PhD Proposal 2017

School: Ecole Centrale Marseille	
Laboratory: M2P2	Web site: www.m2p2.fr
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Collaboration with other partner during this PhD: In France:	In China:

Title: Combustion modeling in the Lattice Boltzmann framework
Scientific field: Mechanical Engineering, Computational Fluid Dynamics
Key words: CFD, Lattice Boltzmann, Combustion

Details for the subject:

Background, Context:

The industry relies increasingly on numerical simulation for designing, improving, and even validating new combustion devices (engine, burner, furnace, etc.). Today, numerical combustion modelling relies almost exclusively on numerical codes solving the Navier-Stokes equations.

The Lattice Boltzmann solvers are very different from these codes, intending to solve a discrete variant of the Boltzmann equation. This type of flow solver is progressing rapidly, however, in low-Mach turbulent flows configurations. The results obtained with Lattice Boltzmann methods (LBM) have proved very good for aerodynamic applications, motivating intensive development of new methods.

Lattice Boltzmann methods applied to industrial applications are recent, however, so few models are able to deal with multiphase flows, and almost none with reactive (combusting) flows.

The development of combustion modelling within the LBM framework is the topic of this thesis.

Research subject, work plan:

Extending the LBM capabilities to combustion requires a profound rethinking of existing methods developed within the Navier-Stokes framework.

The thermodynamic closure will first have to be extended to cope with multi-component ideal gas phase, including indeed the diffusive effects within (thermal and species diffusion). This, indeed, is a prerequisite to the second step, which will be to include the description of the kinetics responsible for combustion within the LBM framework. Serious fundamental work, as well as numerical modelling is indeed required.

The student will be part of one of the leading research groups on LBM in France. The thesis will be co-supervised by P. Boivin, combustion specialist, and P. Sagaut, a world-renowned scientist on turbulence modelling and LBM.

References on this topic:

S. Marié, D. Ricot, P. Sagaut, Comparison between lattice Boltzmann method and Navier–Stokes high order schemes for computational aeroacoustics (2009)

C. Lin, A. Xu, G. Zhang, Y. Li, Multiple-distribution-function lattice boltzmann kinetic model for combustion phenomena (2014)