3D MHD, **dissipative** runs, 512^3 grids, ideal or large-scale initial conditions Total enstrophy $<\omega^2+j^2>$



Ideal phase

3D MHD, **dissipative** runs, 512^3 grids, ideal or large-scale initial conditions Total enstrophy $<\omega^2+j^2>$



line). The magnetic Prandtl number is unity. Notice the two p small-scale development, slightly retarded and significantly lesser sity (smaller ϵ) as the Reymond support increases followed by a Reynolds-dependent phase of constant dissipation.

corresponds to a correlation coefficient of 10%. Furthermore, the kinetic enstrophy is 5.23 and the magnet strophy 5.89. For the other run, the kinetic energy is the magnetic energy 1.58, and the cross-correlation. Thus the correlation is 77%. The kinetic and magnet strophies are 5.37 and 6.07, respectively. The visco again $v = 1 \times 10^{-3}$ and we use a time step $dt = 2.5 \times$ Figure 8 shows the kinetic and magnetic enstrophies time for the two runs. We notice that the magnetic enstrophies its kinetic counterpart, although they are a equal initially. A similar dominance is seen in the ensurement of the kinetic enstrophy shows a strong bursts.

Reconnection and strong intermittency



Is there a path from ideal structures to reconnection?



3D MHD **Ideal** run 6144³ equiv.



Brachet et al., PRE 2013



3D MHD **Ideal** run 6144³ equiv.





3D MHD **Ideal** run 6144³ equiv.





3D MHD **Ideal** run 6144³ equiv.





Dissipative 2048³ equiv., sheet roll-up & bubbles (also Mininni et al. NJP 2008 movie)

Dissipation rate, 3D up to 1536³ grids, *also 2D*





Dissipative 2048³ equiv., sheet roll-up & bubbles (also Mininni et al. NJP 2008 movie)

1- Do singular (ideal) structures matter for the dissipative case?2- Does the 2D case matter to understand the 3D case?

3- Are rotational discontinuities a central piece of **3D** reconnection?4- Does current sheet roll-up play a role?

Both are observed in the Solar Wind 5- What role do invariants (magnetic & cross helicity) have?

6- Is the rate of dissipation independent of Reynolds number?7- What are the structures, and how to select them?

- *8-* What is the role of the magnetic Prandtl number?
- 9- Do small-scale kinetic effects alter large-scale dynamics? How?10- How can Adaptive Mesh Refinement help?

What could be the next ``big'' runs to progress?

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Thank You!