Predator-Prey dynamics between Zonal flows and Turbulence

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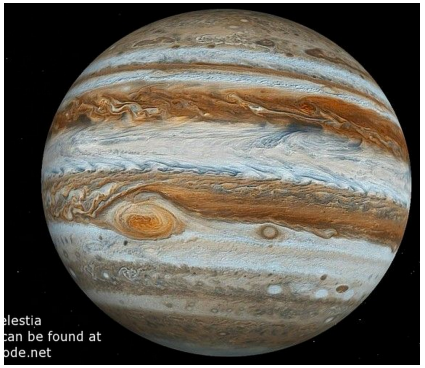
Turbulence create self-organized flows

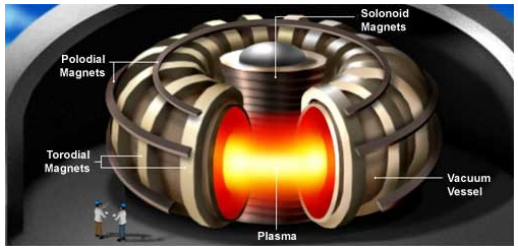
- Turbulence can create Self-organized flows such as zonal flows

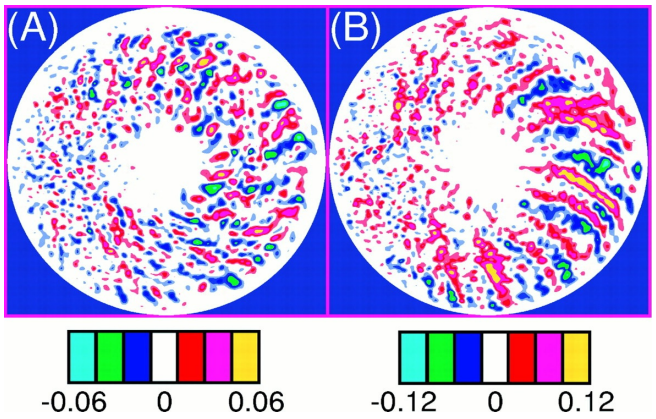
  … Jupiter, Saturn, Earth's jet streams, etc

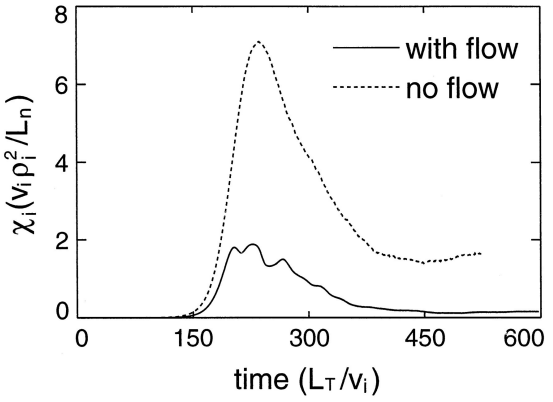


- "Zonal flows" suppress Turbulence

  … Critical for Magnetic Fusion



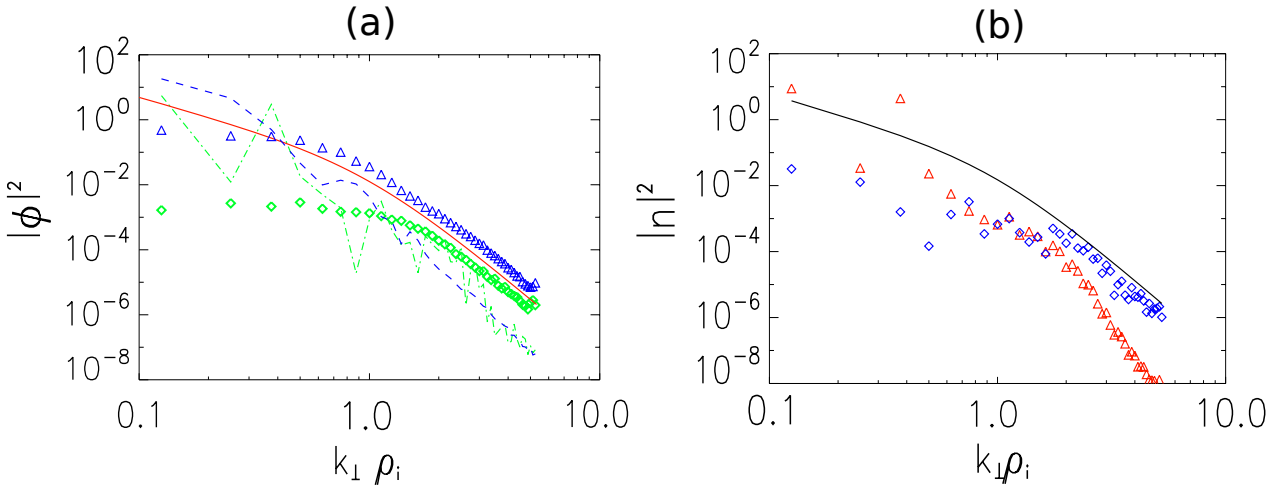




[Lin et al, Science, 1998]

