Dynamos driven by magnetic instabilities

Examples: magnetic buoyancy, MRI

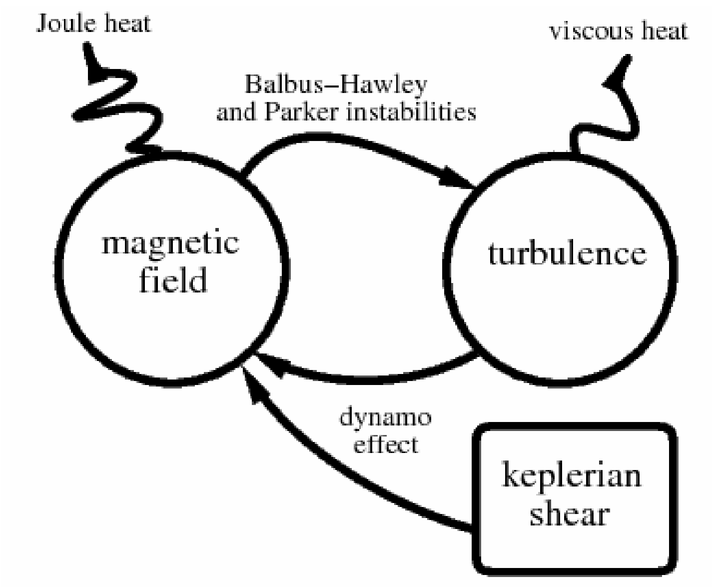
More “powerful”, can overcome quenching?

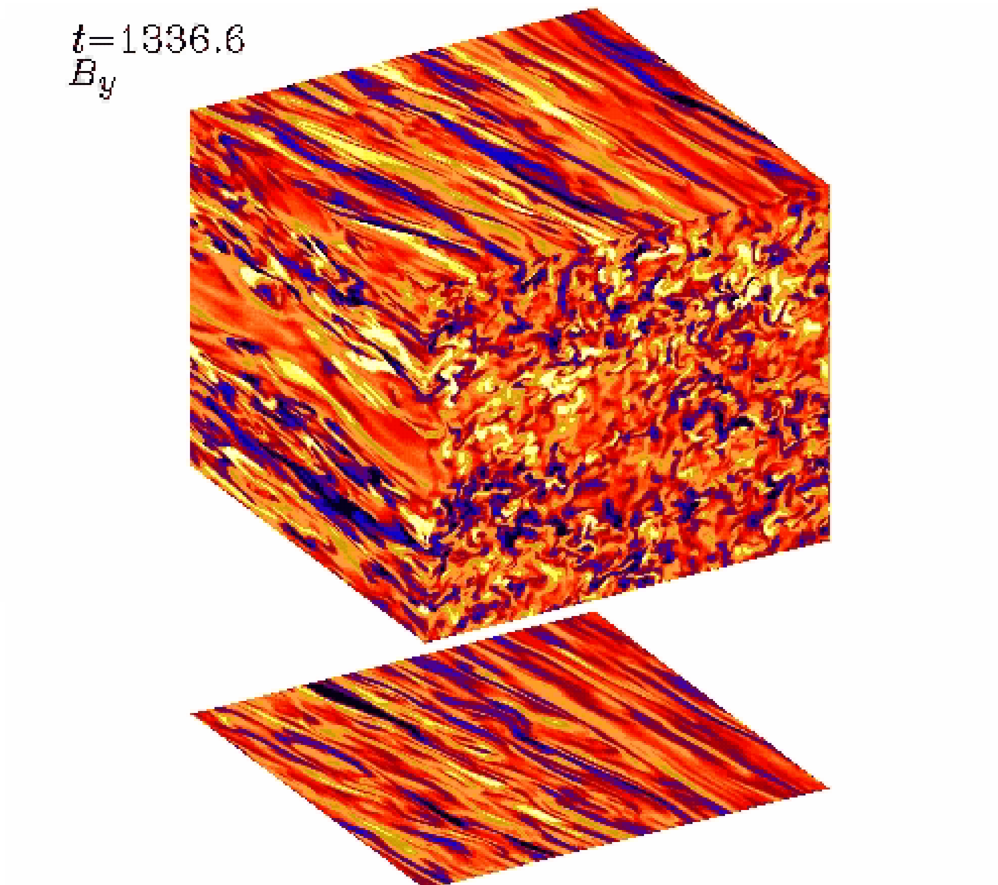
No! …still have to fight magnetic helicity!

