On stability of lattice Boltzmann schemes with relative velocities

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We present here a new class of Lattice Boltzmann schemes induced by the work of M. Geier [2] which allow to simulate some fluid flows problems (Navier-Stokes). It aims to improve the issue of stability.

These schemes introduce in the matrix of moments M a dependence on a velocity field $\widetilde{u}$. The moments are thus defined by $m(\widetilde{u}) = M(\widetilde{u})f$ where f is the vector of particle distributions. This framework embeds the usual d'Humières schemes [1] and the cascaded scheme [2].

The third order consistency of this scheme has already been studied and the results are presented in [3]. Particularly, it is proven that the equivalent equations are independent of the velocity field up to the second order. This field only appears on the third order of the momentum equation.

In this contribution, we focus on a two dimensional case : the D2Q9 scheme with relative velocities. The purpose is to study its properties of stability according to $\widetilde{u}$. We point out that the choice of the polynomials defining the moments is essential to stabilize the scheme. To achieve this, a linear Von Neumann analysis is presented. Some non linear test cases such as the Kelvin-Helmhotz instability and the Taylor Green vortex confirm the linear results.

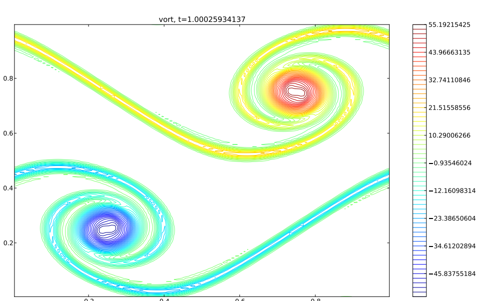

Fig. 1: *Kelvin-Helmhotz instability*

References

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