Inertial range scaling of inhomogeneous turbulence

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We investigate how inhomogeneity influences the $k^{-5/3}$ inertial range scaling of turbulent kinetic energy spectra (with k the wavenumber). For weak statistical inhomogeneity, the energy spectrum can be described as an equilibrium spectrum plus a perturbation. Theoretical arguments suggest that this latter contribution scales as $k^{-7/3}$.

The prediction is assessed using direct numerical simulations of three-dimensional Kolmogorov flow[1]. Since Kolmogorov flow is statistically inhomogeneous in a single direction only, spectra are conveniently determined in planes perpendicular to this direction. In Fig. 1(a) we show a flow visualization of the considered Kolmogorov flow. In Fig. 1(b) we show, for three different values of the Reynolds number R_λ, the non-equilibrium part of the energy spectrum, extracted from the total planar energy spectrum.

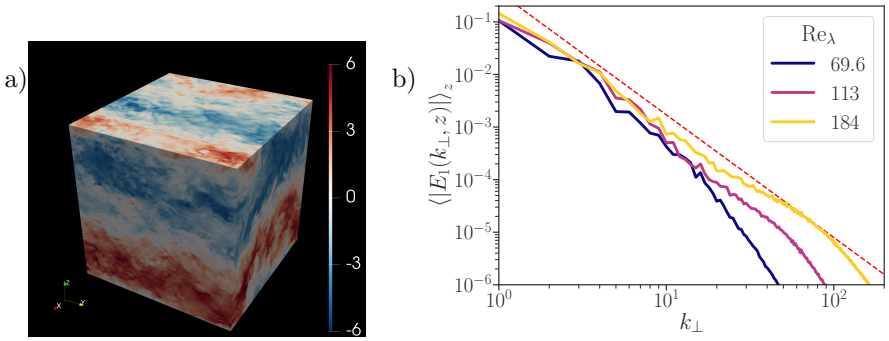

Figure 1: (a) Visualization of the y-component of the velocity in the turbulent Kolmogorov flow. (b) Average of the absolute value of the non-equilibrium part of the kinetic energy spectrum. The dashed line indicates $k^{-7/3}$ scaling.

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[1]Bos and Araki, *ArXiv* preprint arXiv:2210.14516, 2022