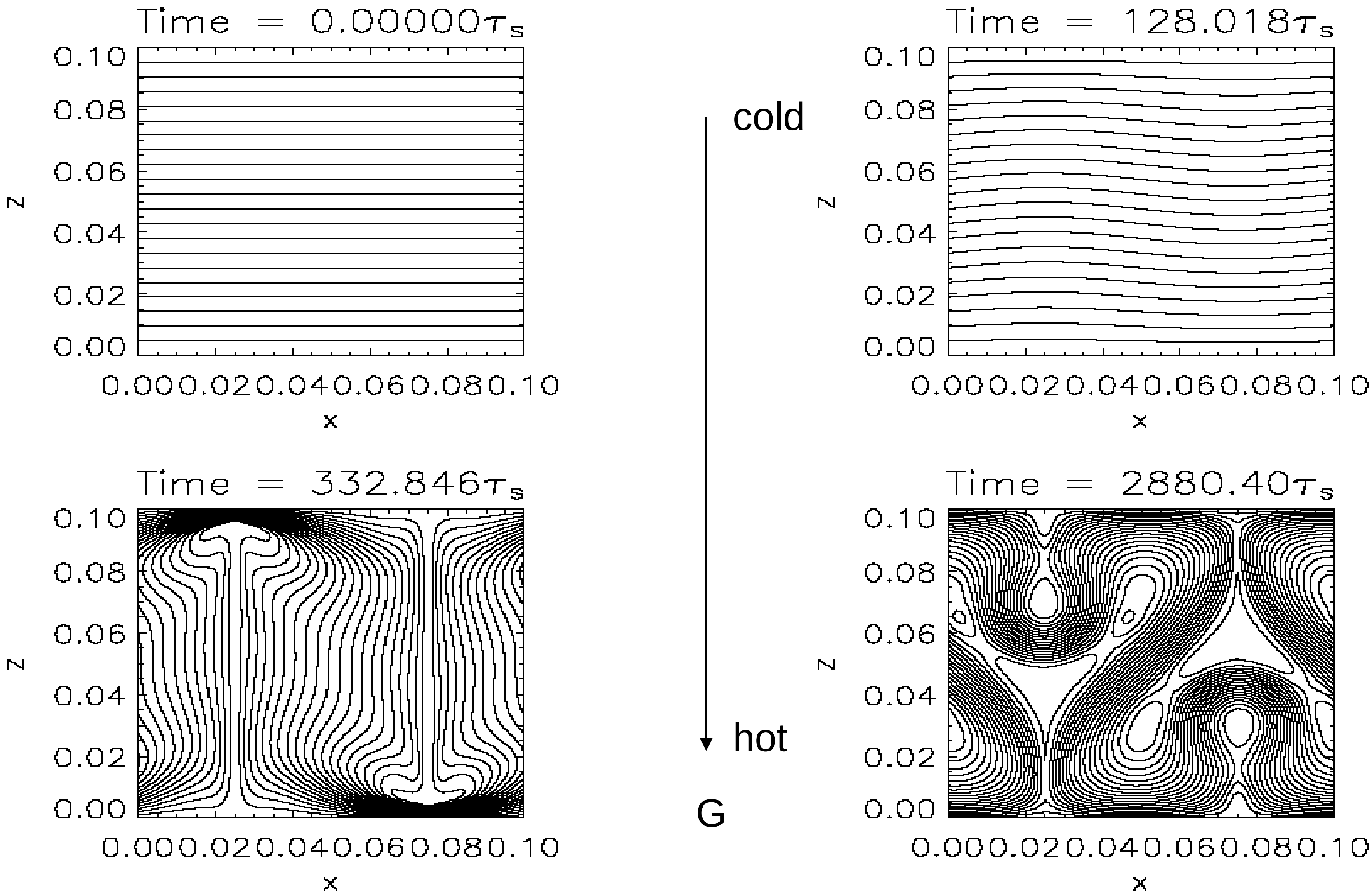
Thermal conduction in dilute plasma

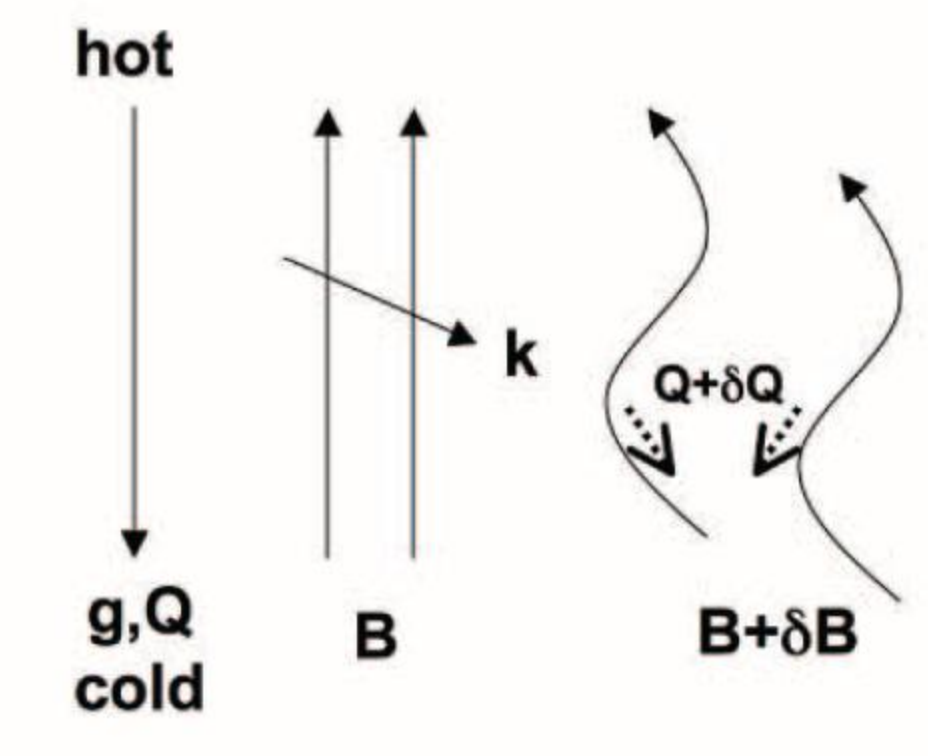
- In dilute plasma, thermal conduction is anisotropic, along magnetic field lines.
- When temperature increase in the gravity direction: MTI
- When temperature decrease in the gravity direction: HBI

