Hyperbolic Type Explicit Scheme of Magnetogasdynamics for the High Performance Computing Systems

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ABSTRACT

The tremendous progress of the kinetic consistent schemes in solution of the gas dynamic problems and development of the effective parallel algorithms for the modern high performance parallel computing systems leads to development of advanced methods for solution of the magneto gas dynamic problems for critical areas of today and future investigations.

The novel method proposed to extend the Boltzmann like distribution function for the kinetically consistent method with implementation of electromagnetic terms. This gives powerful tools for the solution of the MHD system of equation in frame of kinetic consistent schemes with common approach. The numerical algorithm is based on the explicit scheme, considered preferable for the new generation of the high performance parallel computing systems. It is explained by the logical simplicity and efficiency the algorithms and possibility of easy adaptation to the modern high performance parallel computer systems, including hybrid computing systems with graphic processors. However, the stability conditions of the explicit algorithms are the price to be paid for algorithmic simplicity and it gives the strong limitation on the time discretisation depended on the fine space mesh.

The proposed algorithm allows include a regularization mechanism through hyperbolic terms of the equations. This mechanism improves the stability of the algorithm with a consequent relaxation of the time discretisation on the high detailed spatial mesh. The proposed hyperbolic type kinetic magneto gas dynamics model provides a more stable condition for the numerical calculations and the possibility of realization of the high space discretisation with acceptable time discretisation. The analysis shows that in the region of the physical parameters of an ionized gas (plasma), in particular of the viscosity, the time discretization for the hyperbolic type of the magnetogasdynamics equations gives the relaxation of the order of magnitude in comparison to the time discretisation for the parabolic type of magnetogasdynamics equations

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