ENTROPY STABLE FINITE DIFFERENCE SCHEMES FOR CHEW, GOLDBERGER AND LOW ANISOTROPIC PLASMA FLOW EQUATIONS

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In this article, we consider the Chew, Goldberger and Low (CGL) plasma flow equations, which is a set of nonlinear, non-conservative hyperbolic PDEs modeling anisotropic plasma flows. These equations incorporate the double adiabatic approximation for the evolution of the pressure, making them very valuable for plasma physics, space physics, and astrophysical applications. We first present the entropy analysis for the weak solutions. We then propose entropy-stable finite-difference schemes for the CGL equations. The key idea is to reformulate the CGL equations by rewriting some of the conservative terms in the non-conservation form. The conservative part of the reformulated equations is very similar to the magnetohydrodynamics (MHD) equations which is then symmetrized using Godunov's symmetrization process for the MHD equations. The resulting equations are in the form where the conservative part combined with non-conservative Godunov's terms is compatible with the entropy equation and the rest of the non-conservative terms do not contribute to the entropy equations. The final set of reformulated equations is then discretized by designing entropy conservative numerical flux and entropy diffusion operator based on the entropy scaled eigenvectors of the conservative part. We then prove the semi-discrete entropy stability of the schemes for the reformulated CGL equations. The schemes are then tested using several test problems derived from the corresponding MHD test cases.

In this talk, I will discuss the results of my following paper:

- Chetan Singh, Anshu Yadav, Deepak Bhoriya, Harish Kumar, and Dinshaw S Balsara. Entropy stable finite difference schemes for chew, goldberger and low anisotropic plasma low equations. Journal of Scientific Computing, 102(2):51, 2025.