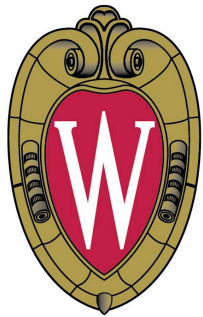


Intermittent Magnetic Field Excitation by a Turbulent Flow of Liquid Sodium

Mark Nornberg

Cary Forest, Erik Spence, Adam Bayliss, Roch Kendrick,
Craig Jacobson, Carlos Parada

To appear in Phys. Rev. Lett. (arXiv:physics/0606239)



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MADISON

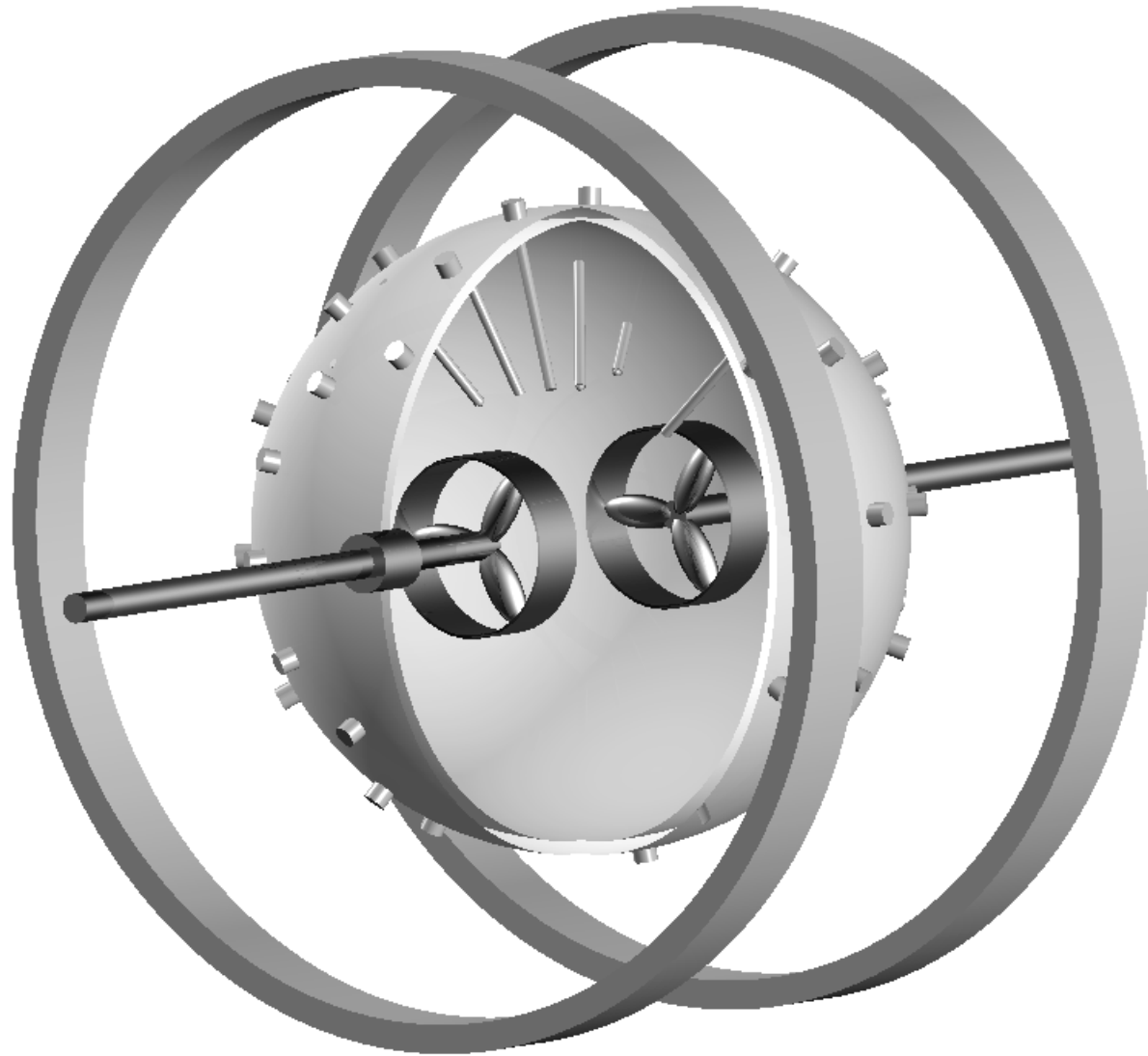
Geophysical Turbulence
Workshop

NCAR Boulder, CO

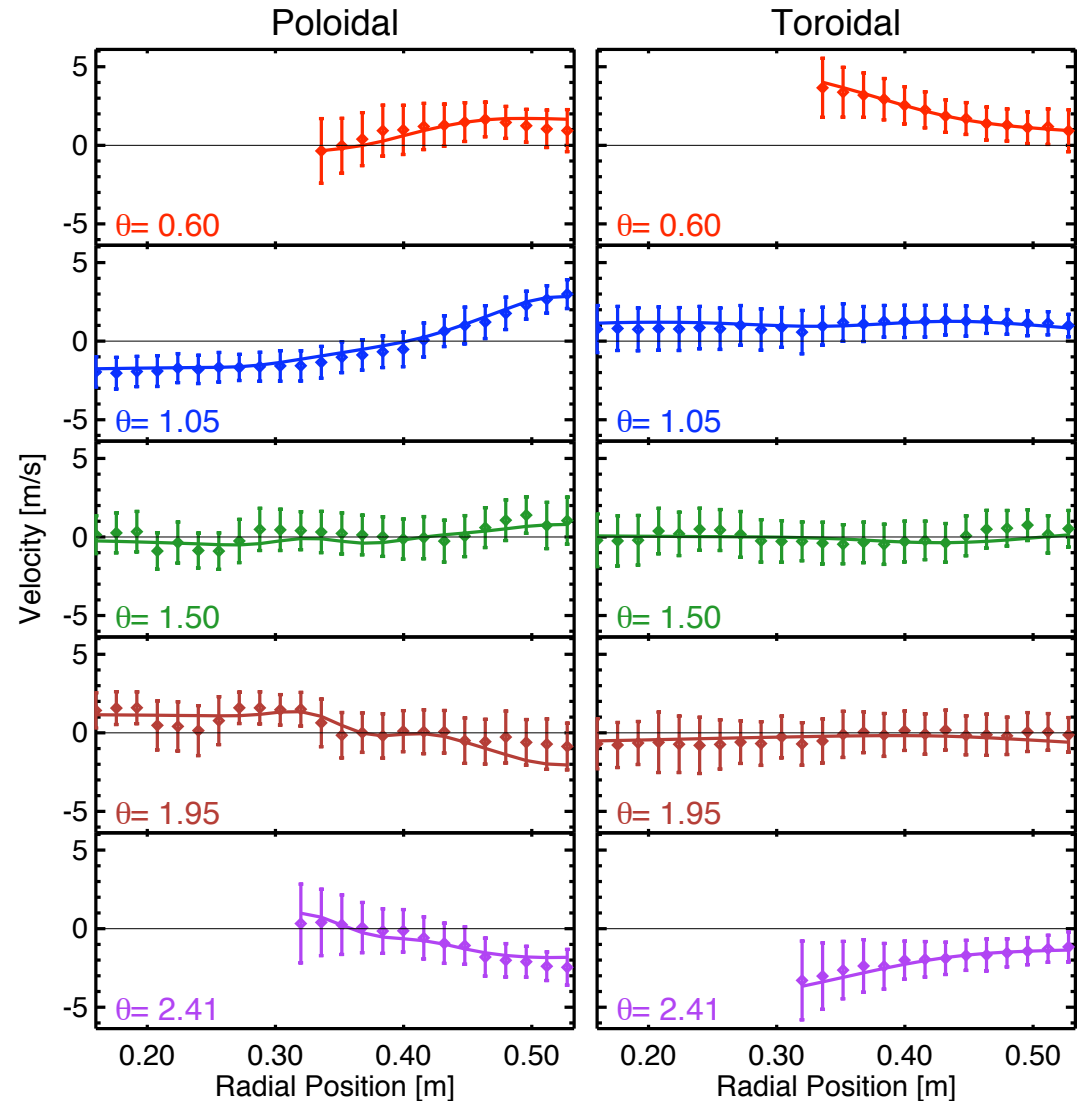
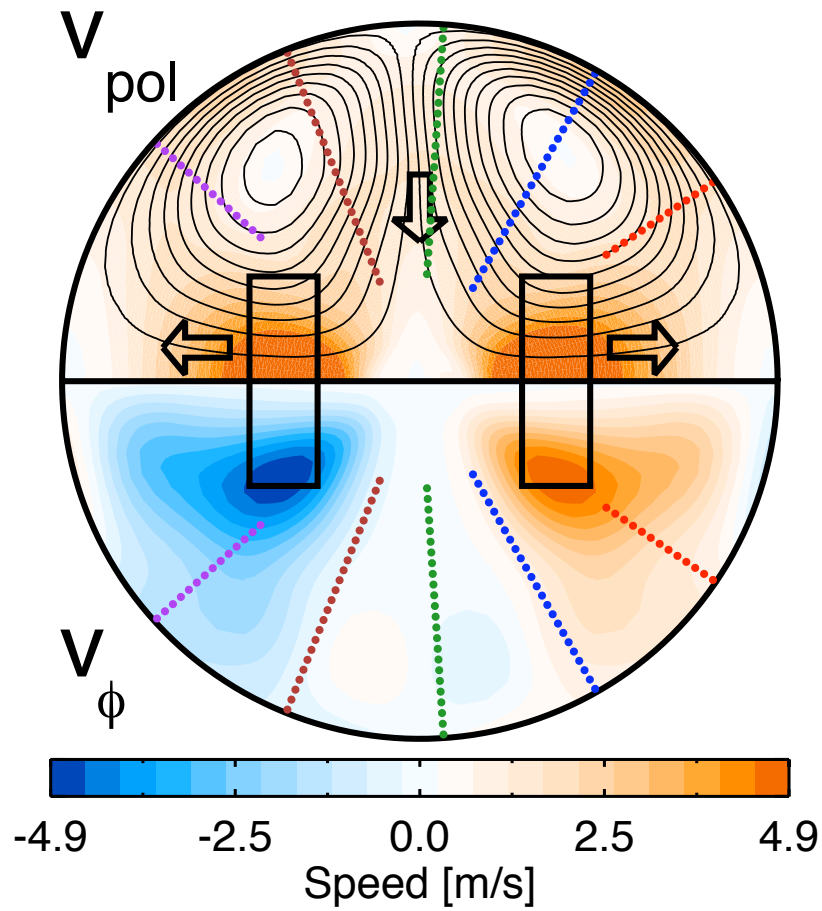
29 June 2006

