CRITICALITY AND THE FRACTAL STRUCTURE OF –5/3 TURBULENT CASCADES

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Abstract

Here we show a procedure to generate an analytical structure producing a cascade that scales as the energy spectrum in isotropic homogeneous turbulence. We obtain a function that unveils a non-self-similar fractal at the origin of the cascade. It reveals that the backbone underlying –5/3 cascades is formed by deterministic nested polynomials with parameters tuned in a Hopf bifurcation critical point. The cascade scaling is exactly obtainable (not by numerical simulations) from deterministic low dimensional nonlinear dynamics. Consequently, it should not be exclusive for fluids but also present in other complex phenomena. The scaling is obtainable both in deterministic and stochastic situations.

Keyword

Cascade; Criticality; Fractals; Navier-Stokes equation; Nonlinear; Stochastic; Turbulence; Maps; Complex