Physics > Fluid Dynamics

Anomalous scaling and generic structure function in turbulence

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(Submitted on 7 Jun 2011)

We discuss on an example a general mechanism of apparition of anomalous scaling in scale invariant systems via zero modes of a scale invariant operator. We discuss the relevance of such mechanism in turbulence, and point out a peculiarity of turbulent flows, due to the existence of both forcing and dissipation. Following these considerations, we show that if this mechanism of anomalous scaling is operating in turbulence, the structure functions can be constructed by simple symmetry considerations. We find that the generical scale behavior of structure functions in the inertial range is not self-similar $S_n(\ell)\propto \ell^{\zeta_n}$ but includes an "exponential self-similar" behavior $S_n(\ell) \propto \exp[\zeta_n\alpha^{-1} \ell^{\alpha}]$ where α is a parameter proportional to the inverse of the logarithm of the Reynolds number. The solution also follows exact General Scaling and approximate Extended Self-Similarity.

Subjects:	**Fluid Dynamics (physics.flu-dyn)**; Other Condensed Matter (cond-mat.other); Chaotic Dynamics (nlin.CD)
Journal reference:	J. Phys II France vol 6 p 1825-1840 (1996)
Cite as:	**arXiv:1106.1225 [physics.flu-dyn]**
	(or **arXiv:1106.1225v1 [physics.flu-dyn]** for this version)

Submission history

From: Berengere Dubrulle [view email]
[v1] Tue, 7 Jun 2011 00:50:32 GMT (150kb,D)

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