ASTR/ATOC-5410: Fluid Instabilities, Waves, and Turbulence

Project description November 11, 2016, Axel Brandenburg

Project on intermittency

Background

Shell models of turbulence have revealed that higher moments q of the spectral velocity, $\langle|u_n|^q\rangle$, show scaling with wavenumber k_n (Jensen et al., 1991) that is compatible with She-Leveque scaling (She & Leveque, 1994).

Project details

Run shell models to study this for yourself.

1. Determine the scaling exponents, ζ_q, from the inertial range scaling of $\langle|u_n|^q\rangle \sim k_n^{-\zeta_q}$. Determine error bars and compare with She-Leveque.
2. Study the nature of the temporal fluctuations and link them to the model assumptions made in the She–Leveque scaling in the shell model.
3. Study the scaling of temporal velocity differences. Focus on the odd moments.
4. How do the complex moments, $|\langle u_n^q\rangle| \sim k_n^{-\tilde{\zeta}_q}$?
5. How does the scaling change if you change the conservation law and enforce enstrophy conservation?

References

Jensen, M. H., Paladin, G., & Vulpiani, A., "Intermittency in a cascade model for three-dimensional turbulence," *Phys. Rev.* **A 43**, 798-805 (1991).

She, Z.-S., Leveque, E., "Universal scaling laws in fully developed turbulence," *Phys. Rev. Lett.* **72**, 336-339 (1994).