On Turbulence and its Relation With Kappa Distributions:
a Langevin Approach

Iván Gallo-Méndez[1] and Pablo S. Moya[1,2]

[1]Departamento de Física, Facultad de Ciencias, Universidad de Chile

Abstract: Considering a coupled map lattice model [1] we analyze the relationship between turbulent cascades on the spatial scale and Kappa-like distributions representing the velocity probability distributions of eddies at different scales. We generate the steady-state velocity distribution of the fluid at each scale k and show that the generated distributions are well fitted by Kappa-like distributions. We observe a robust scaling relationship between the κ parameter, the scale, and the Reynolds number of the system, *Re*. Our results show that there is a closed scaling relation between the level of turbulence and the κ parameter; namely $\kappa \sim Re\ k^{-5/3}$. Furthermore, we also consider skew velocity distributions that usually appear in turbulent systems driven by a chaotic forcing. We consider the Ulam map noise in the lattice and fit them with $\kappa\delta$-distributions (Beck's distribution) [2]. We characterize the relation between κ and δ parameters and focus on possible physical interpretation of skewness. We expect these results to be useful to characterize turbulence in different contexts, and our numerical predictions to be tested by observations and experimental setups [3,4].

References:

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