

Lattice kinetic simulations of 3D MHD turbulence

G. Breyiannis and D. Valougeorgis

Department of Mechanical and Industrial Engineering
University of Thessaly, Pedion Areos, Volos, 38333, Greece
gbregian@mie.uth.gr

A recently proposed lattice kinetic scheme [1] offers a promising tool for simulating complex MHD flows. Unlike the conventional multispeed expansion which facilitates magnetic behavior in a rather inefficient manner, a separate BGK-like evolution equation for the magnetic field is used to model the induction equation. This enhances simplicity and allows for the independent adjustment of the magnetic resistivity. Furthermore the algorithm correctly recovers the macroscopic dissipative MHD equations.

The coupling of the two distribution functions, the generic for the flow field and the corresponding one for the magnetic field, includes two alternatives. Dellar [1] suggested a heuristic extension of the equilibrium distribution function which incorporates the Maxwell matrix at the appropriate moment of f . A more straightforward approach is to include a force term representing the Lorenz force, based on macroscopic quantities [2].

We intent to report on the ability of both schemes to simulate 3-D incompressible, homogeneous MHD turbulence in a periodic cubelet in terms of the temporal evolution of kinetic and magnetic energies. In all cases tested the divergence free condition in the induction equation is preserved. A detailed and systematic comparison of the results obtained by the proposed 3D MHD lattice kinetic scheme to corresponding spectral numerical simulations [3] is performed.

References

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