The Madison Dynamo Experiment

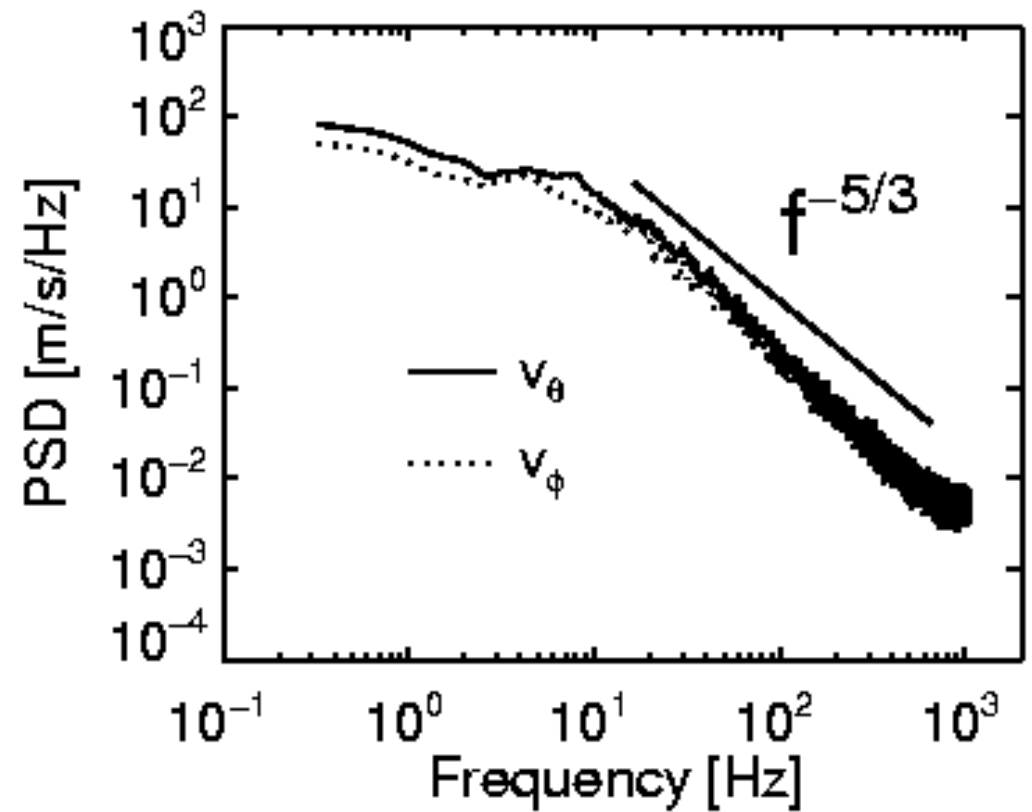
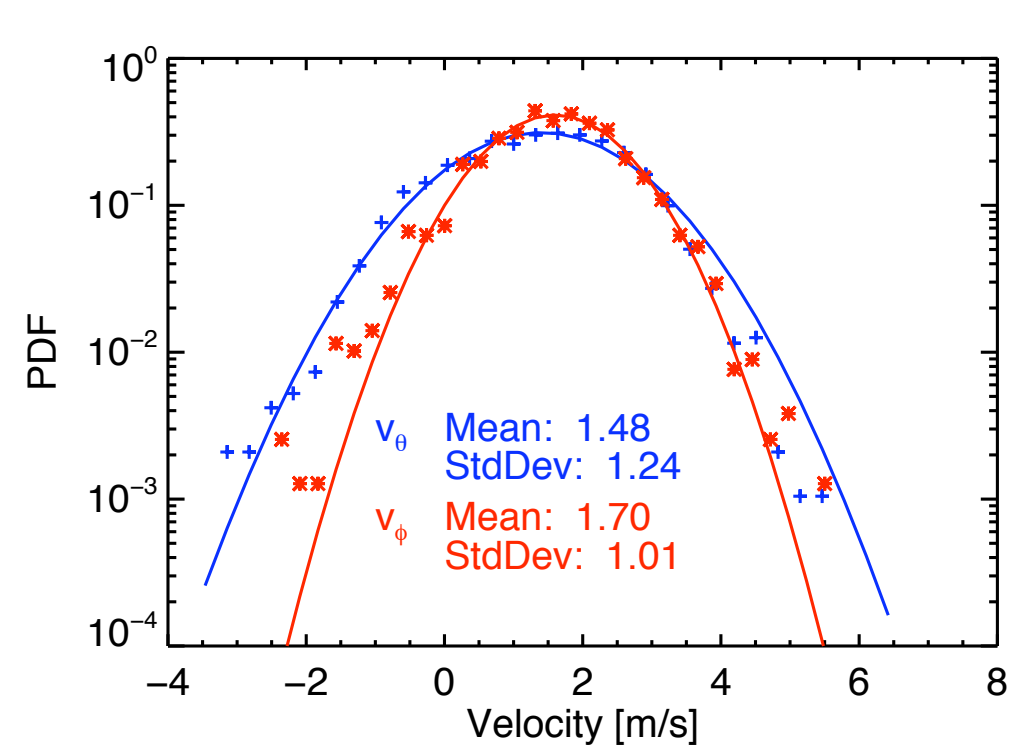
- 1 meter diameter sphere
- 180 gallons liquid sodium
- Two 75 kW motors drive impellers (30 Hz max)
- External coils create a nearly uniform magnetic field coaxial with the symmetry axis
- 74 Hall probes on surface of sphere to measure field



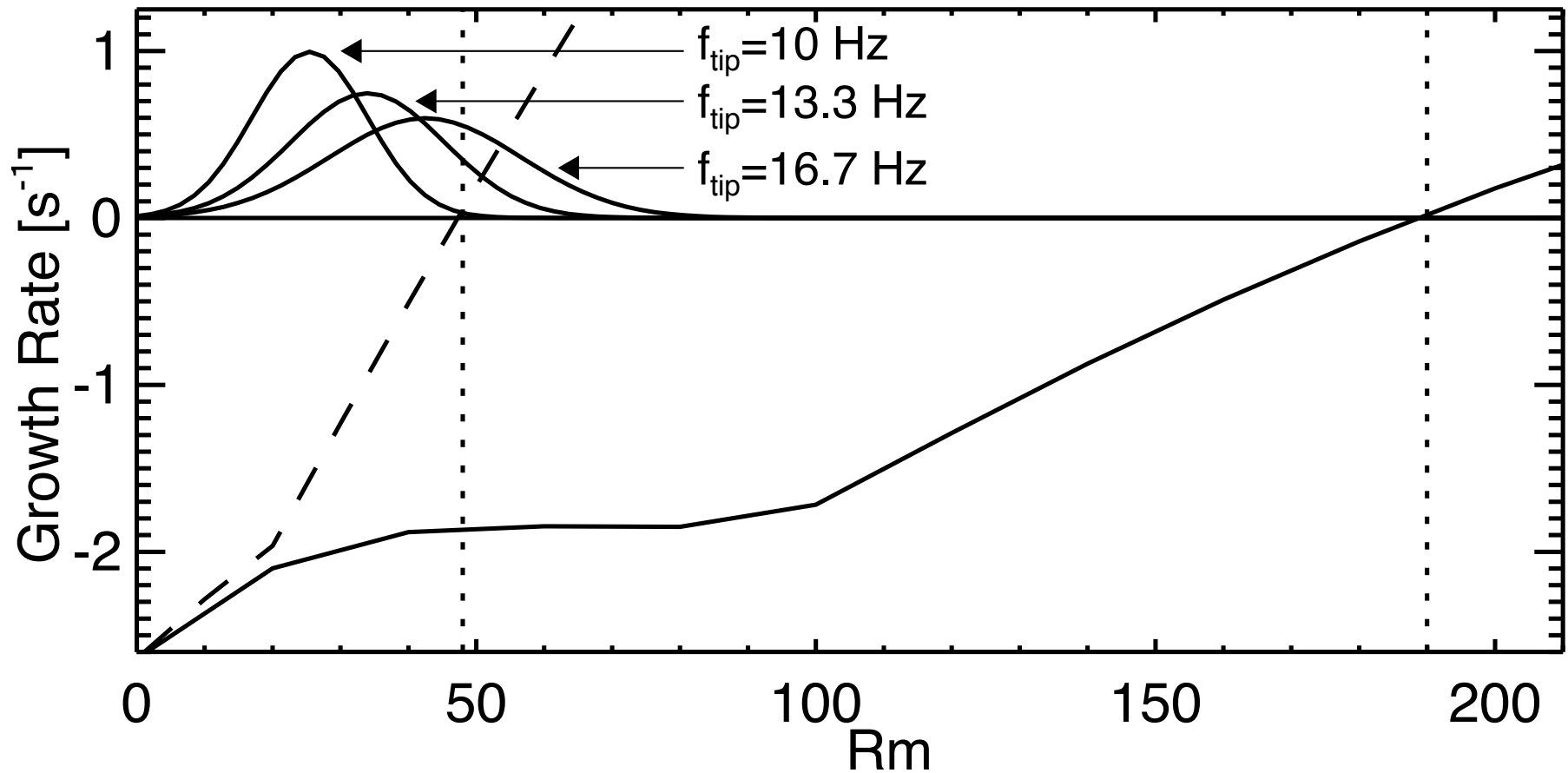
Mean velocity field model constructed from LDV measurements



