Postdoctoral position

Turbulence modelling for Lattice-Boltzmann Methods

Motivations

Unsteady simulation of turbulent flows has become a very valuable tool for both fundamental and applied research, but also for design and optimization in real systems engineering. Therefore, the development of improved physical and numerical models that are able to handle the full complexity of real systems is among the main research topic in Computational Fluid Dynamics (CFD). It should be emphasized that the system complexity originates in the coupling between very different scales (very small and very large ones) and the coupling between physical mechanisms of different nature. The exponential growth of computing power has enabled, in the recent past, to predict the dynamics of complex turbulent flows (in which complexity stems from geometry and multiphysic couplings), but mostly for simplified systems. A main objective is still to develop new methods that will allow to handle the total complexity of full scale real systems, and to diffuse these methods thanks to simulation tools that are available for both academic and industrial CFD communities.

This research project aims at developing new physical models and numerical methods for the unsteady simulation of turbulent flows based on Lattice Boltzmann Methods (LBM). LBM appeared, under its modern formulation, in the early 1990s. This approach has now reached a maturity level which is sufficient to consider it as a potential alternative to Navier-Stokes-based CFD tools. From the theoretical standpoint, LBM is a method to solve the Boltzmann equation, and therefore to describe flow dynamics at a finer level than continuum mechanics, considering velocity density distribution functions instead of usual macroscopic quantities (velocity, pressure, ...) From a practical standpoint, LBM-based simulation tools have proved to be more efficient than classical Navier-Stokes based solvers for subsonic aerodynamics and aeroacoustics. This is illustrated by the fact that PowerFlow, which is a commercial CFD tool based on LBM, is the worldwide leader for ground transport applications (for aerodynamics, aeroacoustics and heat transfer).

Despite their success and their huge potential, LBM methods have received a little attention compared to classical CFD approaches based on Navier-Stokes equations. Therefore, there are many fundamental and practical open questions in the LBM theory, along with a very important industrial demand. The present project is built in this context. **It aims at inproving turbulence models within the LBM framework for the unsteady simulation of turbulent flows in complex geometries.**

Research program

The aim of the present project is to develop efficient turbulent closures for LBM-based approaches. Several issues will be addressed, among which:

- consistent closures for compressible flow simulations
- development of wall models for solid surfaces with arbitrary geometry modelled via the Immersed-Boundary Condition approach (including moving/deforming solid boundaries
- development of an efficient Detached-Eddy Simulation model well suited for LBM

The work will be performed in close collaboration with industrial partners (Airbus, Renault) and research centres (ONERA, CERFACS).

Informations

Location: M2P2 Laboratory, Marseille, France

Duration: 12 - 24 months

Net monthly salary: 1930 euros(<3 years after PhD) or 2300 euros (>3 years after PhD)

Contact : Prof. Pierre Sagaut
Email : pierre.sagaut@univ-amu.fr
URL: www.lmm.jussieu.fr/~sagaut