Hidden symmetry in passive scalar advected by 2D Navier-Stokes turbulence

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The statistical behaviour of a scalar passively advected by a Navier-Stokes flow resulting from a two-dimensional inverse energy cascade is strongly intermittent, displaying anomalous multiscaling [1], which violates Kolmogorov's self-similarity predictions. Recently, the concept of hidden symmetry has been introduced to define a new set of dynamically rescaled (projected) variables for which scale invariance is restored and allowing to calculate from the projected equation of motion the anomalous scaling of the structure functions. Hidden symmetry has been validated numerically in the context of the shell models [2,3]. In this work [4], we scrutinize its validity for the case of the passive scalar by inspecting (i) the probability distribution function of multipliers, obtained as the ratio of suitably defined scalar increments at two different inertial scales and (ii) the validity of the Perron-Frobenius scenario for the non-linear scaling of structure functions.

[1] Celani et al., Physical review letters, 84 (2000).
[2] Mailybaev, Phys. Rev. Fluids, 7 (2022).
[3] Thalabard and Mailybaev, arXiv 2402.04198 (2024).
[4] Calascibetta et al., arXiv 2504.11616 (2025).