Intermittency in a turbulent model as consequence of stationary constraints

Sébastien Aumaître[1] & Stephan Fauve[2]

[1] Service de Physique de l'Etat Condensée, Direction des Sciences de la Matière, CEA-Saclay, CNRS UMR 2464, 91191 Gif-sur-Yvette cedex, France
[2] Laboratoire de Physique statistique de l'Ecole Normale Supérieure, CNRS UMR 8550, 24 Rue Lhomond, 75231 Paris Cedex 05, France
sebastien.aumaitre@cea.fr

In its seminal work on turbulence, Kolmogorov used dimensional arguments to determine the Power Spectral Density of the velocity field in turbulent flows[1,2]. However to our knowledge, the constraints that stationary processes impose on the fluctuations of the energy flux have never been used in the context of turbulence. Here we first recall how the Power Density Spectra of the fluctuations of the injected power, the dissipated power and the energy flux have to converge at vanishing frequency[3]. Then we show that these constraints cannot be easily satisfied in the non intermittent framework of the 1941 Kolmogorov theory (K41). Yet there are fulfilled by the intermittent GOY–shell model [4,5]. Hence constraints on the power fluctuations seems to force some intermittency.Indeed we show that these constraints imply a relation between the scaling exponents that is fulfilled by the GOY shell model and in agreement with the She-Leveque formula. It also fixes the intermittent parameter of the log-normal model to a realistic value. Some possible extensions to real turbulence are drawn in the concluding remarks.

Références

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