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Chapman-Enskog analyses on gray lattice Boltzmann schemes for fluid flow in porous media CHEN CHEN, LIKE LI, RENWEI MEI, JAMES KLAUSNER, Univ of Florida - Gainesville — Gray lattice Boltzmann (GLB) schemes have recently been used to simulate fluid flow in porous media. It employs a partial bounce-back of populations (through a fractional reflection coefficient θ, which represents the fraction of populations being reflected by the solid phase) in the evolution equation to account for linear drag of the medium. These schemes are very easy to implement; but there exists uncertainty about the need for re-defining macroscopic velocity as there has been no systematic analysis to recover the Brinkman equation from various GLB schemes. In this work, Chapman-Enskog analyses are performed to show that the momentum equation recovered from these schemes can satisfy Brinkman equation to second order in ε only if $\theta = \mathrm{O}(\varepsilon)$ in which ε is the ratio of the lattice spacing to the characteristic length of physical dimension. The need for redefining macroscopic velocity is shown to be scheme-dependent. When gravitational force is considered or a body force is used to represent pressure gradient, the forcing term requires a modification factor that accounts for the effect of θ. The modification factor is derived for each combination of the forcing implementation method and the GLB scheme. The theoretical findings are verified by numerical results.

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