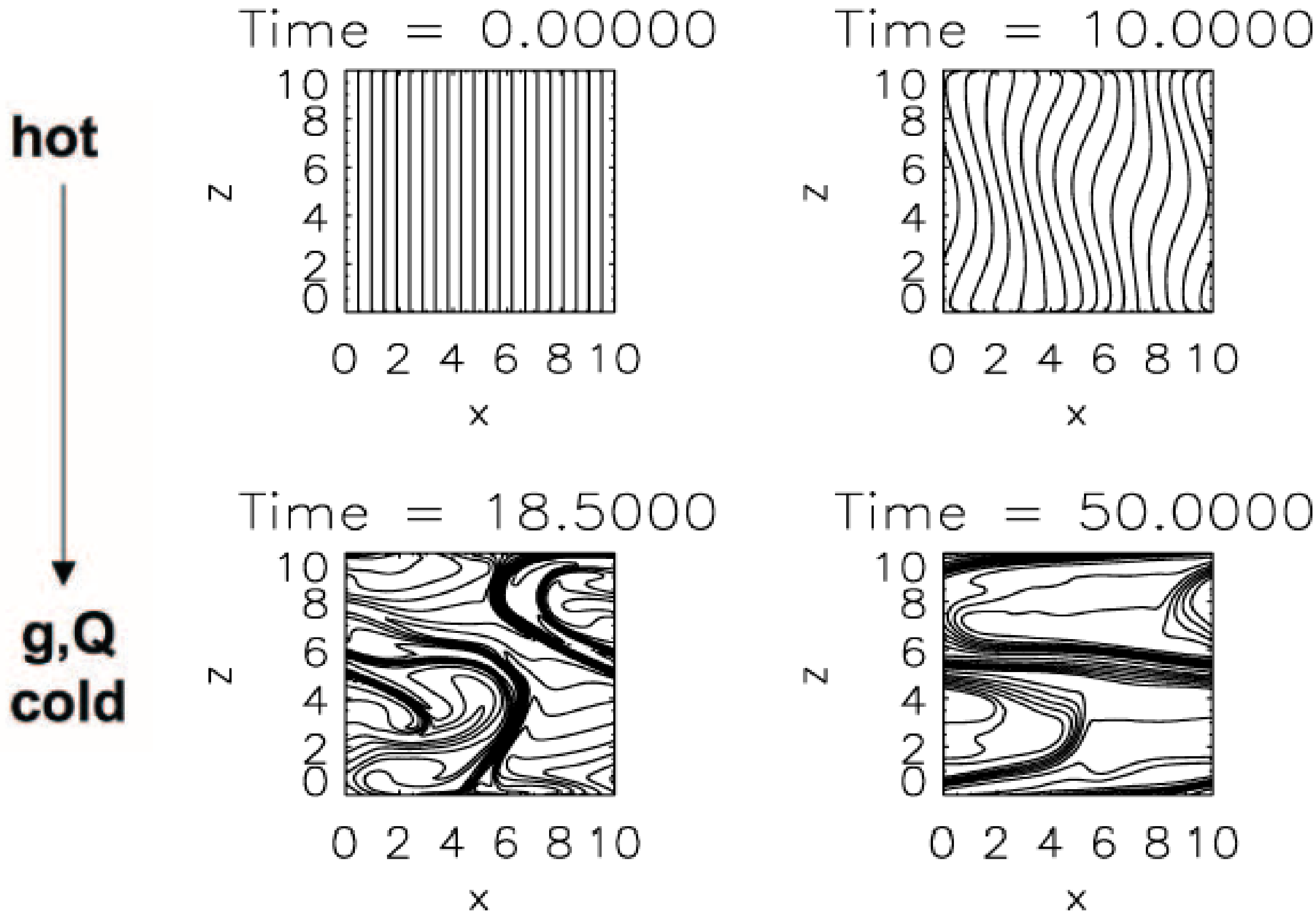
What is MTI



Time = 0.00000τs
Time = 128.018τs
Time = 332.846τs
Time = 2880.40τs
z
x
cold
hot
G

What is HBI




hot
g,Q
cold
Time = 0.00000
Time = 10.0000
Time = 18.5000
Time = 50.0000
z
x
0 2 4 6 8 10

Dispersion relation

$$\omega^2 \simeq g\left(\frac{d\ln T}{dz}\right)\left[\left(1-2b_z^2\right)\frac{k_\perp^2}{k^2}+\frac{2b_xb_zk_xk_z}{k^2}\right]$$

Maximum growth rate for MTI:

$$\omega^2 \simeq g\left(\frac{d\ln T}{dz}\right)\frac{k_\perp^2}{k^2}.$$

Maximum growth rate for HBI:

$$\omega^2 \simeq -g\left(\frac{d\ln T}{dz}\right)\frac{k_\perp^2}{k^2}$$

Result due to MTI

- Magnetic field can be amplified by a factor of 30.

- Field lines is aligned with temperature gradient

- Magnitude of conduction increase

Result due to HBI

- Magnetic field can be amplified by a factor of 30.

