Dissipation Anomaly: “Zeroth law of turbulence"

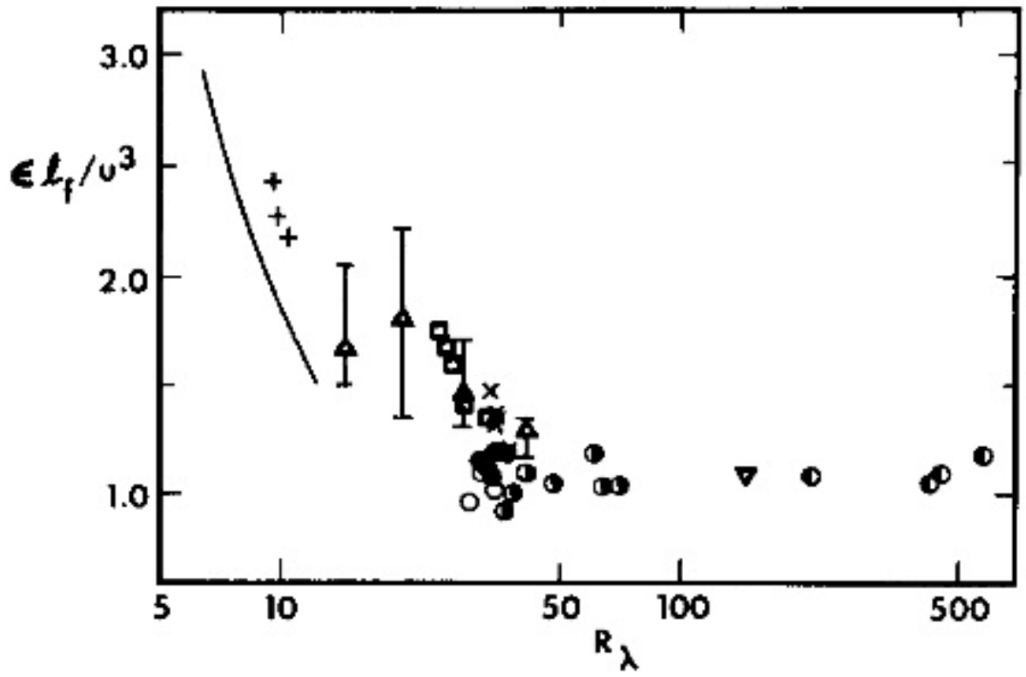
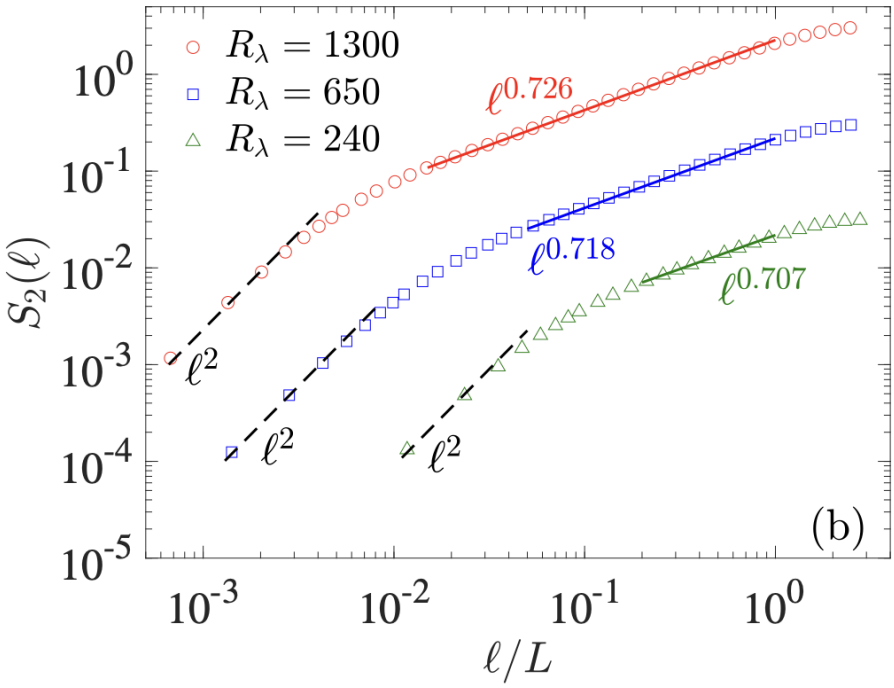
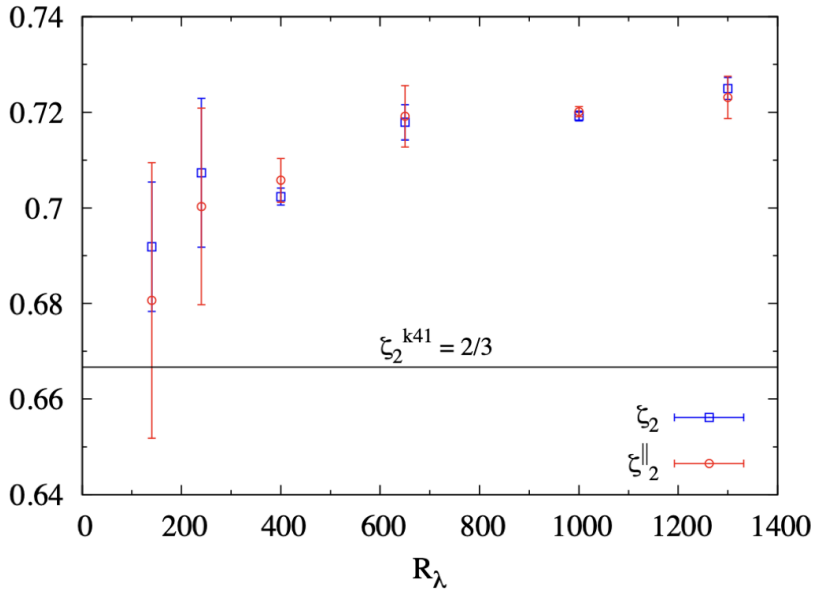