Negative alpha: why?

Axel Brandenburg (*Nordita, Stockholm*)

Unstratified MRI turbulence





w/o hypervisc.

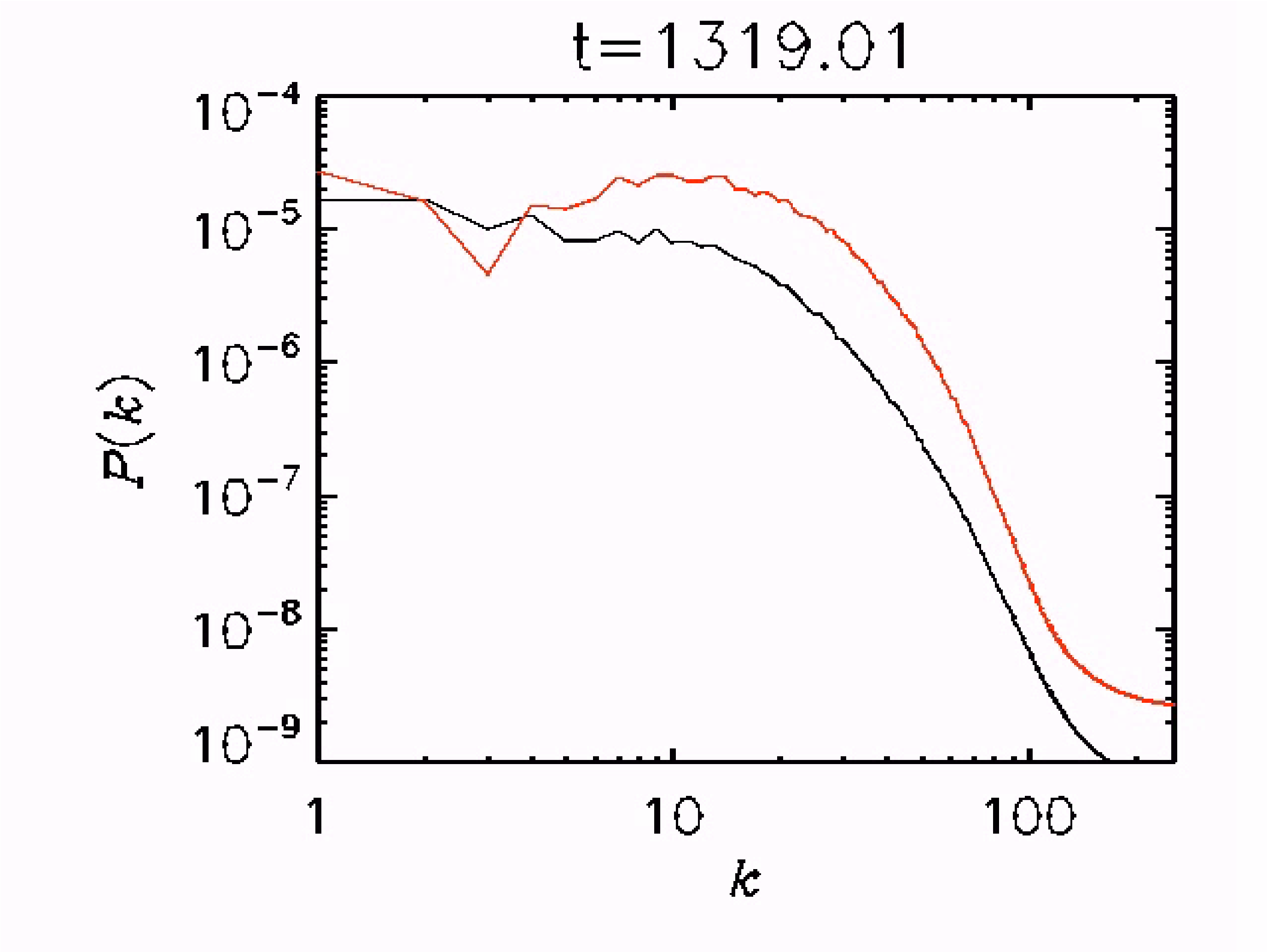
$\Delta t = 60 = 2$ orbits

No large scale field

(i) Too short?

(ii) No stratification?