- Field lines is rearranged perpendicular to temperature gradient

- Magnitude of conduction decrease significantly

Implication

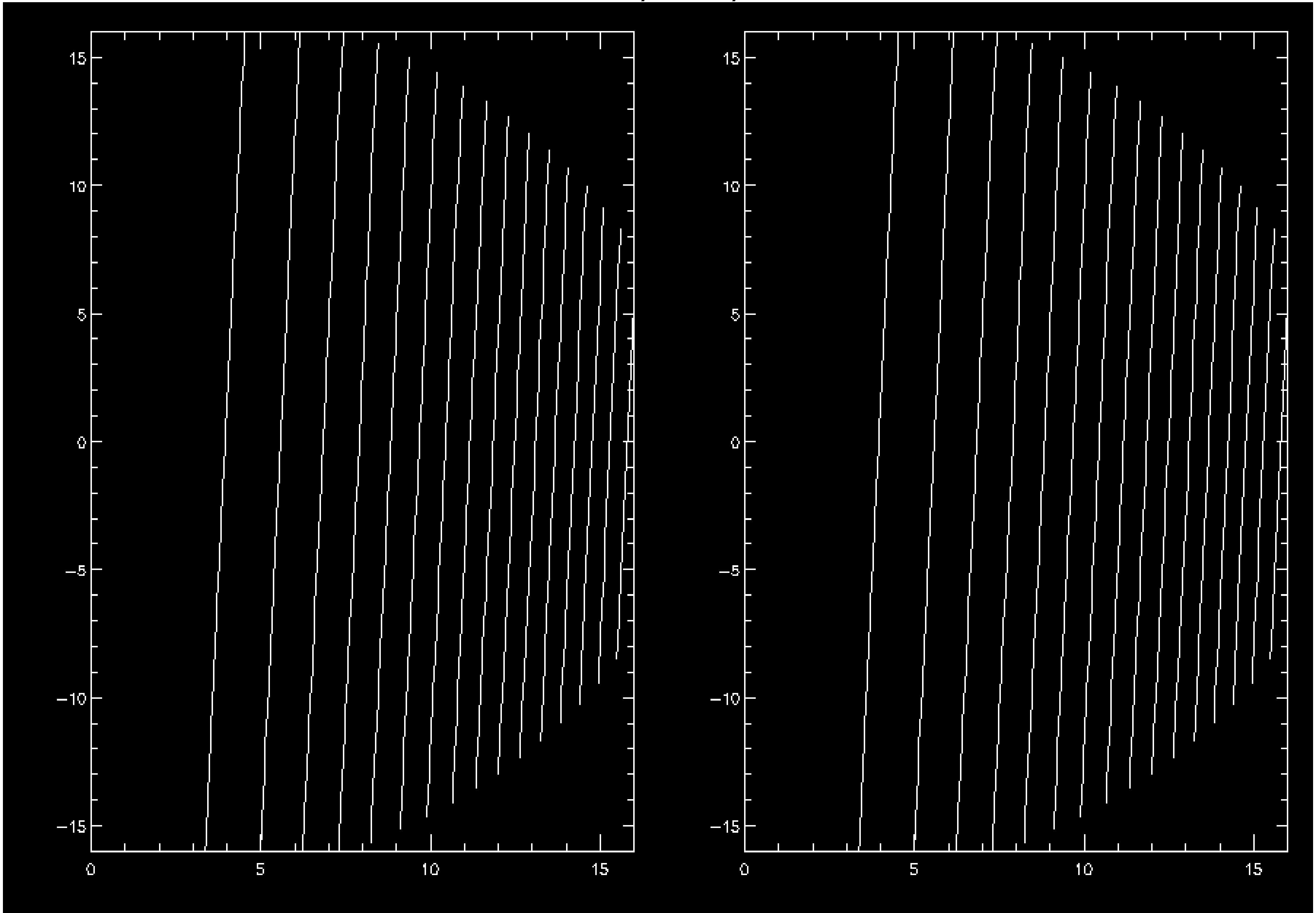
- MTI:
  - ✓ Intracluster medium （outside cool core):

