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« Turbulence regimes beyond d_e »

The inviscid three-dimensional electron MHD equations can be written in SI units as (Biskamp et al. 1996)

$$\partial_t (1 - d_e^2 \Delta)\mathbf{B} = -d_i \nabla \times \left[\mathbf{J} \times (1 - d_e^2 \Delta)\mathbf{B}\right], \qquad (1)$$

$$E = \frac{1}{2} \int (B^2 + d_e^2 J^2) d\mathbf{x},$$

Exact relation for EMHD turbulence

Meyrand & Galtier, ApJ, 2010

$$4d_i \langle [(\overline{\mathbf{J} \times \mathbf{B}}) \times \delta \mathbf{B}]_L \rangle - \underbrace{d_i d_e^2 \langle (\delta \mathbf{J})^2 \delta J_L \rangle = -\tfrac{4}{3}\varepsilon^T r.}_{d_i d_e^2 J^3 \sim \varepsilon^J r,}$$

=> $$E^J(k) \sim \left(\frac{\varepsilon^J}{d_i d_e^2} \right)^{2/3} k^{-5/3},$$

=> $$\boxed{B^2(k) \sim \left(\frac{\varepsilon^J}{d_i d_e^2} \right)^{2/3} k^{-11/3}.}$$

FLUID POINT OF VIEW

- $B_0 \sim 0$: Kolmogorov's isotropic exact relation is derived
  - $B_0 \sim b$: critical balance may be used
    - $B_0 \sim 10b$: quasi-bidimensional model may be used