Animated spectra

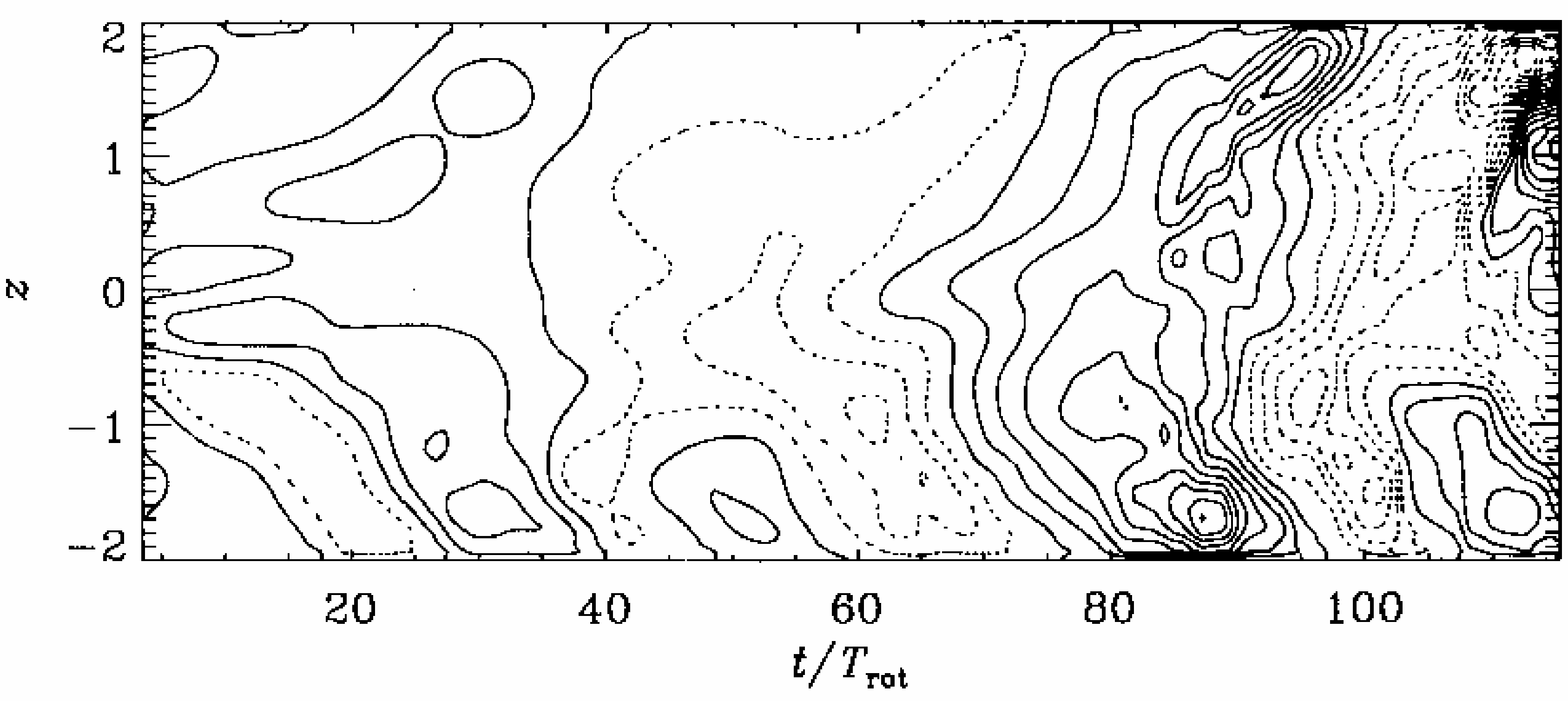


Red
E_M

Black
E_K

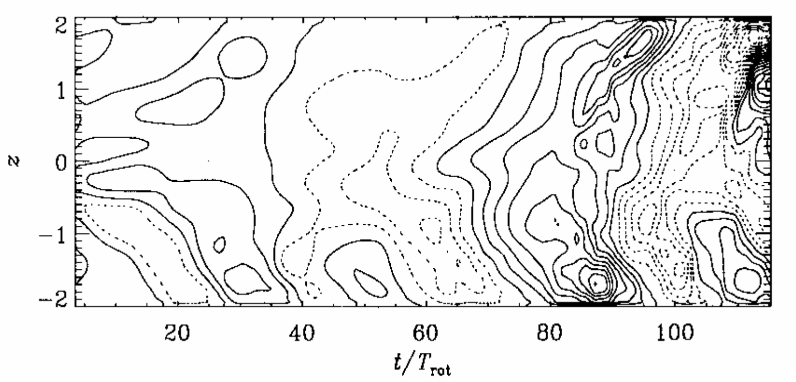
Old *stratified* runs