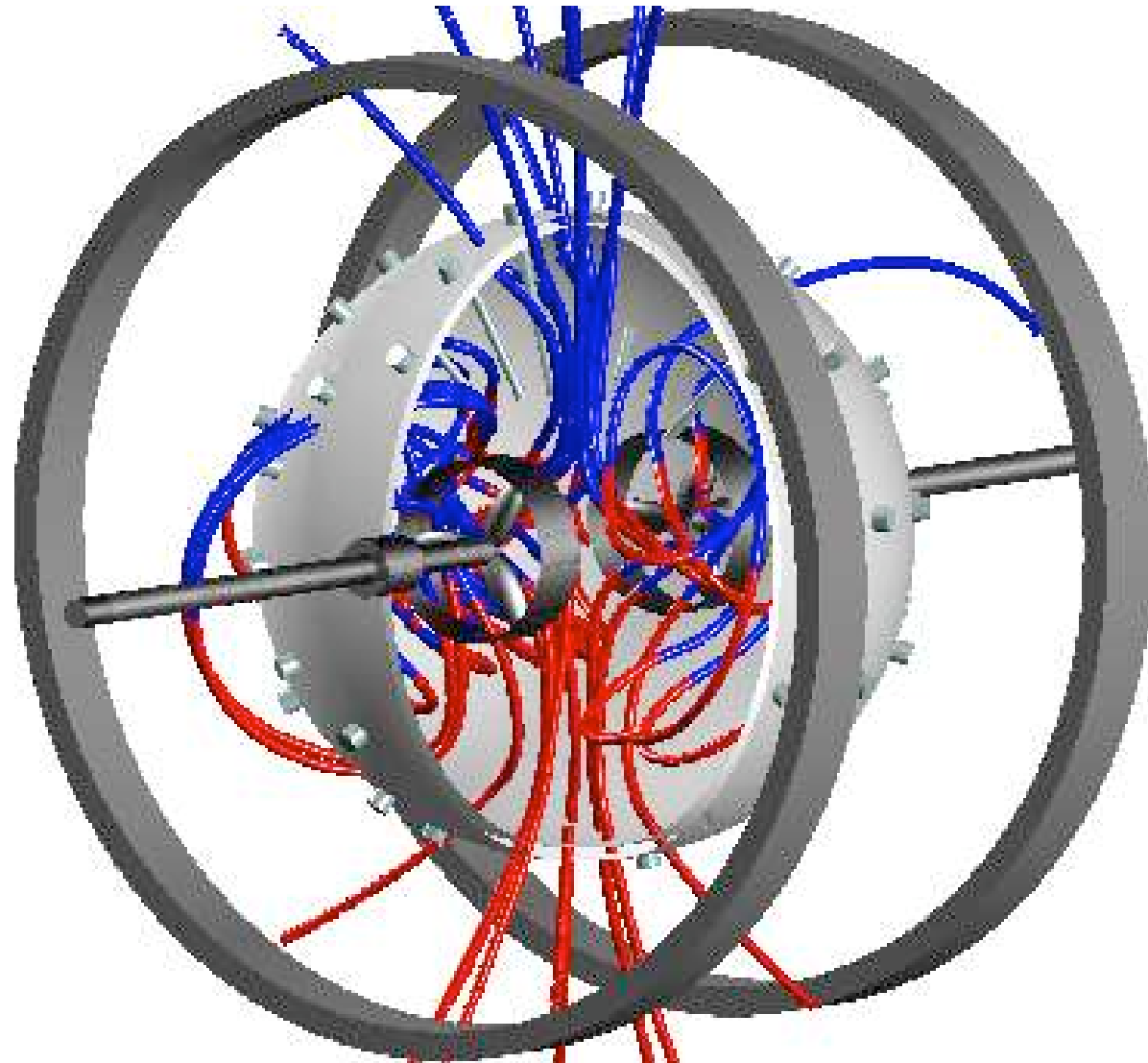
Velocity measurements have gaussian PDFs and Kolmogorov spectra



