Lattice Boltzmann Representations of MHD Turbulence

GEORGE VAHALA, William & Mary, LINDA VAHALA, Old Dominion University, MIN SOE, Rogers State University, CHRISTOPHER FLINT, William & Mary — Lattice Boltzmann algorithms are an ideally parallelized method for the solutions of macroscopic nonlinear equations of physics — like resistive MHD. In its simplest LB representation one introduces a scalar distribution for the density-velocity fields and a vector distribution for the magnetic field. An important feature is that gradients of certain macroscopic fields can be represented by local moments of the mesoscopic distribution functions. In particular, \( \text{div} \, B = 0 \) can be exactly enforced to machine accuracy, without any divergence cleaning. One of the problems facing the explicit LB code is numerical instabilities. Methods to permit strong turbulence simulations include: (a) moving from a single BGK to multiple collisional relaxation, (b) quasi-equilibria and central moment enhanced LB representations. The LB turbulence modeling of Ansumali et. al. to Navier-Stokes turbulence will be extended to MHD in which in its noted that filtering and Chapman-Enskog limits do not commute. In the NS-case, it leads to unique Samgorinsky closure scheme, with definite filter width.