$\langle B_y \rangle$

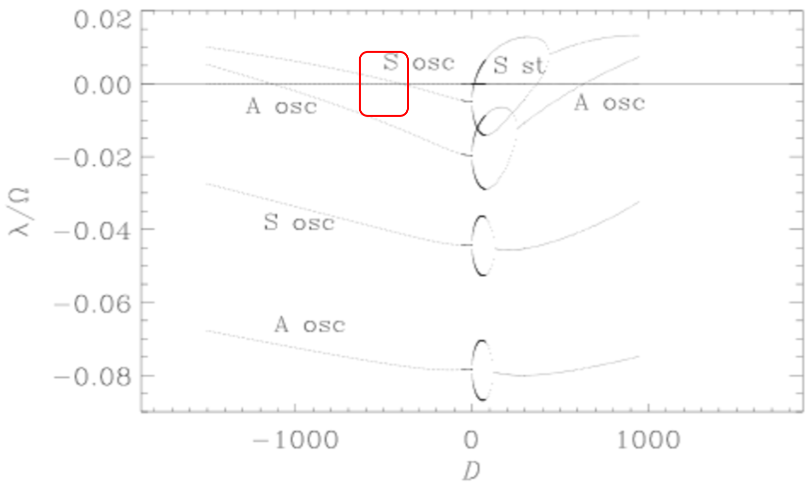


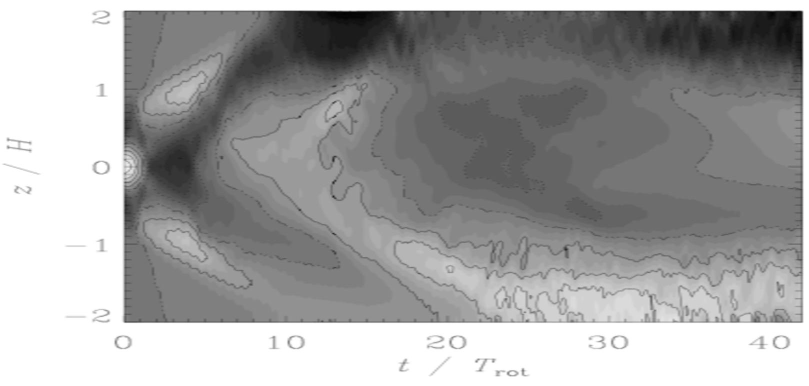
Brandenburg et al. (1995)

