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Lattice Boltzmann Models for Flows with Axial Symmetry and Mass and Momentum Sources without Cubic Velocity Errors FARZANEH HAJABDOLLAHI, KANNAN PREMNATH, University of Colorado Denver — Three-dimensional flows with axial symmetry arise in numerous applications, which can be solved more efficiently on a two-dimensional Cartesian coordinate system with appropriate source terms. Lattice Boltzmann (LB) method is a promising recent development in CFD. However, existing LB models are not Galilean invariant (GI) due to the degeneracy of the resulting third-order longitudinal moments, which leads to cubic velocity truncation errors. This can lead to anisotropic stress tensor with velocity-dependent viscosities and numerical instability under high shear even with finer grids. In this investigation, we develop a new radius-weighted LB model for axisymmetric flows using a non-orthogonal moment basis with an extended moment equilibria and restore GI on standard lattices. Also, as another related example, we consider flows with mass and momentum sources, which are important in various contexts, including acoustics, reacting flows and flows undergoing phase change. To handle such problems, we develop a new LB model by incorporating sources in its zeroth and first order moments, with extended moment equilibria to eliminate the cubic velocity errors. Both the resulting new models will be validated for benchmark problems.

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