Role of shear in large scale dynamo

Unquenching alpha

Omega contours perpendicular to surface

Explicit role of shear in MRI

Incoherent alpha-shear dynamo

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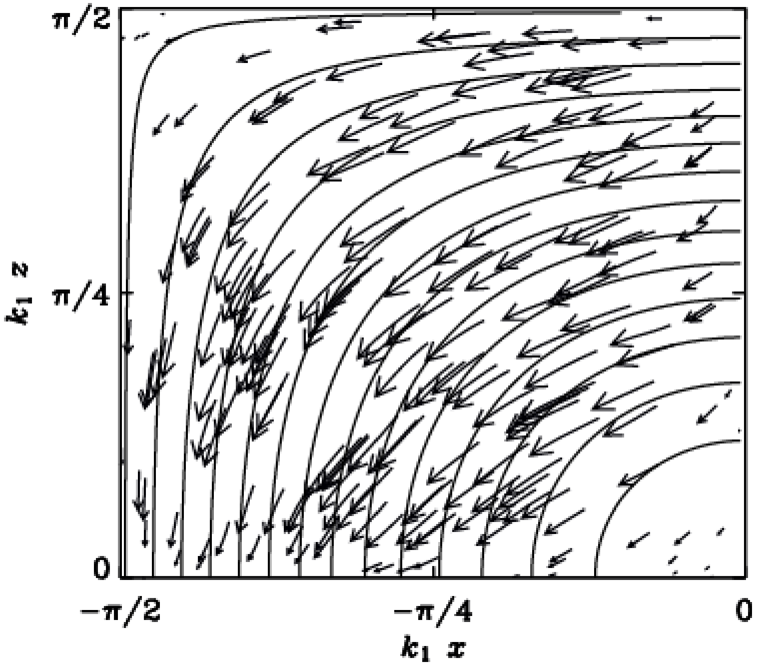
Dual role of shear

