. **14**, 136-157, 1962.

[3] J.A. Benek, J.L. Steger and F.C. Dougherty. "A flexible embedding technique with application to the Euler equations". *AIAA*, Vol. **83-1944**, 1983.

[4] K. Fujii. "Unified Zonal Method on the Fortified Solution Algorithm". *J. Comput. Phys.*, Vol. **118**, 92-108, 1995.

[5] H. Persillon and M. Braza. "Physical analysis of the transition to turbulence in the wake of a circular cylinder by three-dimensional Navier-Stokes simulation". *J. Fluid. Mech.*, Vol. **365**, 23-88, 1998.

[6] G. Bouchet, M. Mebarek, J. Dusek. "Hydrodynamic forces acting on a rigid fixed sphere in early transitional regimes". *European J. of Mech.*, Vol. **25**, 321-336, 2006.