Construction and analysis of lattice Boltzmann schemes

François Dubois[ab]

[a] *Laboratoire de Mathématiques d'Orsay, Université Paris-Sud, CNRS, Université Paris-Saclay, Orsay, France.*
[b] *Conservatoire National des Arts et Métiers, LMSSC laboratory, F-75003 Paris, France.*

15 May 2023 *

This lecture is divided into three parts.

First we recall the numerical framework for the construction of multiple relaxation times lattice Boltzmann schemes, in the spirit proposed by Lallemand, d'Humières et Luo [1, 2].

Secondly, we analyse the one-dimensional D1Q3 scheme when it is used for the approximation of acoustic problems. With this study, we use the Taylor expansion method proposed in [3].

In a third part, we explain how the general "ABCD" framework [4] can be used to study the question of the approximation of the compressible Navier-Stokes equations with a single distribution [5].

References

[1] D. d'Humières, "Generalized Lattice-Boltzmann Equations", in *Rarefied Gas Dynamics: Theory and Simulations*, volume 159 of *AIAA Progress in Astronautics and Astronautics*, p. 450-458, 1992.

[2] P. Lallemand, L.-S. Luo, "Theory of the Lattice Boltzmann Method: Dispersion, Dissipation, Isotropy, Galilean Invariance, and Stability", *Physical Review E*, volume 61, 6546, 2000.

[3] F. Dubois, "Equivalent partial differential equations of a lattice Boltzmann scheme", *Computers and Mathematics with Applications*, volume 55, p. 1441-1449, 2008.

[4] F. Dubois, "Nonlinear fourth order Taylor expansion of lattice Boltzmann schemes", *Asymptotic Analysis*, volume 127, pages 297-337, 2022.

[5] F. Dubois, P. Lallemand. "On single distribution lattice Boltzmann schemes for solving Navier Stokes equations", *Communications in Computational Physics*, accepted, April 2023.

* This contribution is submitted to the 19th International Conference for Mesoscopic Methods in Engineering and Science, Chengdu, 24–28 July 2019.