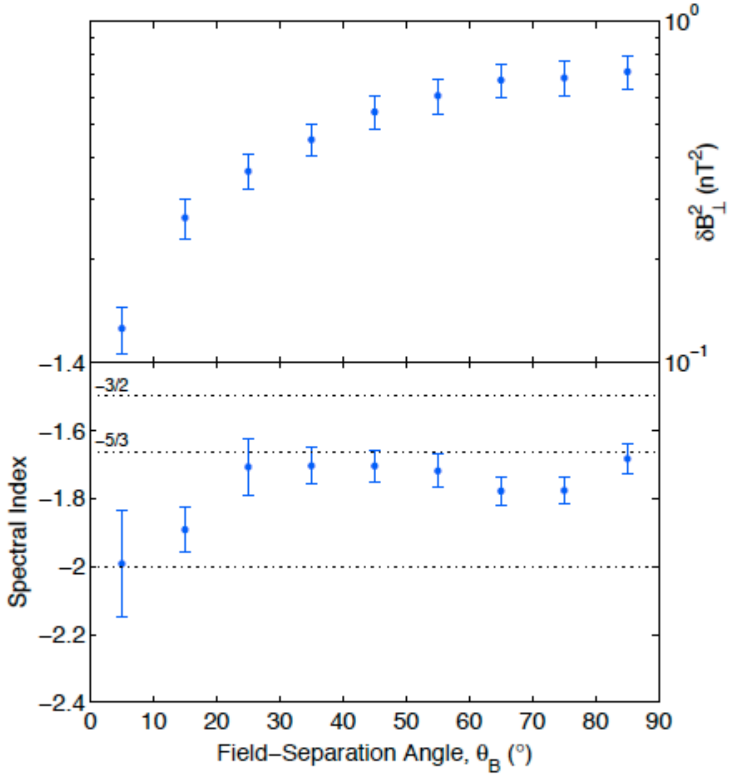
Anisotropic Scaling

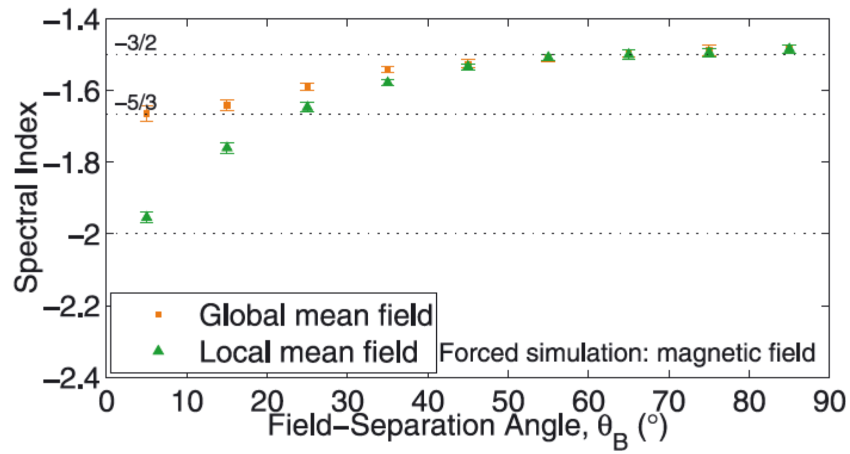
- *Cluster* multi-spacecraft measurement in slow wind
- Power increases with angle to the local mean field $\rightarrow$ $k_\perp > k_\parallel$
- Like Bieber et al. 1996 but stronger anisotropy due to local mean field
- -2 parallel spectrum as in critical balance predictions (Horbury et al. 2008 PRL, Podesta et al. 2009 ApJ, Luo & Wu 2010 ApJL, Wicks et al. 2010 MNRAS, Chen et al. 2011 MNRAS, Wicks et al. 2011 PRL, Horbury et al. 2012 SSR, Chen et al. 2012 ApJ, He et al. 2013 arXiv)



