Comment on "An improved gray lattice Boltzmann model for simulating fluid flow in multi-scale porous media"

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Comment

In a recent paper [1], Zhu and Ma introduced a lattice Boltzmann model with a new partial bounce-back algorithm (hereafter referred to as the ZM model) and compared it to their implementation of a similar partial bounce-back algorithm previously proposed by Walsh *et al.* [2] (hereafter referred to as the WBS model). In most of the test cases, they reported that the *"results of the both models match closely"* (*sic*). However, for an important test case, the authors reported that *"the WBS velocity appear to be discontinuous at the two interfaces, an unphysical behavior, whereas the velocity of the proposed model remains smooth"* (*sic*). They consequently concluded that the ZM model *"is more stable numerically"* than the WBS model *"at solid walls and interfaces of different porous media"*. They also concluded that *"the WBS model is inferior"* to the ZM model.

We have independently developed and validated a three-dimensional version of the WBS model [3]. The model is similar to the one developed by the authors of [1] but uses (a) pressure boundary conditions acting inside injection chambers instead of forcing to drive the fluid and (b) a relaxation time $\tau = 1$ instead of $\tau = 2$. Using our implementation, we computed the flow for test *"case 3"* as described in section 4.3 and figure 2 of [1]. Briefly, the flow is simulated *"along three*

layer strata of porous media, where the top and bottom layers are the same but different from the middle one" and the three layers are sandwiched between solid walls in the directions parallel to the flow. We observed no discontinuity in the velocity profile at the interfaces as reported in [1]. Furthermore, we modified our implementation in order to match the exact setup of Zhu and Ma by using a force to drive the fluid and a relaxation time of $\tau = 2$. The results are essentially the same. Figure 1 shows the normalized velocity profile in the direction of the flow along the *y* axis for the setup of *"case 3"* as defined in section 4.3 and figure 2 of [1].

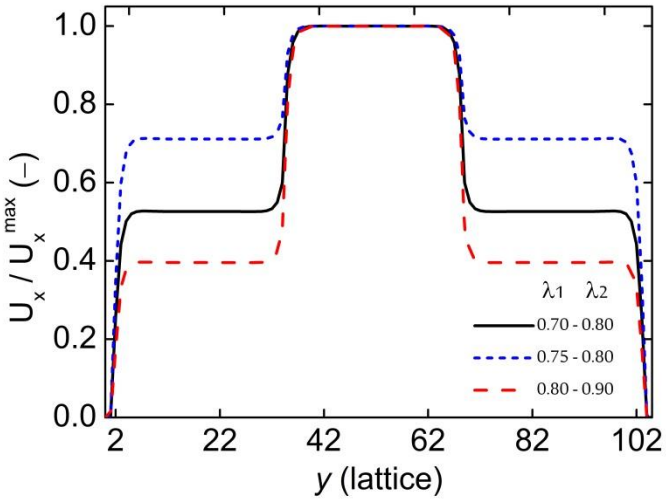

Figure 1. Normalized velocity profile along the *y* axis for test *"case 3"* as described in section 4.3 and figure 2 of [1]. The parameters λ_1 and λ_2 are the porous media model parameters as defined in [1].

Clearly, in our implementation of the WBS model, the velocity profile is smooth and displays no discontinuity as shown in figure 5 of [1]. The results are obtained without the use of *"averaged velocities at prior and post collision to determine the velocity for the equilibrium function"* as discussed in section 5.2 of [1]. We conclude that the discontinuity reported by Zhu and Ma is not a property or a limitation of the WBS model. Rather, we suggest that it may be due to an error in the implementation of the WBS model by the authors of [1].

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References

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