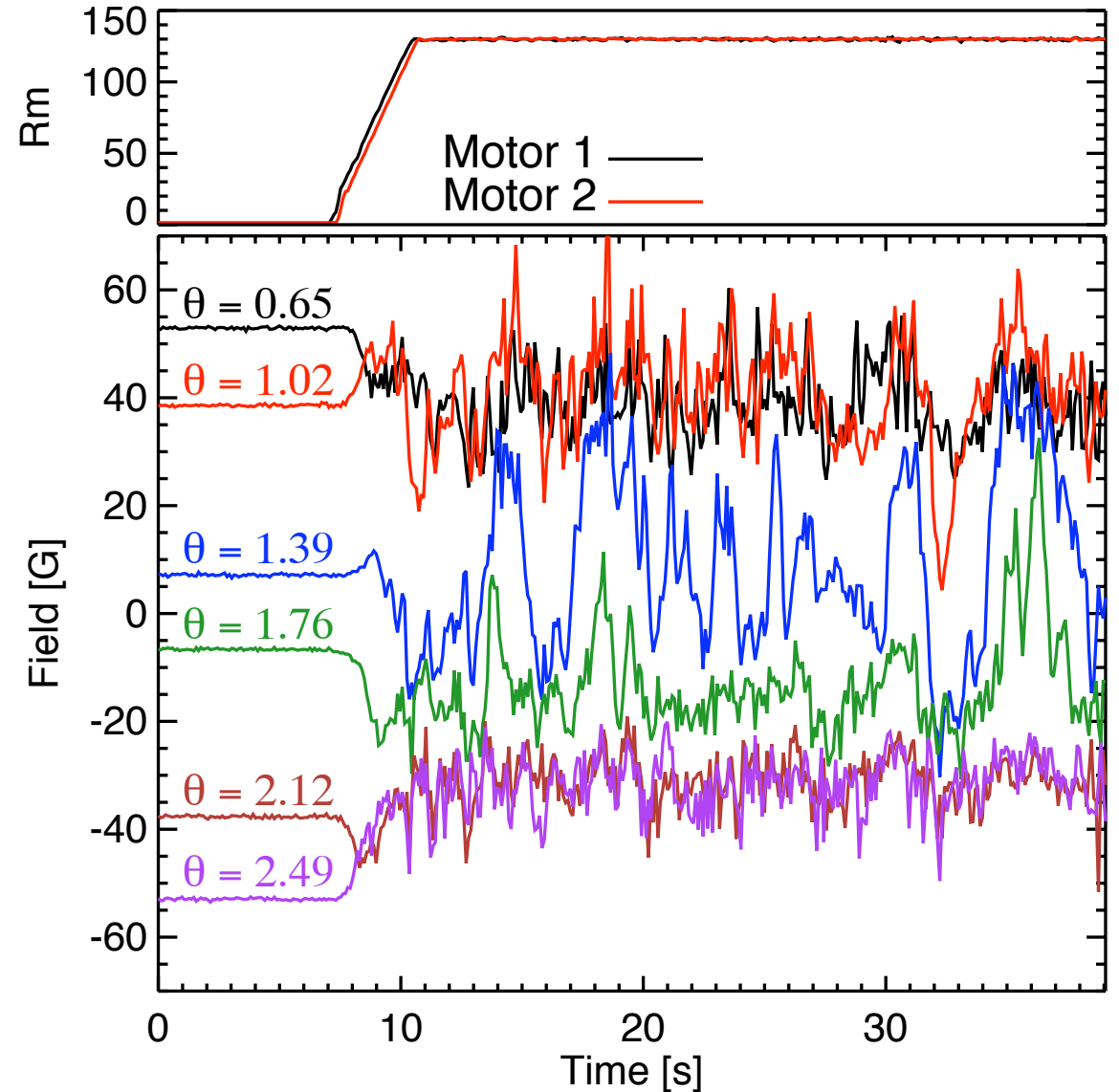
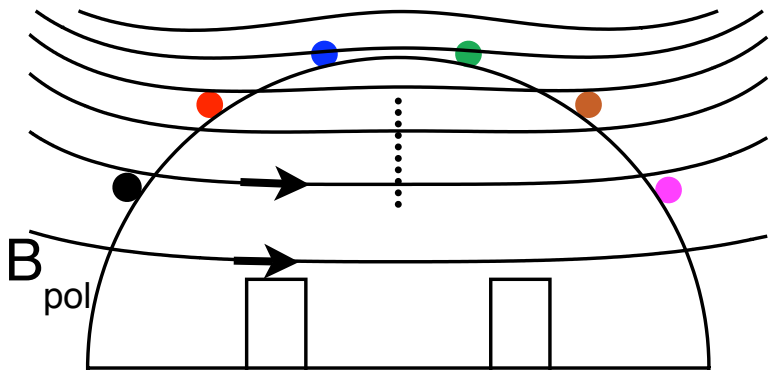
Changes in the large-scale flow profile can change the dynamo threshold