FIG. 1. The quantity $\epsilon L_f/u^3$ for biplane square-mesh grids. All data except + are for the initial period of delay, and are explained in Table I. + indicate typical data[13] in the final period of decay. — corresponds to Eq. (1).

K. R. Sreenivasan, On the scaling of the turbulence energy dissipation rate, Phys. Fluids 27: 1048-1051 (1984)

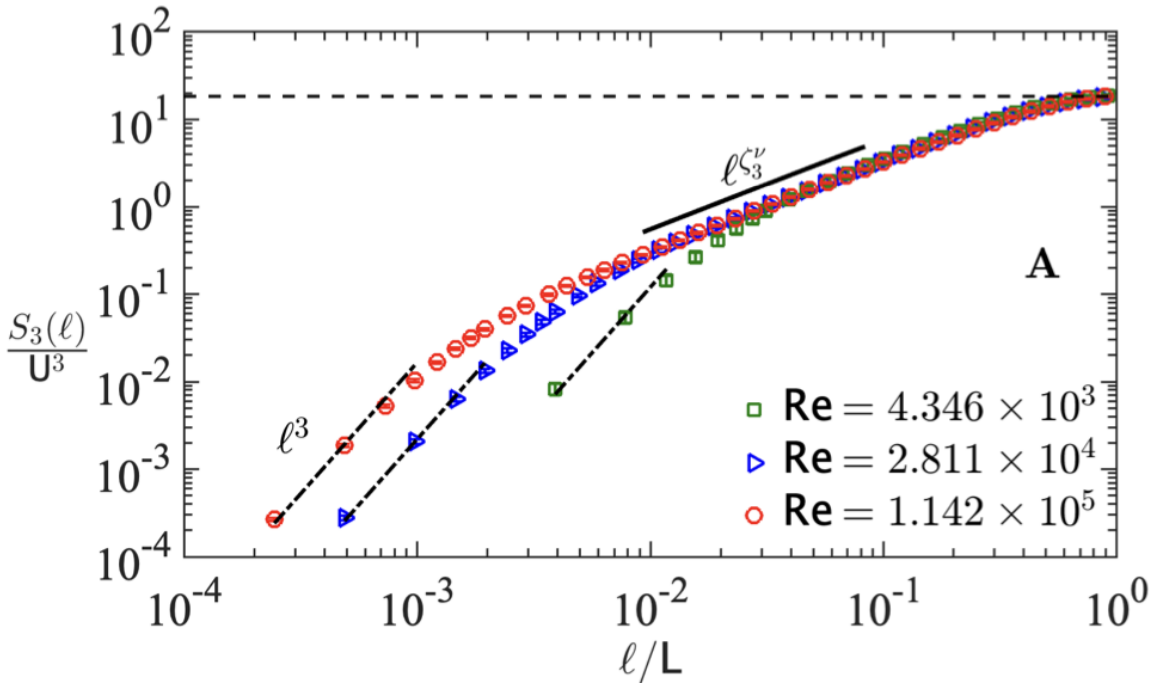
Evidence for emergence of weak Euler solutions





