

Hydrostatic, ideal-gas reference states in spherical coordinates

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1 The Induction Term

In MHD, the evolution of magnetic field \mathbf{B} in a fluid with local velocity \mathbf{u} is described by

$$\frac{\partial \mathbf{B}}{\partial t} = \nabla \times [\mathbf{u} \times \mathbf{B} - \eta \nabla \times \mathbf{B}], \quad (1)$$

$$\text{and} \quad \nabla \cdot \mathbf{B} = 0, \quad (2)$$

which is the induction equation and “no magnetic monopoles” condition, respectively. Here we ignore the diffusive piece (dependent on magnetic diffusivity η) and focus on the induction term,

$$\mathbf{I} = \nabla \times [\mathbf{u} \times \mathbf{B}]. \quad (3)$$

In this document, we show the various interpretations of \mathbf{I} , focusing on how it appears in spherical coordinates.