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Reduction of the temperature jump in the immersed boundary-thermal lattice Boltzmann method TAKESHI SETA, University of Toyama, KOSUKE HAYASHI, AKIO TOMIYAMA, Kobe University — We analytically and numerically investigate the boundary errors computed by the immersed boundary-thermal lattice Boltzmann method (IB-TLBM) with the two-relaxation-time (TRT) collision operator. In the linear collision operator of the TRT, we decompose the distribution function into symmetric and antisymmetric components and define the relaxation parameters for each part. We derive the theoretical relation between the relaxation parameters for the symmetric and antisymmetric parts of the distribution function so as to eliminate the temperature jump. The simple TRT collision operator succeeds in reducing the temperature jump occurring at the high relaxation time in the IB-TLBM calculation. The porous plate problem numerically and analytically demonstrate that the velocity squared terms should be neglected in the equilibrium distribution function in order to eliminate the effect of the advection velocity on the temperature jump in the IB-TLBMs. The passive scalar model without the velocity squared terms more accurately calculates the incompressible temperature equation in the IB-TLBMs, compared to the double distribution model, which is based on the relation of the distribution function $g_k = (e_k - u)^2 f_k \big/ 2$. We apply the passive scalar model without the velocity squared terms to the simulation of the natural convection between a hot circular cylinder and a cold square enclosure. The proposed method adequately sets the boundary values and provides reasonable average Nusselt numbers and maximum absolute values of the stream function.

Takeshi Seta
University of Toyama

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