Anisotropic Thermal Lattice Boltzmann simulation of 2D natural convection in a square cavity

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In this contribution, Natural convection in a square cavity[1] is simulated by multiple relaxation time (MRT) lattice Boltzmann method (LBM) with a separate distribution function to solve for the temperature distribution. The Raleigh numbers examined range from $Ra = 10^3$ to $Ra = 10^6$. The simulations are performed for anisotropic thermal case [2, 3] and compared to isotropic thermal case.

We present double population approach using multiple relaxation time lattice Boltzmann method (MRT-LBM)[4] with D2Q9 lattice model for solving velocity field and another D2Q9 for solving macroscopic temperature. The choice of D2Q9 model for thermal is to be able to model anisotropic thermal diffusion. First we consider natural convection in a square cavity when the flow is laminar (*i.e* Rayleigh number is less then 10^6.). To validate our model, we choose isotropic thermal diffusivity (*i. e. diffusivity in x direction κ_x is equal to diffusivity in y direction κ_y). Then we consider anisotropic thermal diffusion. In fact we consider two cases $\kappa_x = \kappa_y/2$ and $\kappa_x = 2\kappa_y$, and we compare the solution to the isotropic one.*

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References

*[1] G. De Vahl Davis, Natural convection of air in a square cavity: a bench mark numerical solution, Internat. J. Numer. Methods Fluids, **3**, 249, (1983).*

[2] F. Dubois, Equivalent partial differential equations of a lattice Boltzmann scheme, Computers and Mathematics with Applications, **55***, p. 1141–1149, (2008).*

[3] F. Dubois, P. Lallemand and M.M. Tekitek, Using lattice Boltzmann scheme for anisotropic diffusion, Finite volumes for complex applications V, 795, (2008).

[4] M.M. Tekitek, L.-S. Lin and C.-A. Lin, "MRT Thermal Lattice Boltzmann simulation of 2D natural convection in a square cavity for high Rayleigh number", submitted, (2013).

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