IMPLICIT KINETIC SCHEMES FOR THE EULER AND IDEAL MHD EQUATIONS

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Key Words: Kinetic Schemes, MHD Flows

ABSTRACT

During the past two decades, the kinetic schemes, namely the Kinetic Flux-Vector Split (KFVS) scheme and Kinetic Wave/Particle Split (KWPS) scheme for the numerical solution of Euler, Navier-Stokes, and Magnetohydrodynamics (MHD) equations have gained wide recognition for their efficiency and robustness. However, to date, majority of the computations performed with these schemes have employed a time-explicit formulation. The explicit kinetic schemes severely restrict the time step allowed for stability. Only very recently, Agarwal and his students have derived the implicit kinetic schemes for the Euler and ideal MHD equations [1, 2]. This paper is an extension of their previous work. In this paper, implicit KFVS and KWPS schemes are derived for the Euler and ideal MHD equations in generalized coordinate system. Both the explicit and the implicit kinetic schemes are applied to compute the 2-D flow field due to a cylindrical blast wave and supersonic flow over a 2-D planar blunt-body with and without magnetic field. For the ideal MHD equations, the homogeneity of the flux vector is achieved by employing the approach due to MacCormack, and a Poisson solver is used at every time step to enforce the solenoidal condition on the magnetic field.

Numerical tests show that both the KFVS and KWPS implicit schemes retain the accuracy and robustness of the corresponding explicit schemes while increasing their efficiency by reducing the number of time steps required in obtaining the numerical solution.

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