Different boundary conditions

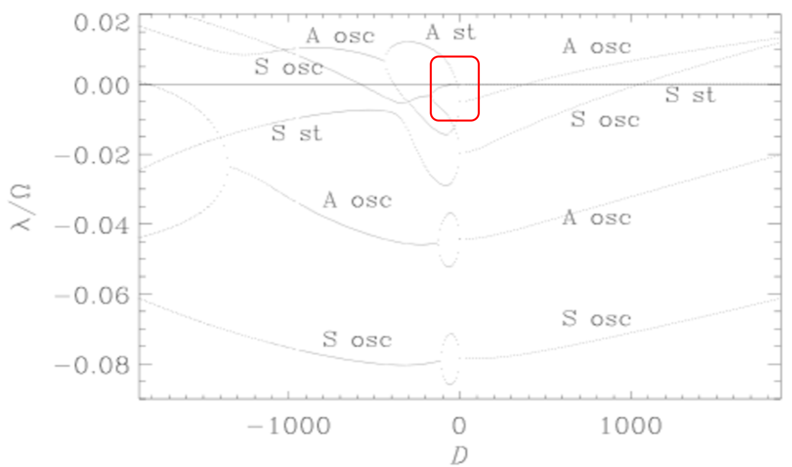


$$B_x = B_y = B_{z,z} = 0$$



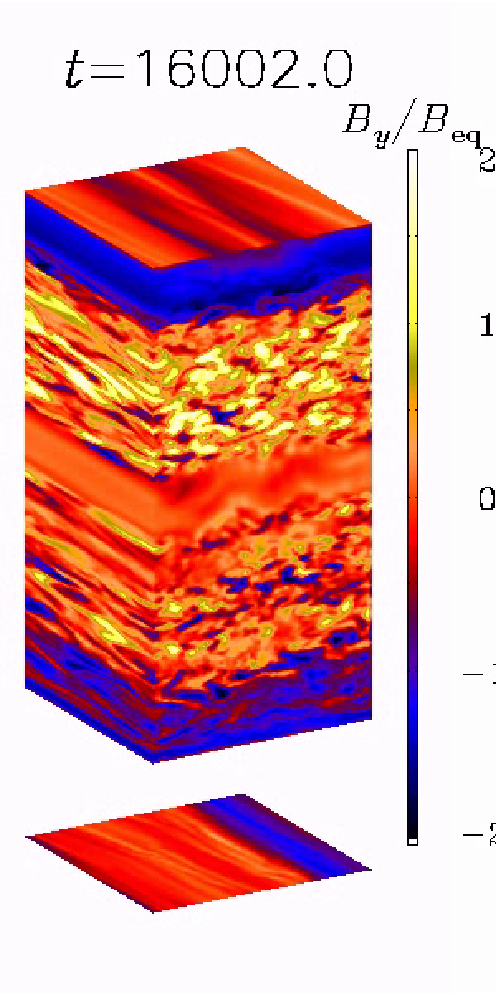


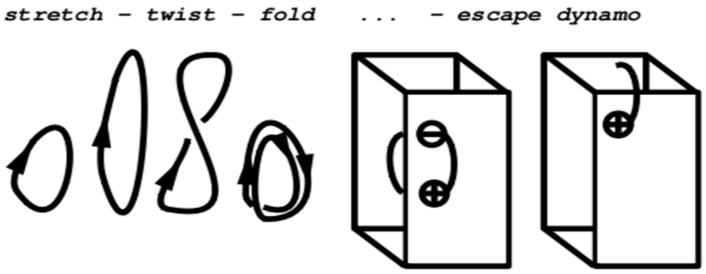
$$B_{x,z} = B_{y,z} = B_z = 0$$

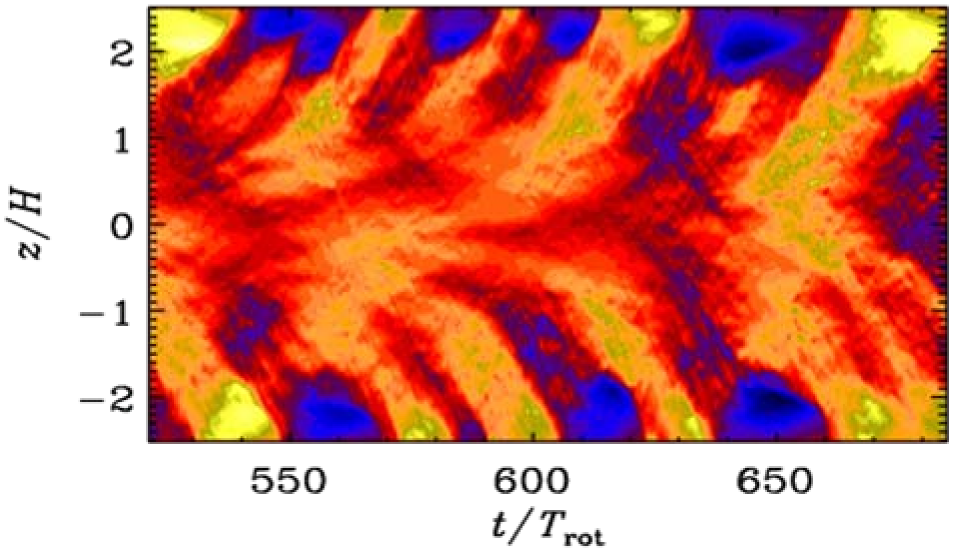


Tall disk with potential field b.c.