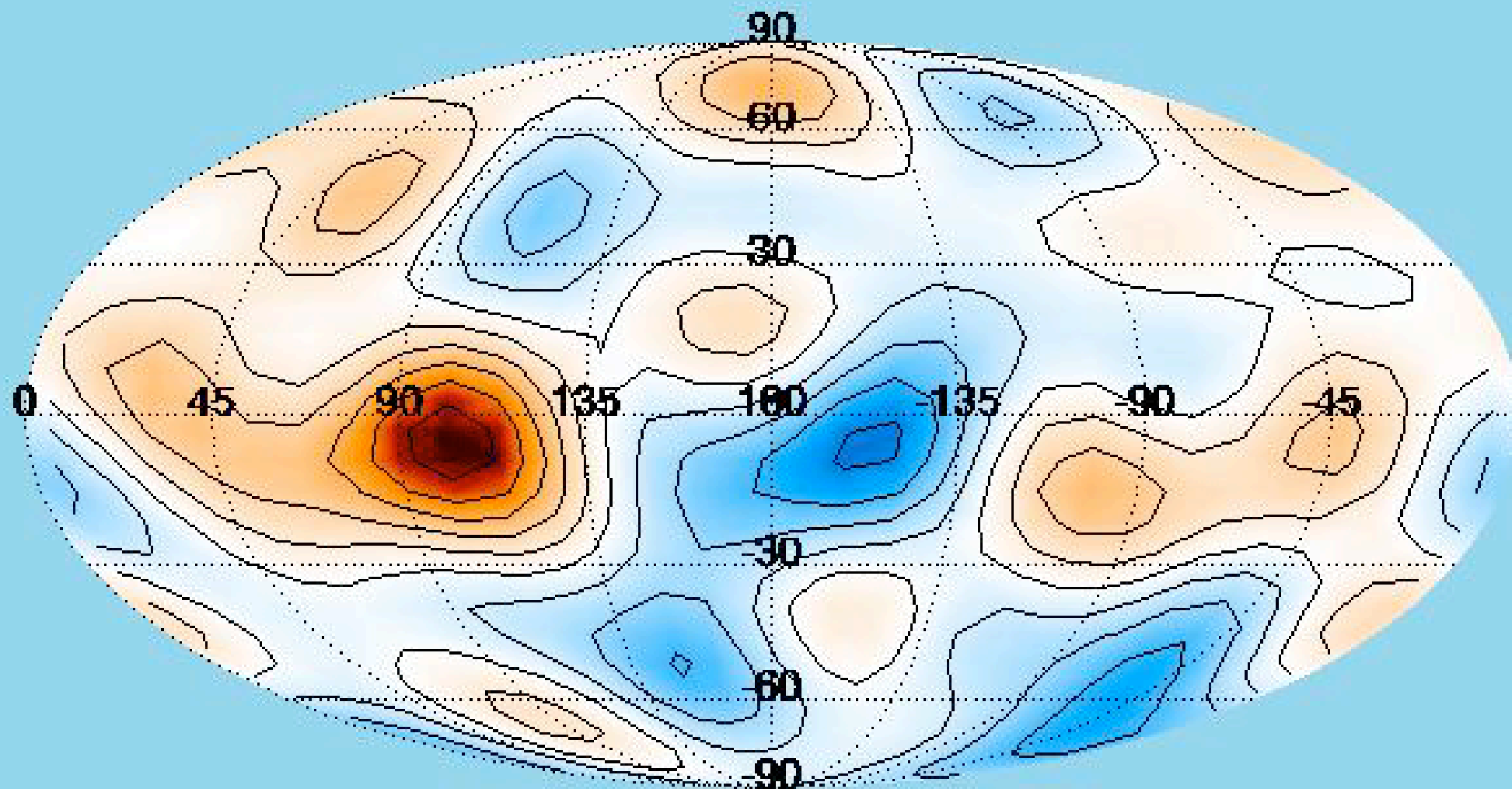


Laminar model predicts excitation of transverse dipole field



Magnetic fields are induced by the turbulent flows





Time: 0.02 s

Response Field [G]



-31

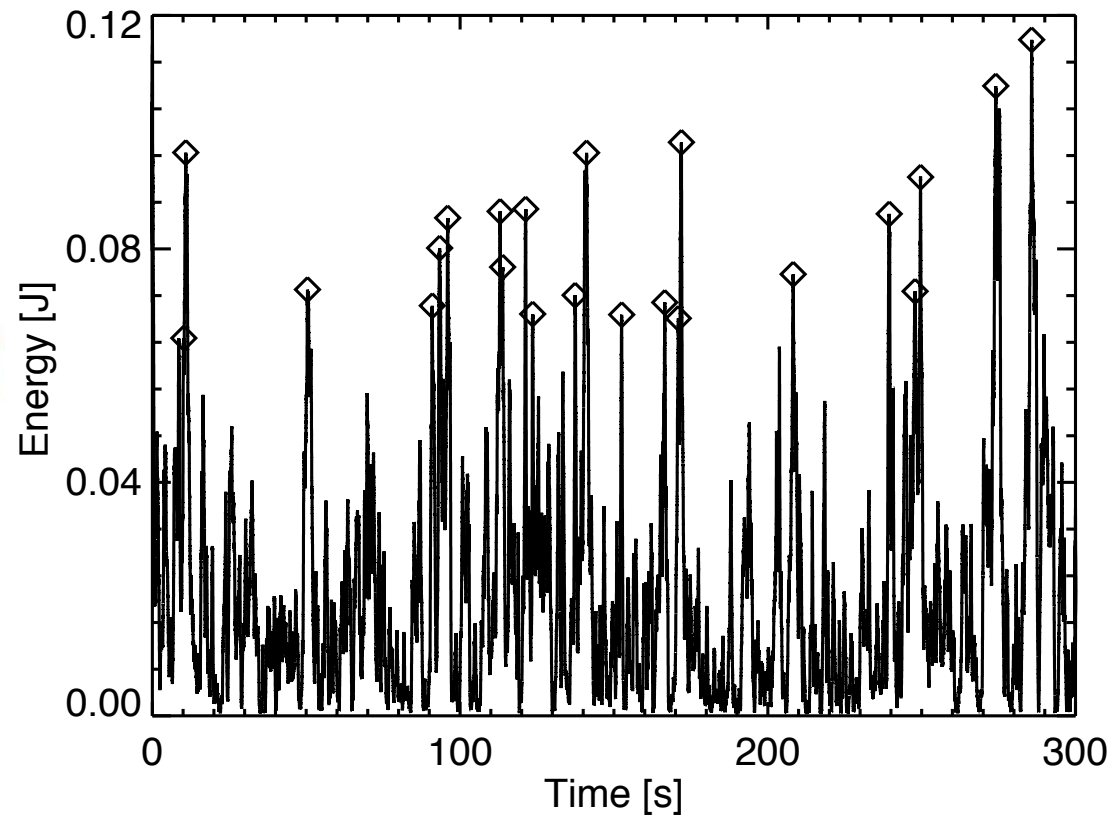
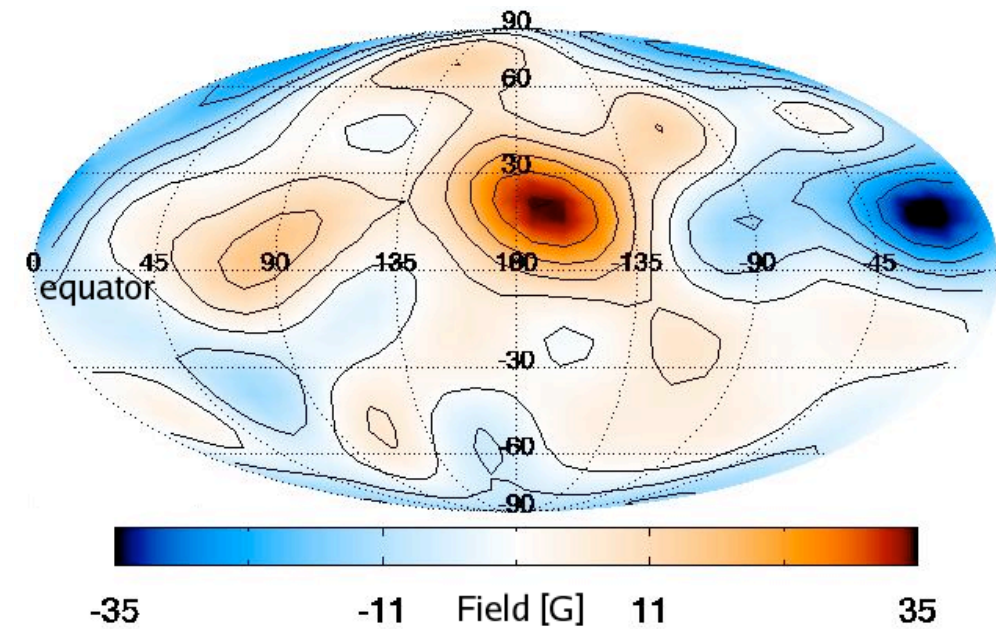
-15

