Contribution ID: **270** Type: **Contributed**

Variational Principles and Applications of Local Topological Constants of Motion for Non-Barotropic Magnetohydrodynamics

Thursday 21 June 2018 11:30 (20 minutes)

Variational principles for magnetohydrodynamics (MHD) were introduced by previous authors both in Lagrangian and Eulerian form. In this paper we introduce simpler Eulerian variational principles from which all the relevant equations of non-barotropic MHD can be derived for certain field topologies. The variational principle is given in terms of five independent functions for non-stationary non-barotropic flows. This is less than the eight variables which appear in the standard equations of barotropic MHD which are the magnetic field B ⃗ the velocity field v ⃗, the entropy s and the density ρ. The case of non-barotropic MHD in which the internal energy is a function of both entropy and density was not discussed in previous works which were concerned with the simplistic barotropic case. It is important to understand the rule of entropy and temperature for the variational analysis of MHD. Thus we introduce a variational principle of non-barotropic MHD and show that five functions will suffice to describe this physical system.
We will also discuss the implications of the above analysis for topological constants. It will be shown that while cross helicity is not conserved for non-barotropic MHD a variant of this quantity is. The implications of this to non-barotropic MHD stability is discussed.

Bibliography

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Session Classification: Vacuum Science & Technology

Track Classification: Plasma Science & Technology