2π x 2π x 8π

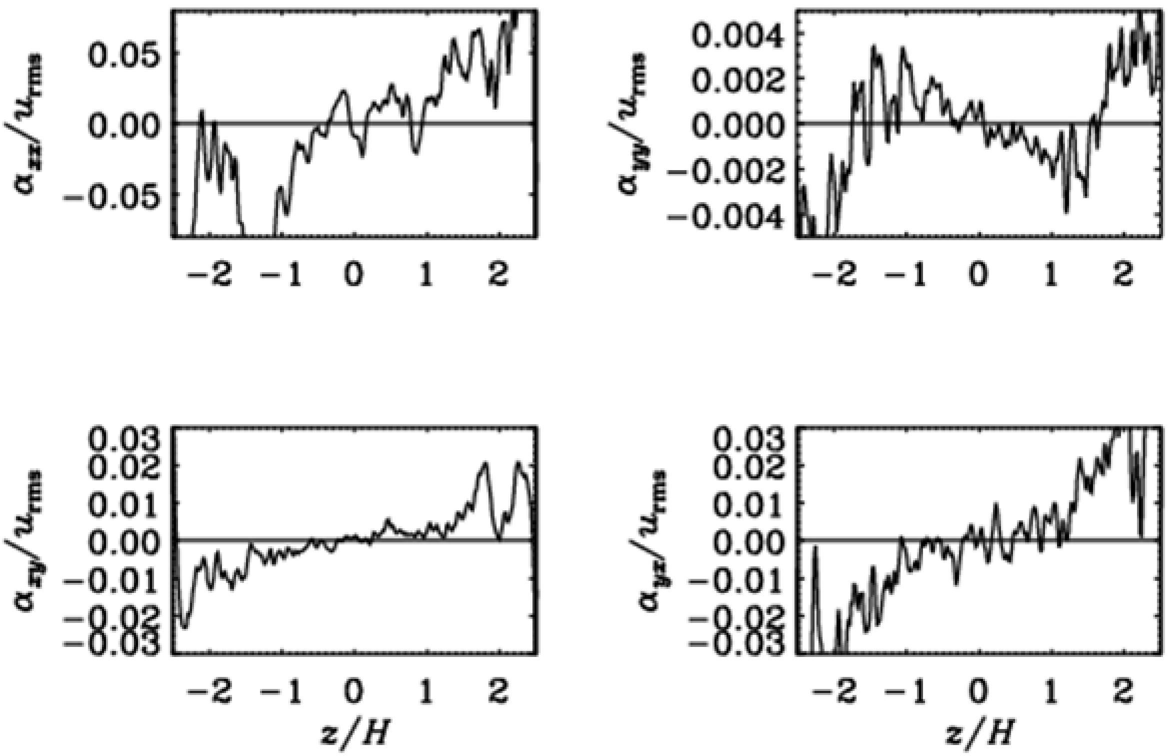


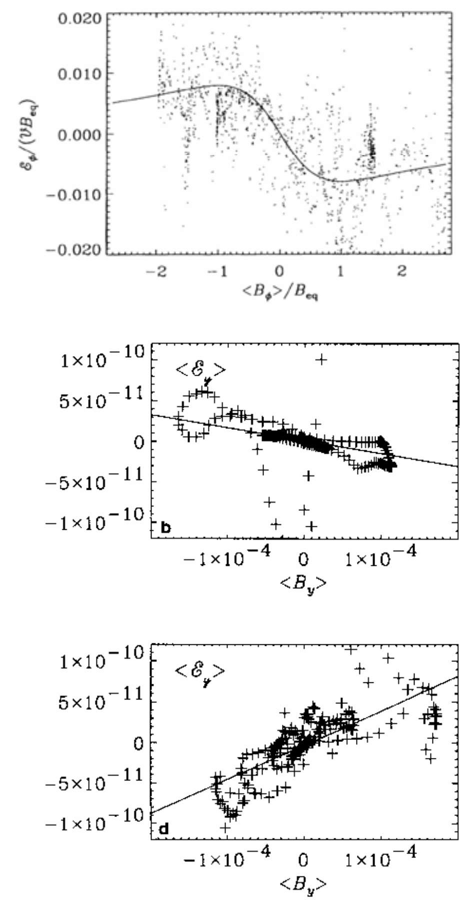




Full alpha tensor for MRI

Testfield method:

