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« Heating rate, turbulence and compression »

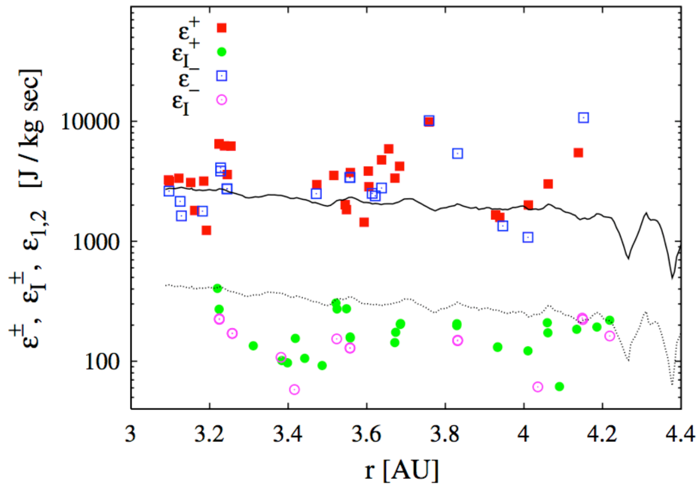
Incompressible HD (exact law) : $-\frac{4}{5}\varepsilon^{v} r = \langle (v'_{\parallel} - v_{\parallel})^3 \rangle$

Incompressible MHD (exact law) : $-\frac{4}{3}\varepsilon^{\pm}\ell = \langle (\delta \mathbf{z}^{\pm} \cdot \delta \mathbf{z}^{\pm}) \delta z_{\ell}^{\mp} \rangle$

Compressible MHD (model) : $\mathbf{w}^{\pm} \equiv \rho^{1/3} \mathbf{z}^{\pm}$ [Carbone et al., 2009]

$$W^{\pm}(\ell) \equiv \langle |\Delta \mathbf{w}^{\pm}|^2 \Delta w_{\parallel}^{\mp} \rangle \langle \rho \rangle^{-1} = -\frac{4}{3}\epsilon^{\pm}\ell$$

→ **Strong** effects although the SW density fluctuations are weak



Exact relation for compressible isothermal turbulence

$$\partial_t \rho + \nabla \cdot (\rho \mathbf{u}) = 0, \qquad P = C_s^2 \rho$$

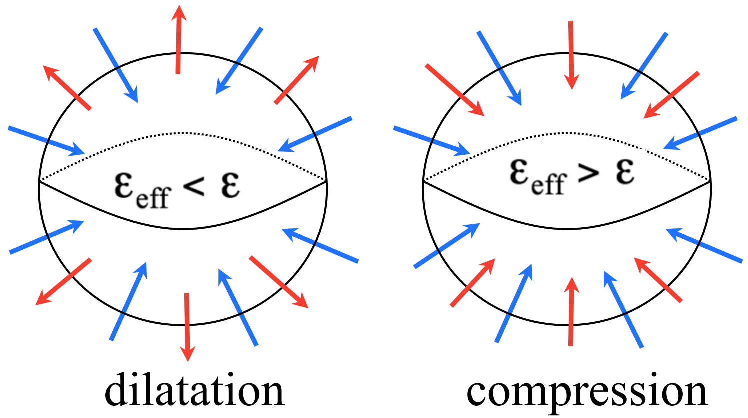
$$\partial_t (\rho \mathbf{u}) + \nabla \cdot (\rho \mathbf{u}\mathbf{u}) = -\nabla P + \mu \Delta \mathbf{u} + \frac{\mu}{3} \nabla (\nabla \cdot \mathbf{u}) + \mathbf{f},$$

$$\begin{cases} E = \rho u^2/2 + \rho e \\ e = C_s^2 \ln(\rho/\rho_0) \end{cases}$$

Galtier & Banerjee, PRL, 2011

$$-2\varepsilon = \nabla_{\mathbf{r}} \cdot \left\langle \left[\frac{\delta(\rho \mathbf{u}) \cdot \delta \mathbf{u}}{2} + \delta\rho\delta e - C_s^2 \bar{\delta}\rho \right] \delta \mathbf{u} + \bar{\delta} e \delta(\rho \mathbf{u}) \right\rangle$$
$$+ \langle (\nabla' \cdot \mathbf{u}')(R - E) \rangle + \langle (\nabla \cdot \mathbf{u})(\tilde{R} - E') \rangle$$

ISOTROPIC TURBULENCE :



→ **The heating rate ε can be overestimated**