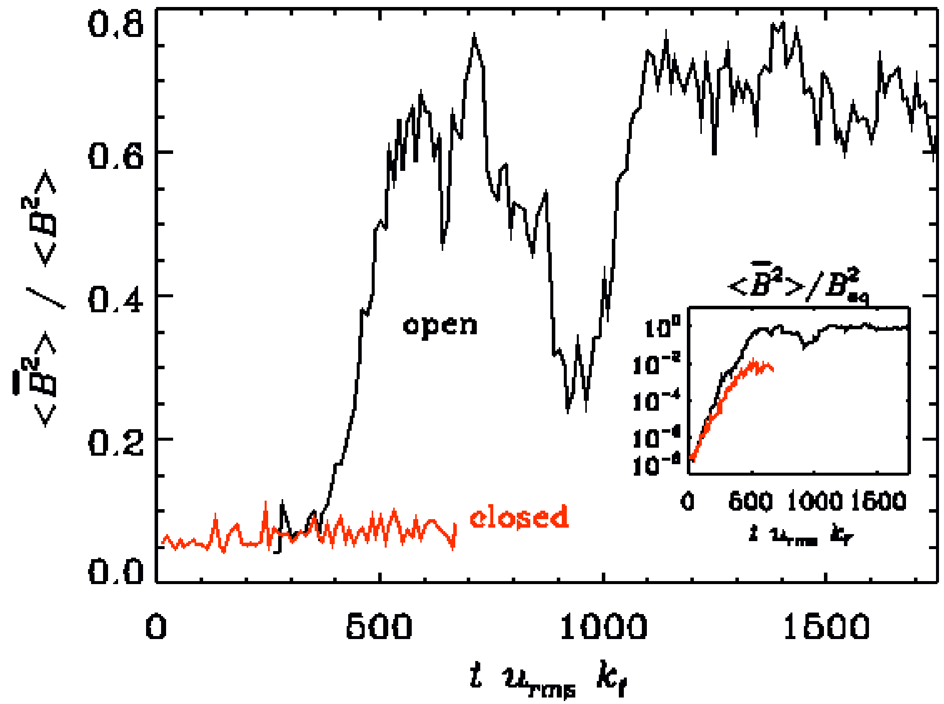
$\nabla\Omega$

$\nabla \cdot \overline{\mathbf{F}}_C^{SS}$

to “unquench” α

Evidence: forced turbulence with shear



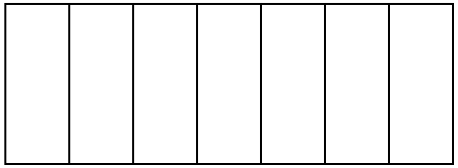


Brandenburg (2005, ApJ)

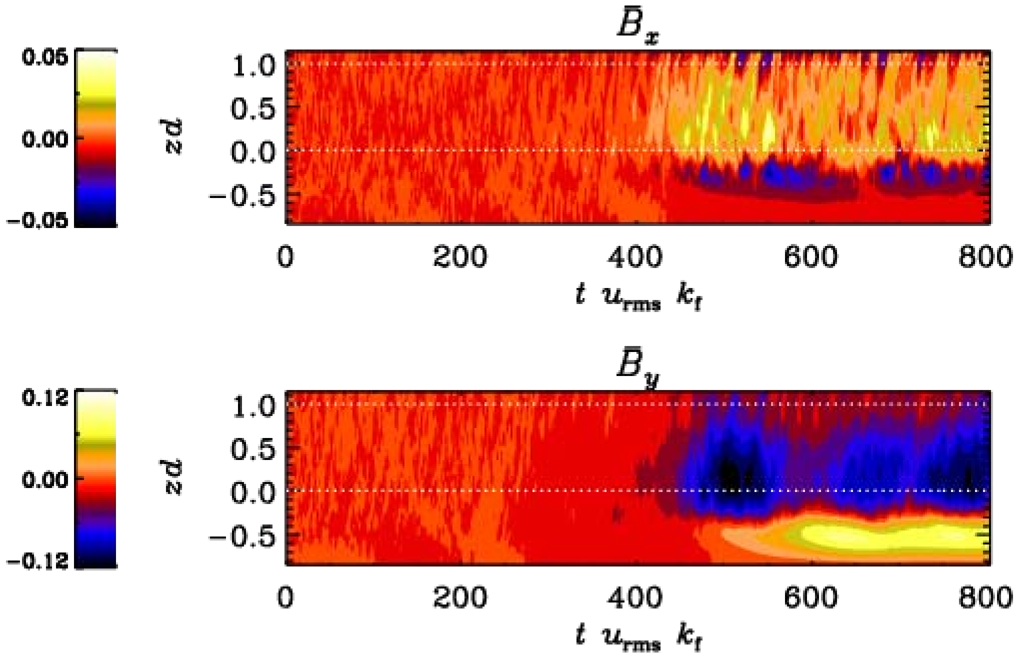
Check: turn on perf cond bc’s in successful LS dyn.

Also need Ω contours ⊥ to surface

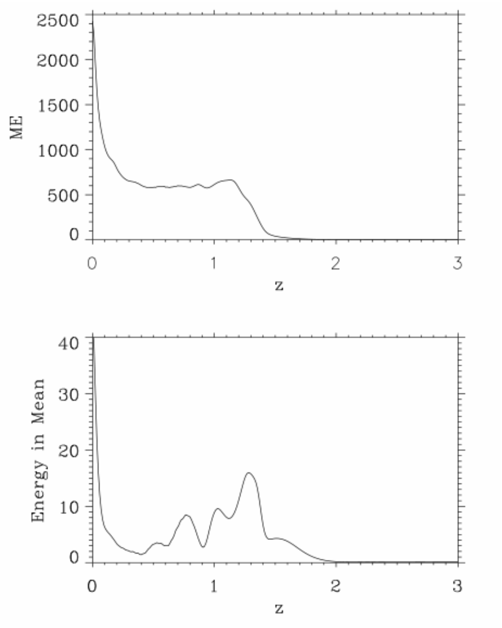
Example: convection with shear



→ need small-scale helical exhaust out of the domain, not back in on the other side