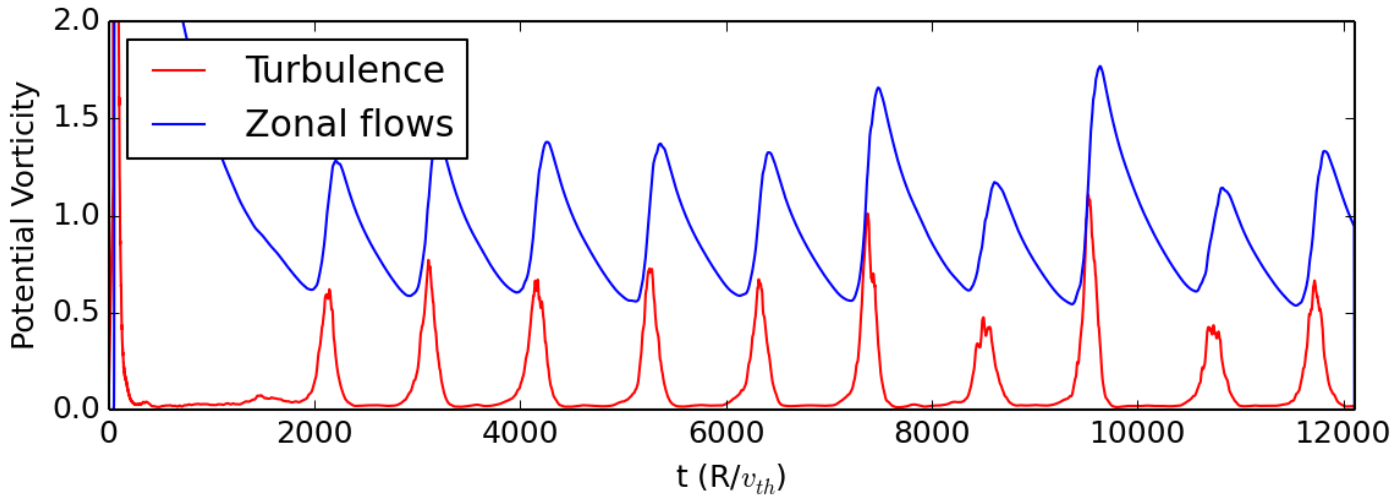
Zonal flows create characteristic spectra

Gyrokinetic Spectra in Zpinch system



- Agree with theoretical prediction
- "Disparate" scale interactions dominate "Local" interactions
- Dynamical spectra (instead of Kolmogorov-type static spectra)

Predator-Prey dynamics between turbulence and zonal flows

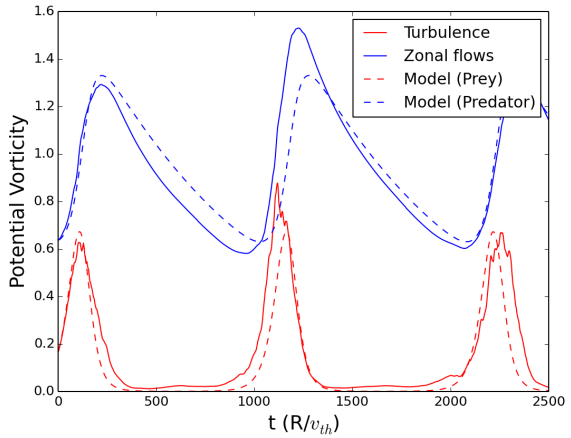


$$N = \sum_k |\phi_k|^2 (1 + k^2)$$

$$E_v = |\phi_q|^2 q^2$$

$$\frac{\partial N}{\partial t} = \gamma_{lin} N - c_1 N E_v$$

$$\frac{\partial E_v}{\partial t} = c_2 E_v N - \gamma_{zf} E$$



Can be fitted with simple Predator-Prey model