Drivas, Theodore D. Self-regularization in turbulence from the Kolmogorov 4/5-law and alignment. Philosophical Transactions of the Royal Society A 380.2226 (2022): 20210033.

Evidence for emergence of locally dissipative Euler solutions



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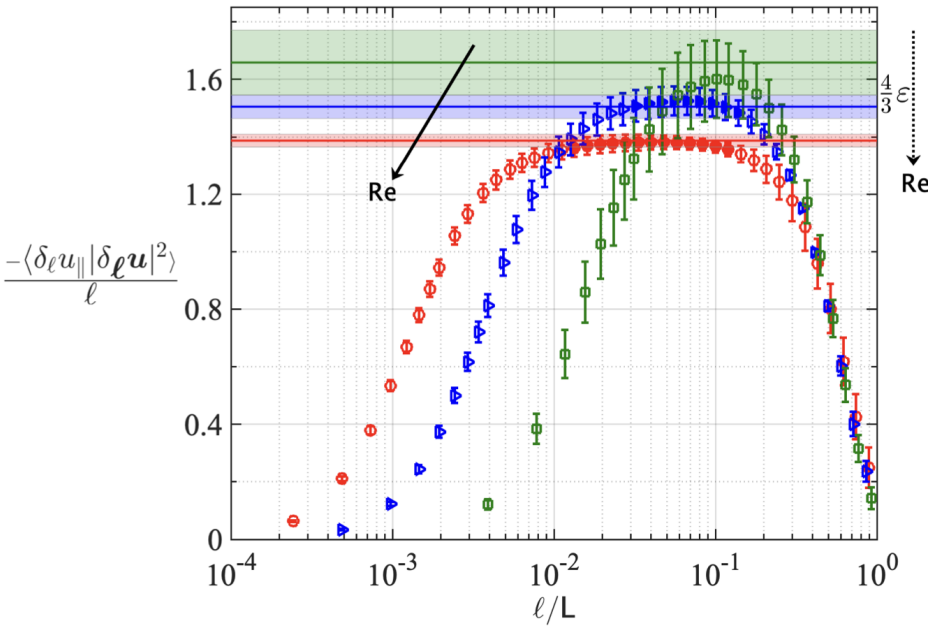
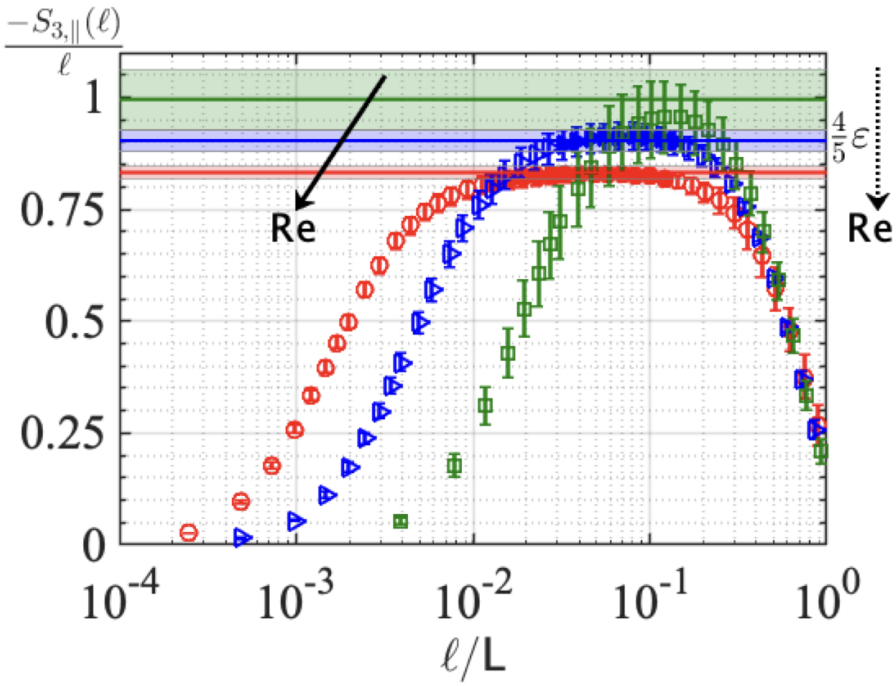
Kolmogorov 4/3 and 4/5 laws