0

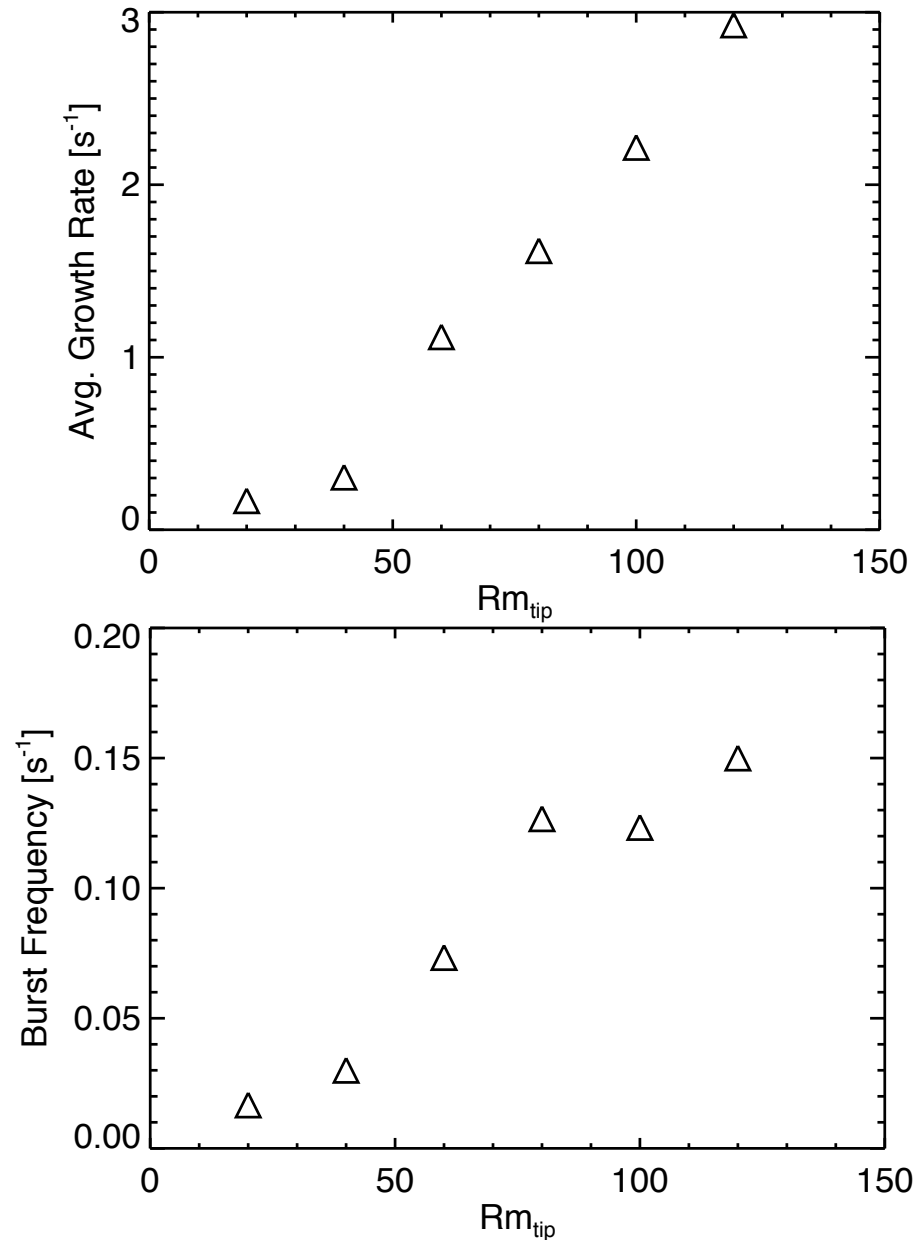
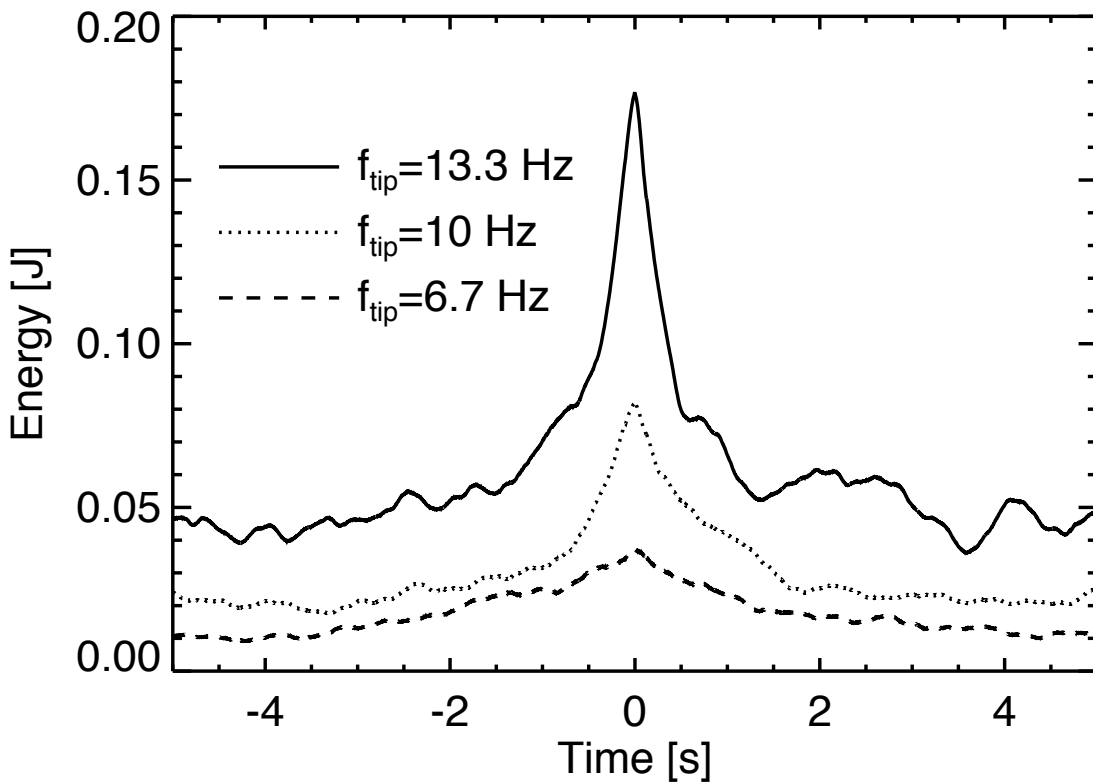
15