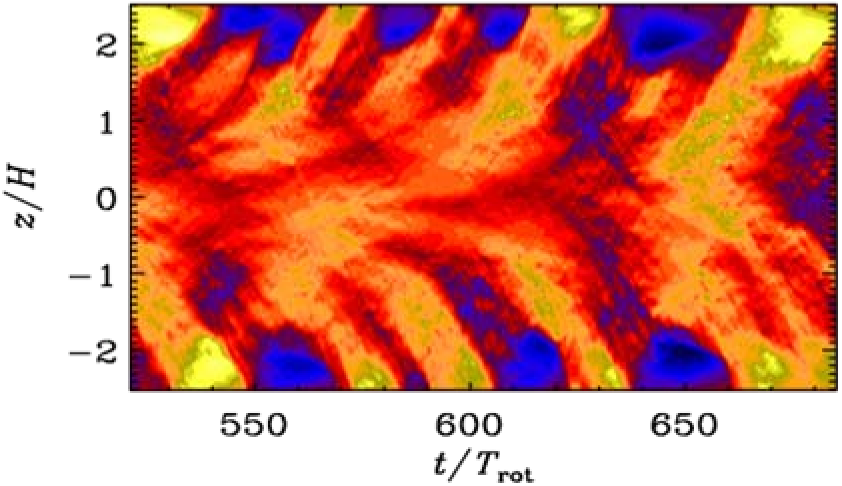


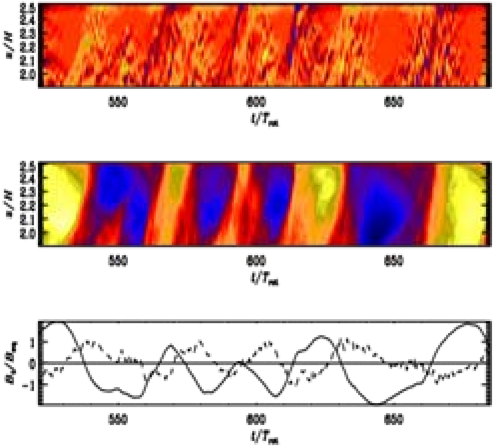
Kapyla et al. (2008, A&A)



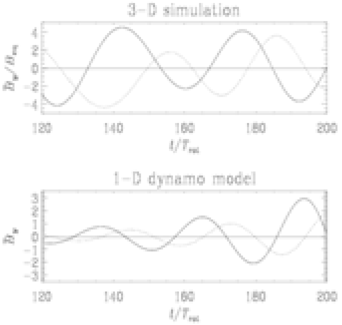
Tobias et al. (2008, ApJ)