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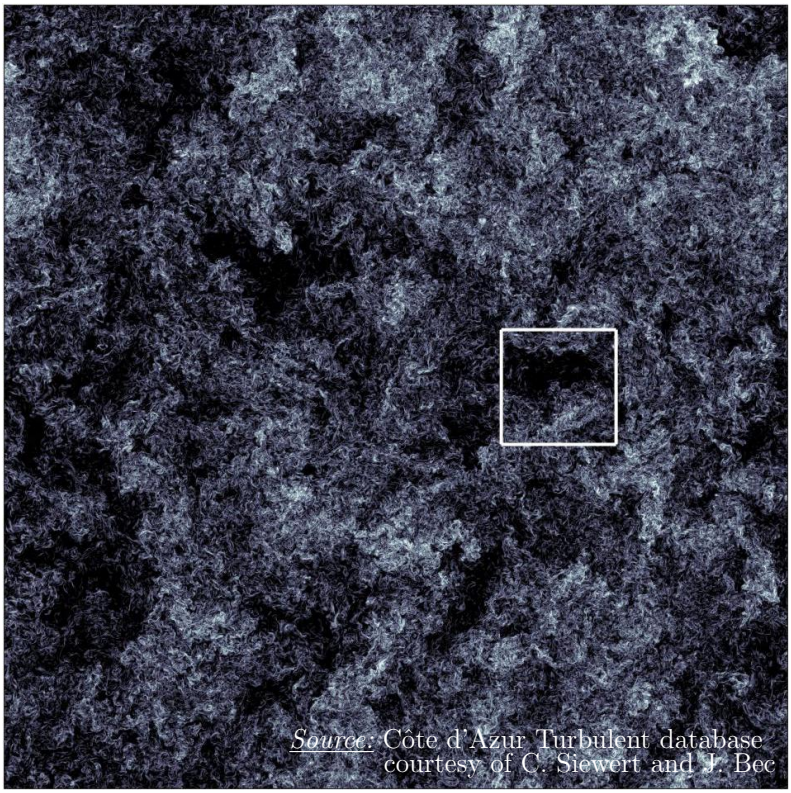
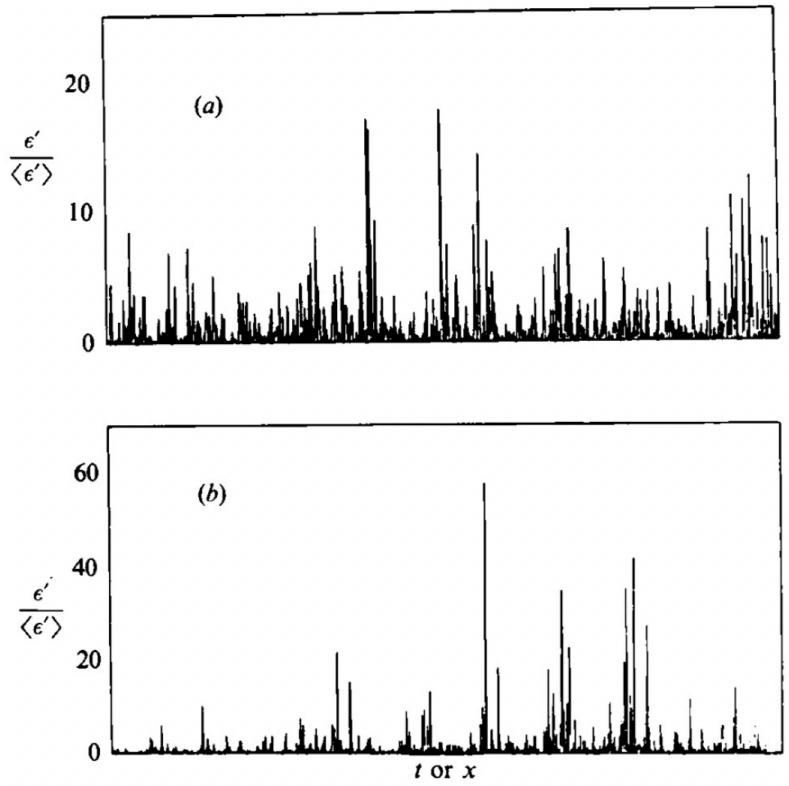
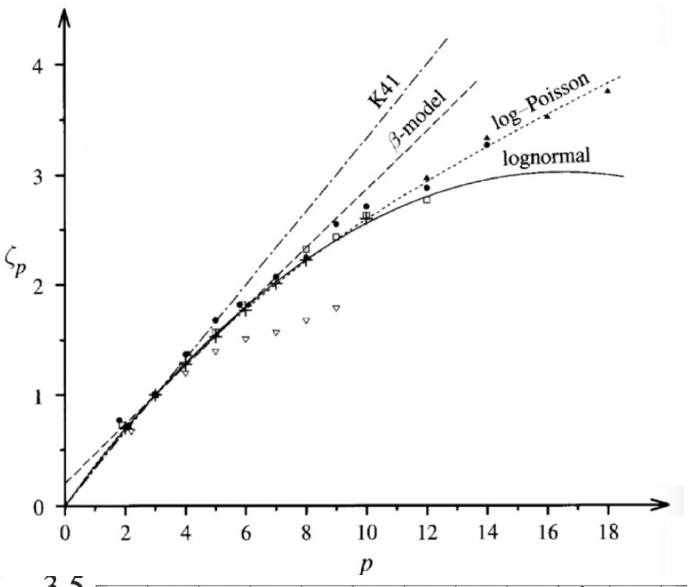
Intermittent energy dissipation