    Parrish, Stone, Lemaster, 2008, ApJ, 688,905
  - ✓ Accretion disks

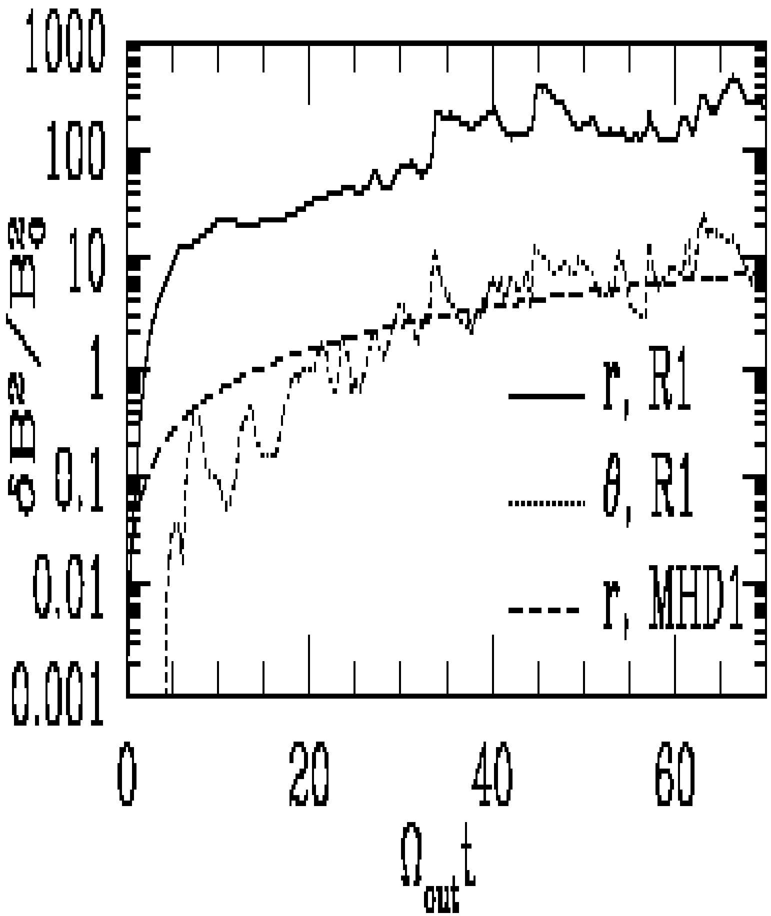
    Sharma, quataert, stone,2008,MNRAS,389,1815
- HBI:
  - ✓ Intracluster medium (inside the cool core):

    Parrish, quataert, Sharma, quataert, MNRAS,389,1815

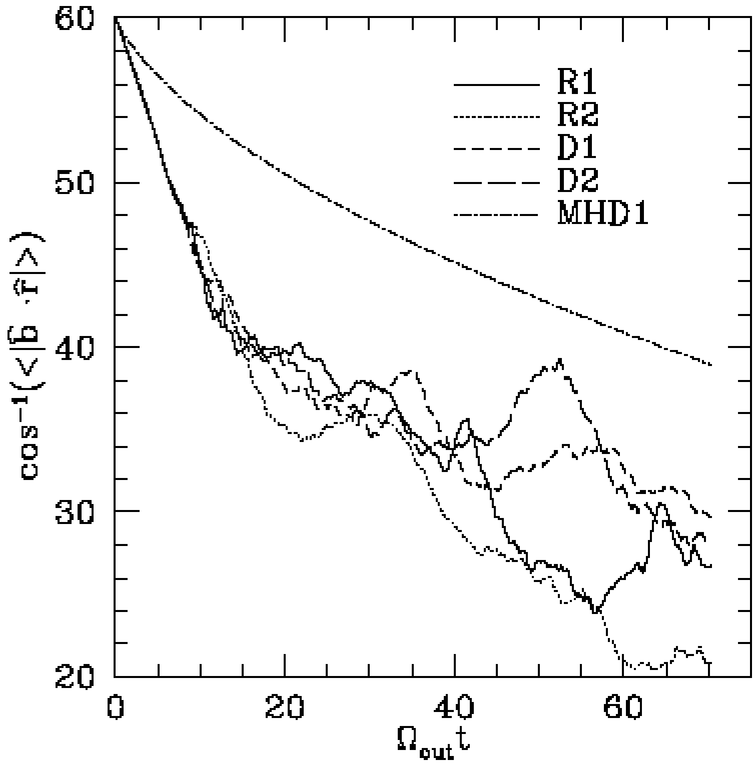
A example—reproduce (Sharma, Quataert, Stone, 2008, MNRAS,389,1815



out



1000
100
10
1
0.1
0.01
0.001
$\delta B^2 / B_\phi^2$
r, R1
θ, R1
r, MHD1
0
20
40
60
$\Omega_{out} t$



60
50
40
30
20
$\cos^{-1}(\langle|\hat{b} \cdot \hat{r}|\rangle)$
R1
R2
D1
D2
MHD1
0
20
40
60
$\Omega_{out} t$

What shall we do

- In rotating dilute plasma, in addition to MTI, MRI should also exists. We will examine the interplay of MTI and MRI.