31

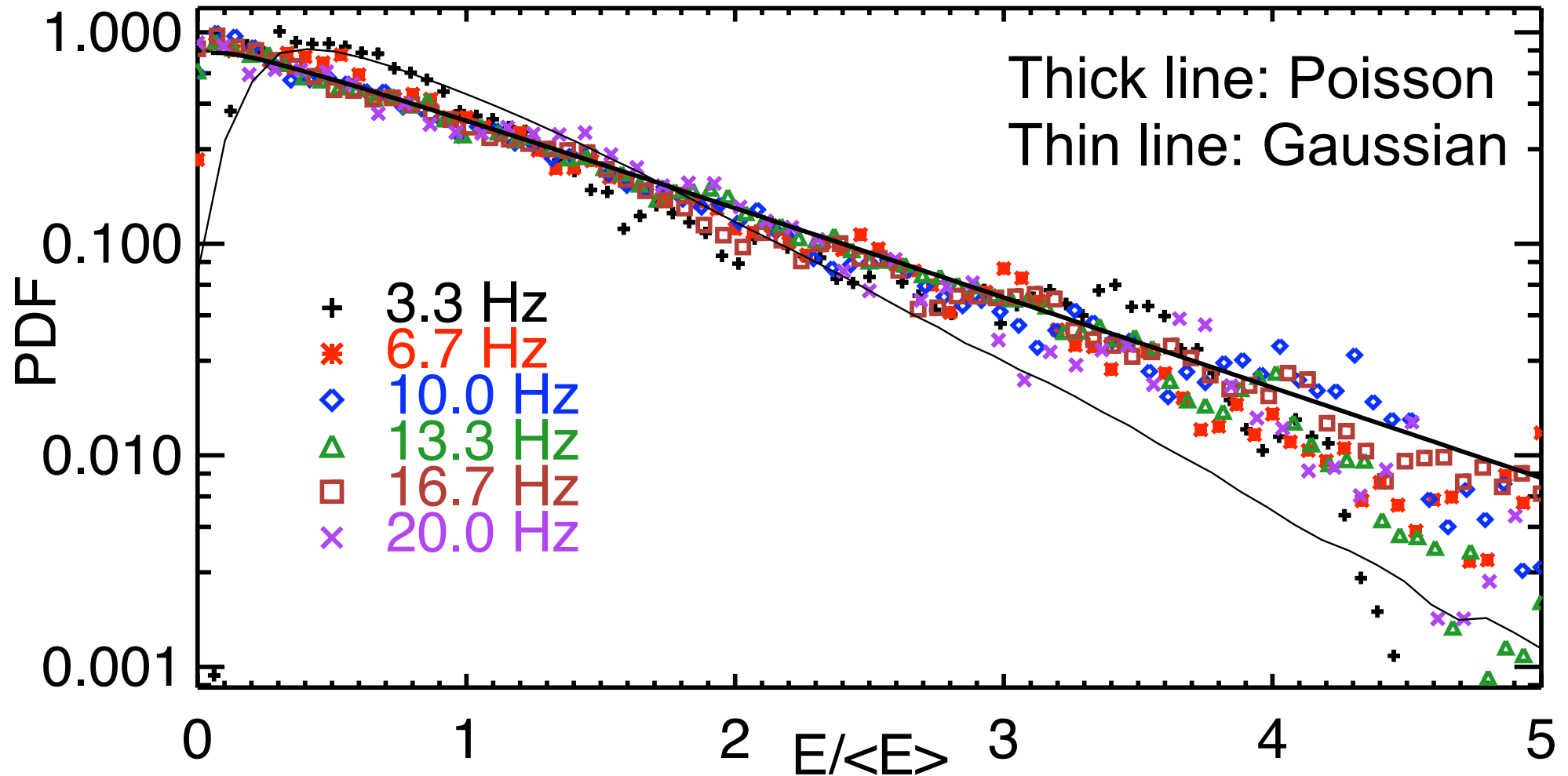
Magnetic bursts have same structure as laminar dynamo prediction



Conditional averaging is used to determine growth rate



Energy Probability Distribution Functions become Poisson at higher rotation rates



Summary

- Turbulence can change threshold for field growth leading to intermittent excitation
- Observed intermittent bursts of magnetic fields with the structure predicted from a laminar dynamo model
- Field bursts gain strength and frequency with increasing impeller rotation rate
- Duration of bursts shortens so that they remain rare events
- Intermittent growth is possible even for flows which are on average sub-critical