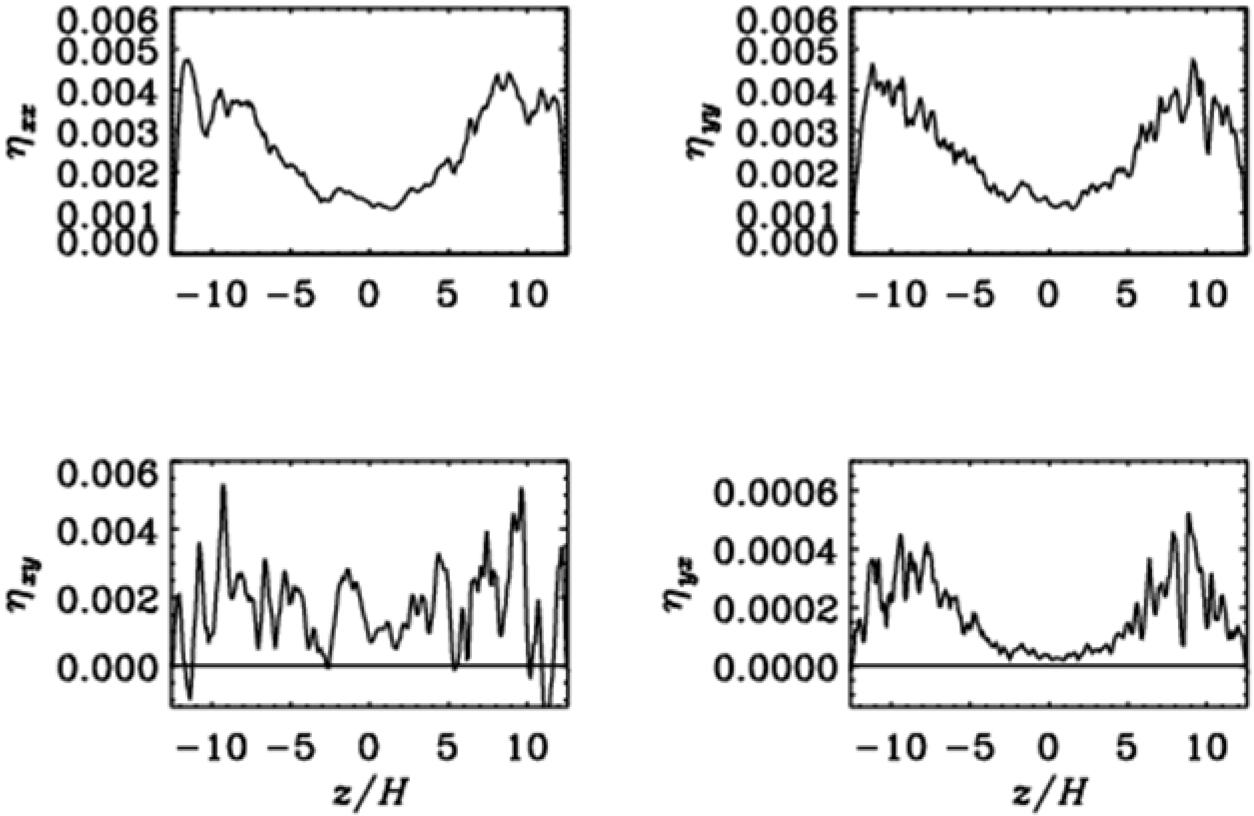




Old 1997 and 1995 results

α_{yy} negative, as before (Brandenburg et al. 1995)

Full eta tensor



η_{xx} and η_{xx} the same and positive (new)

η_{yx} always positive (new)

Negative alpha?

Brandenburg (1998)

$$\frac{\delta\rho}{\rho} = -\frac{\delta\mathbf{B}^2}{8\pi p} = -\frac{2\overline{B}_y b_y}{8\pi p}$$

$$\frac{\partial\overline{\boldsymbol{\mathcal{E}}}}{\partial t} = \overline{\dot{\mathbf{u}}\times\mathbf{b}} + \ldots = \overline{\frac{\delta\rho}{\rho}\mathbf{g}\times\mathbf{b}} + \ldots$$

$$\frac{\partial\overline{\mathcal{E}}_y}{\partial t} = g\overline{B}_y\,\frac{\overline{b_y b_x}}{4\pi p} - \text{triple correlations}$$

$$g = \Omega^2 z,\quad \mathrm{Ro}^{-1} = \tau\Omega,\quad c_\mathrm{s} = \Omega H$$

$$\alpha_{yy} = \tau g\,\frac{\overline{b_x b_y}}{4\pi p} = -\alpha_{SS}\,\mathrm{Ro}^{-1} c_\mathrm{s}\,\frac{z}{H}$$