Chen et al. 2011 MNRAS

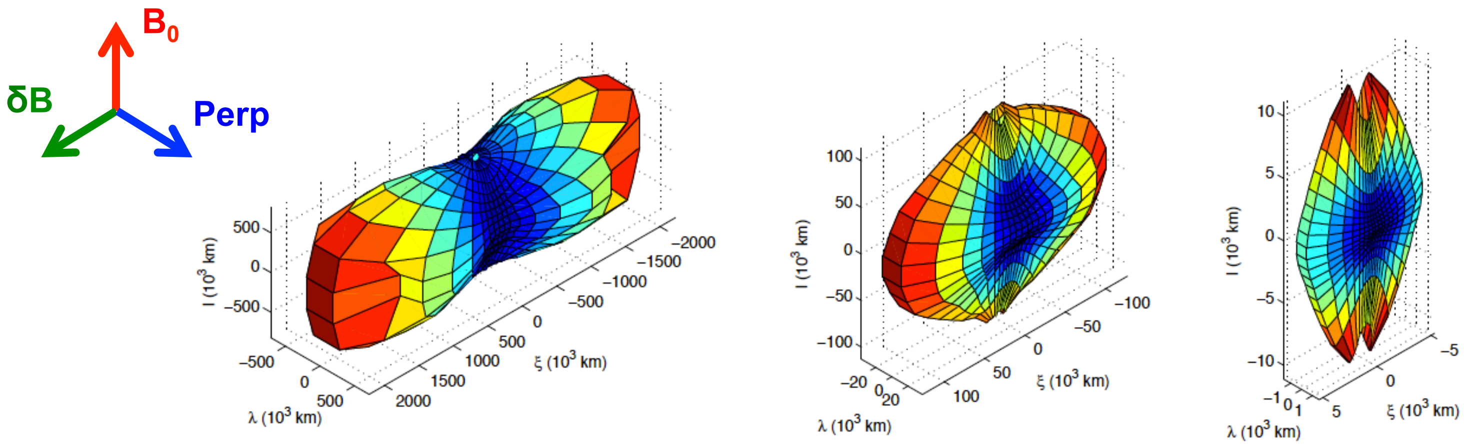
Local vs Global Mean Field

- Applied same technique to 512^3 RMHD simulations
- Scaling is anisotropic to the local mean field, only slightly anisotropic to global mean field
- Using global or local mean field makes a difference, even when $\delta B/B$ small ($\delta B/B \sim k_{\parallel}/k_{\perp}$)
- Local mean gives higher order (Matthaeus et al. 2012 ApJ)



Chen et al. 2011 MNRAS

Local 3D Anisotropy

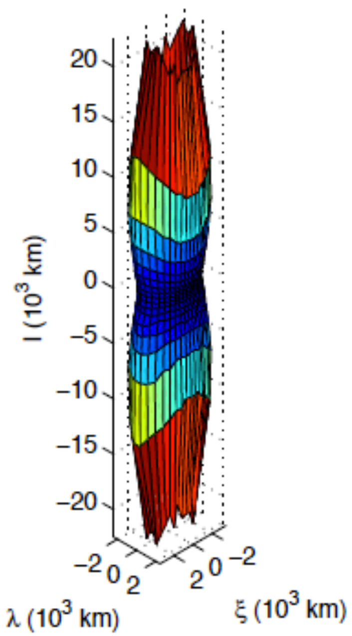


Chen et al. 2012 ApJ

- Pick constant power and plot variation of scale with angle → statistical surface of constant power → “eddy shape”
- Large scales: elongated in δ**B** direction, Alfvén waves from Sun
- Turbulent range: eddy elongates in $\mathbf{B}_0$ direction (critical balance)
- Eddy is anisotropic in the perpendicular plane. Why? Not fully understood but closely related to dynamic alignment, solenoidality, intermittency…

Compressive Fluctuation Anisotropy

- Long standing problem: why are the compressive fluctuations not damped?
- Same technique shows δ|**B**| fluctuations are more elongated than the Alfvénic fluctuations (at least 2-3 times)
- Consistent with no parallel cascade along exact field lines, so little damping since $\gamma \sim k_{||}$ (Schekochihin et al. 2009 ApJS)
- Also could be that the less oblique fluctuations are damped leaving the highly anisotropic ones



Chen et al. 2012 ApJ