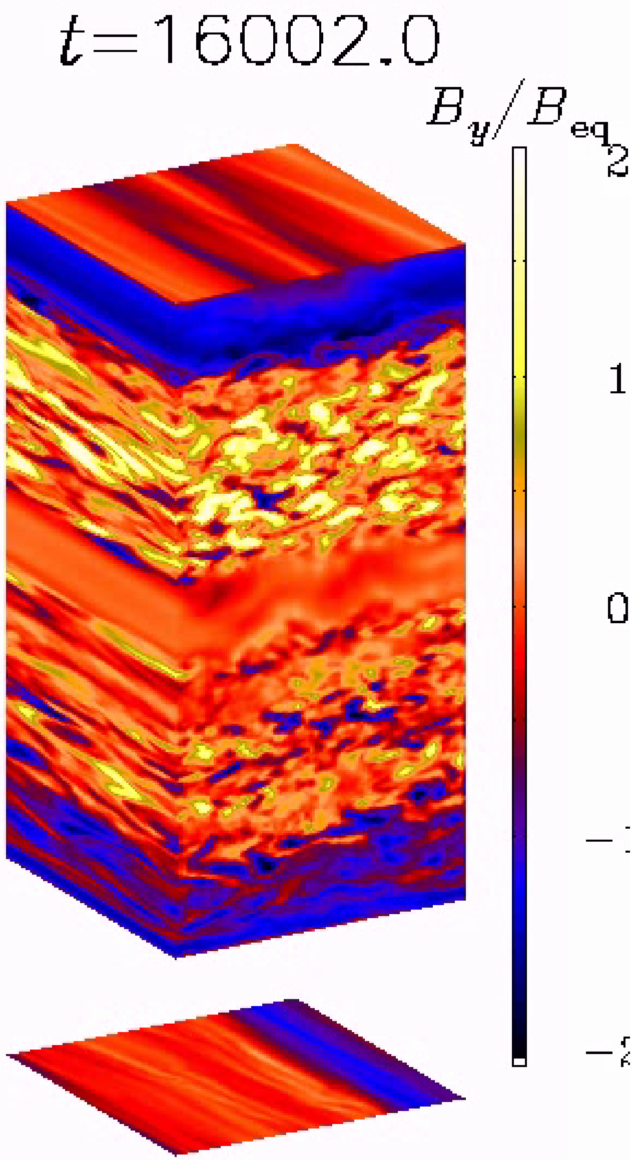
MRI from S+2Ω



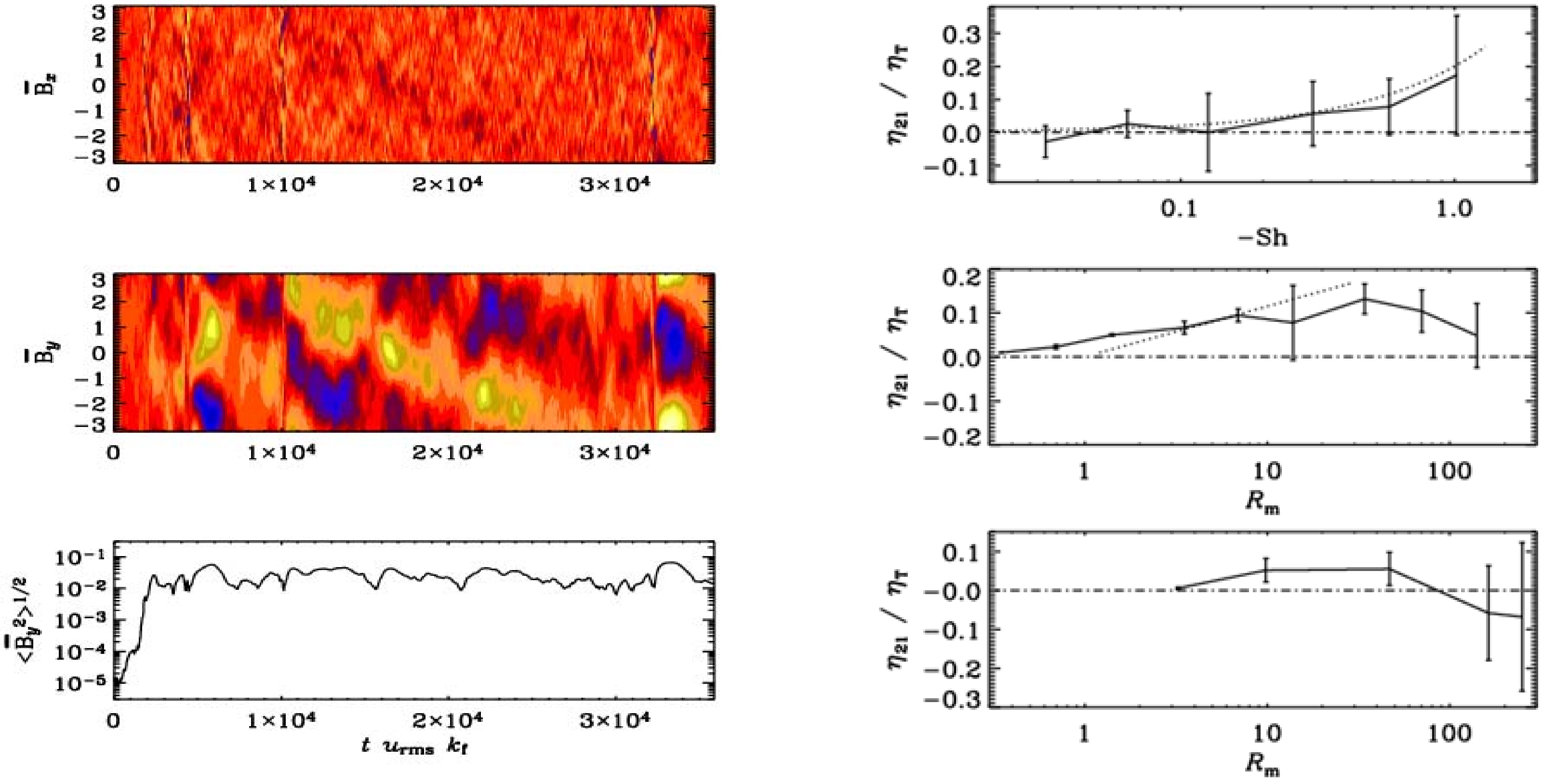


Phase relation





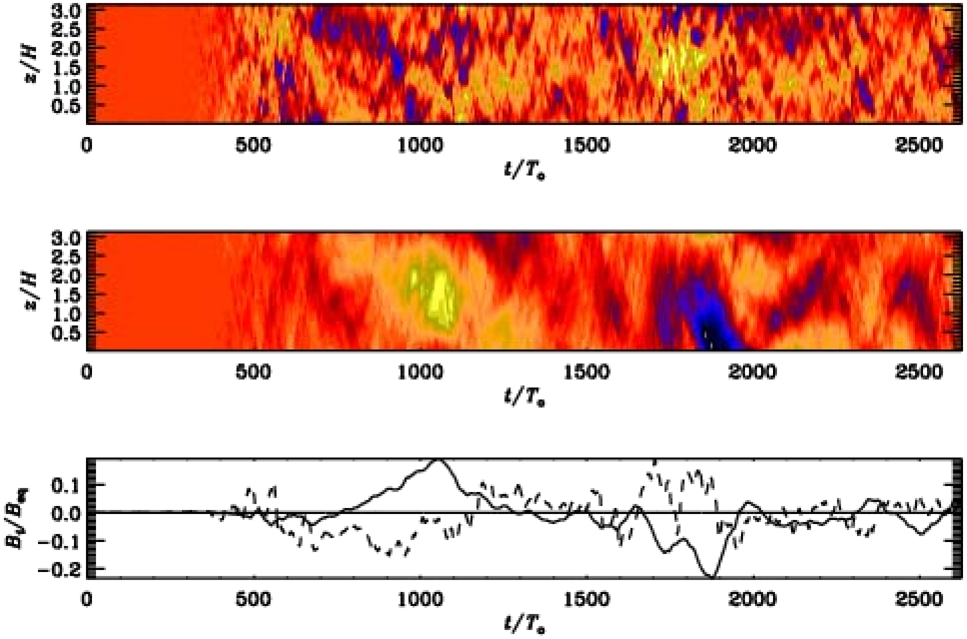
Non-helical shear flow



(i) Cannot be shear-current effect, because here η_{21} has the wrong sign ($\eta_{21}S<0$)

(ii) Incoherent alpha-shear dynamo (Vishniac & Brandenburg 1997, Proctor 2007)

Phase relation as diagnostics?



¾ π for αΩ dynamo
π for incoherent αΩ?

Difficulty: good averaging required

Model equations (VB97)

$$\partial_t B_r = -\partial_z(\alpha B_\theta) + D_t \partial_z^2 B_r \,,$$

$$\partial_t B_\theta = -\tfrac{3}{2}\Omega B_r + D_t \partial_z^2 B_\theta \,,$$