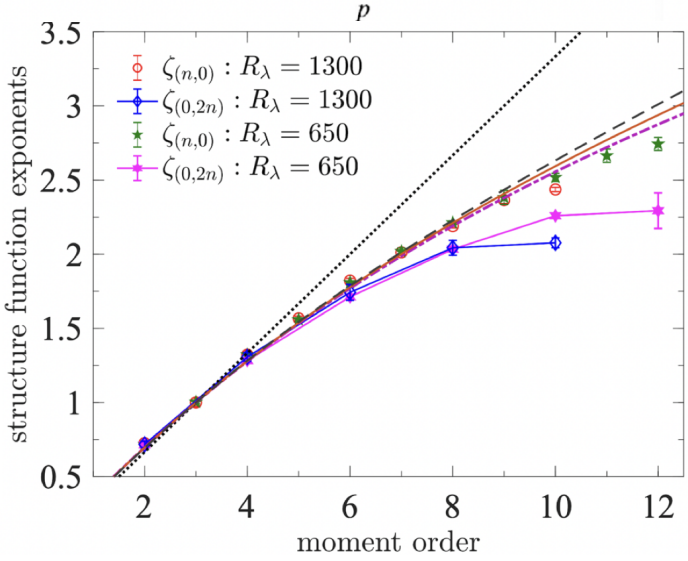


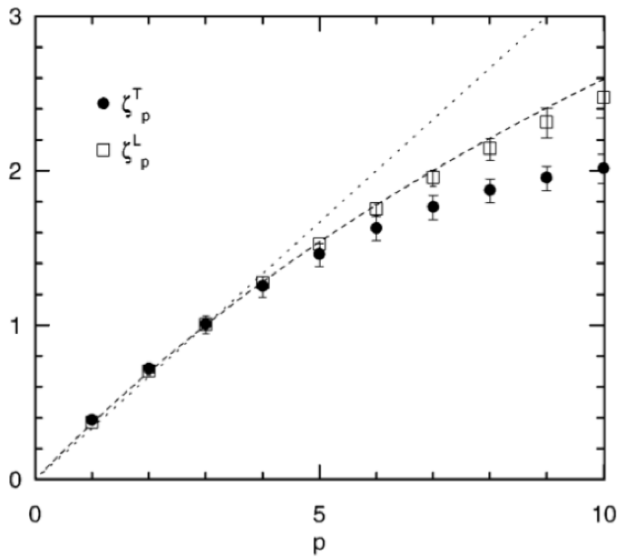


Meneveau, Charles, and K. R. Sreenivasan. The multifractal nature of turbulent energy dissipation. Journal of Fluid Mechanics 224 (1991): 429-484.

Anomalous Scaling Exponents







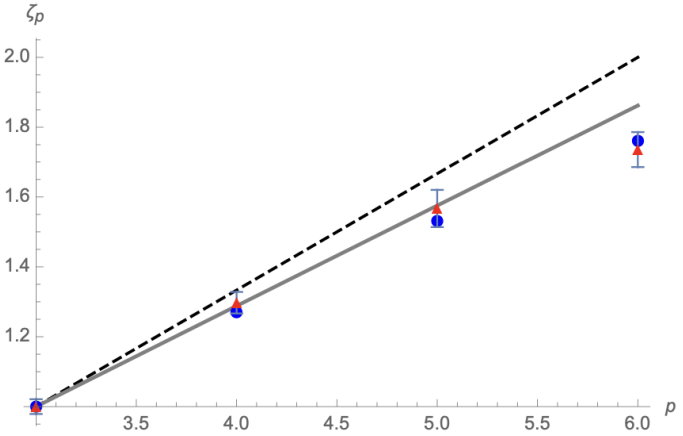


Figure 1: Grey line has slope $\gamma = 3.85$, inferred from Iyer et al (2020)

