Magnetic helicity in LES

• Magnetic, kinetic, cross helicity in LES
  – physical effects caused by them
  – captured in LES? How?

• Can LES take us further than DNS
  – examples

• Mean-field simulations (MFS)
  – alpha effect dynamos
  – negative effective magnetic pressure,
With input from...

- Eric Blackman: inverse transfer in dynamos
- Axel Brandenburg: 2 examples of Rm dependence
- Bill Matthaeus: 1/f noise as a consequence
- Annick Pouquet: what I don’t understand …
- John Shebalin: rotation and helicity
- Hussein Aluie: cross helicity
- Nobu(mitsu) Yokoi: SGS model with helicity
Example 1: evidence for $R_m$ dependence

- Similar to SS dynamo at early times
- Inverse cascade/transfer behavior
- Resistively slow saturation (!)
Example 2: magnetic helicity flux

\[
\frac{d}{dt} \langle \mathbf{A} \cdot \mathbf{B} \rangle = 2 \langle \mathbf{E} \cdot \mathbf{B} \rangle - 2\eta \langle \mathbf{J} \cdot \mathbf{B} \rangle - \nabla \cdot \mathbf{F}_m
\]

\[
\frac{d}{dt} \langle \mathbf{a} \cdot \mathbf{b} \rangle = -2 \langle \mathbf{E} \cdot \mathbf{B} \rangle - 2\eta \langle \mathbf{j} \cdot \mathbf{b} \rangle - \nabla \cdot \mathbf{F}_f
\]

- EMF and resistive terms still dominant
- Fluxes import at large \( Rm \sim 1000 \)
- \( Rm \) based on \( k_f \)
- Smaller by \( 2\pi \)

Gauge-invariant in steady state!