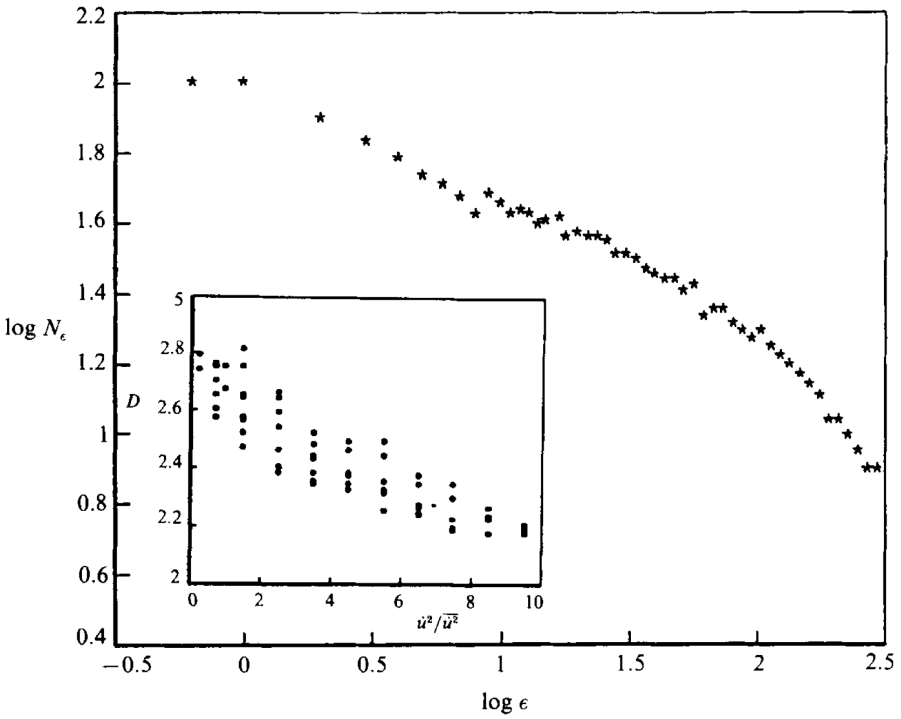
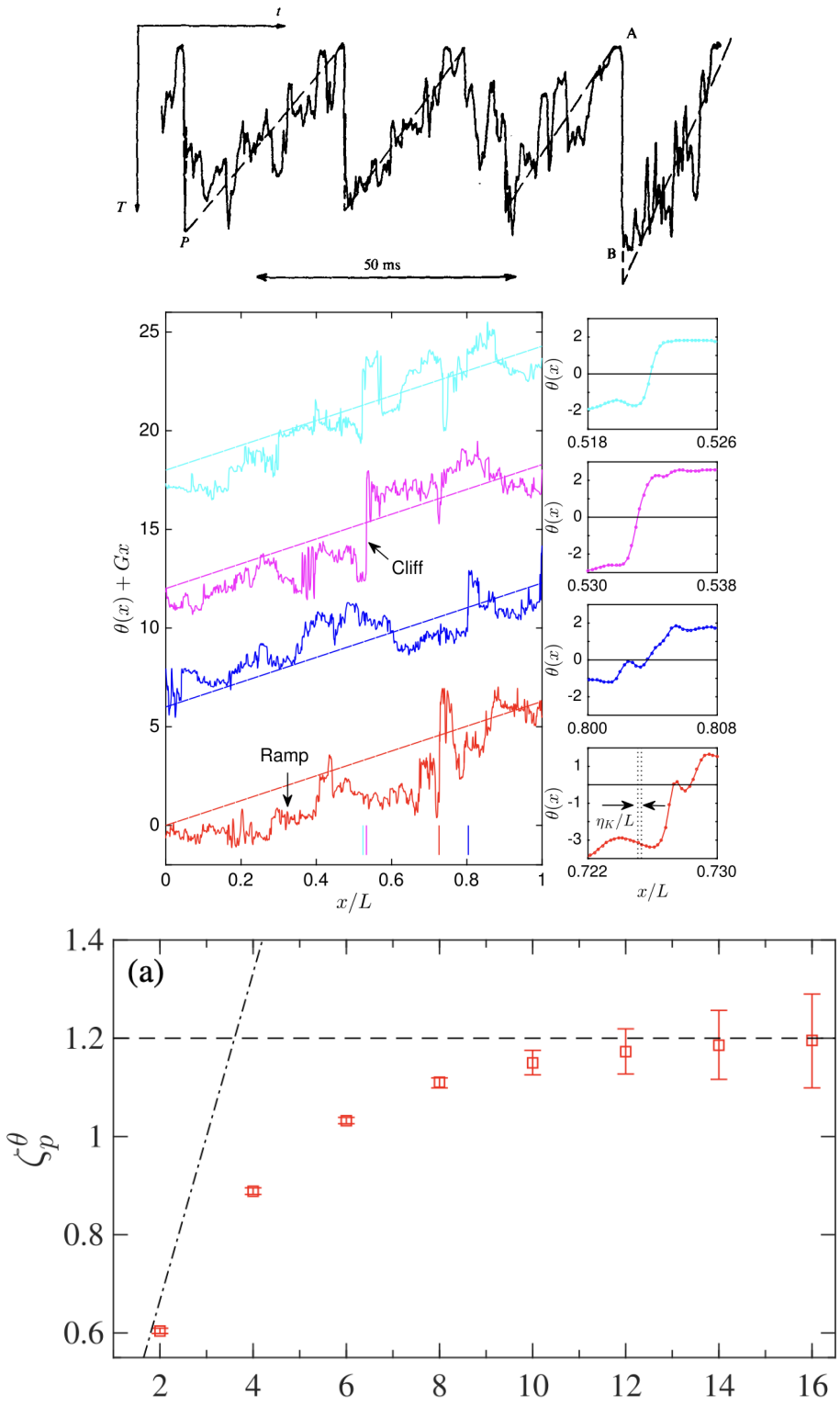


Figure 2: Measured exponent nearby $\gamma = 2.7$, averaged i fixed time. Reported inference from Mandelbrot theory is $\gamma = 2.9$. From multifractal theory, estimated as $\gamma = 2.87$.

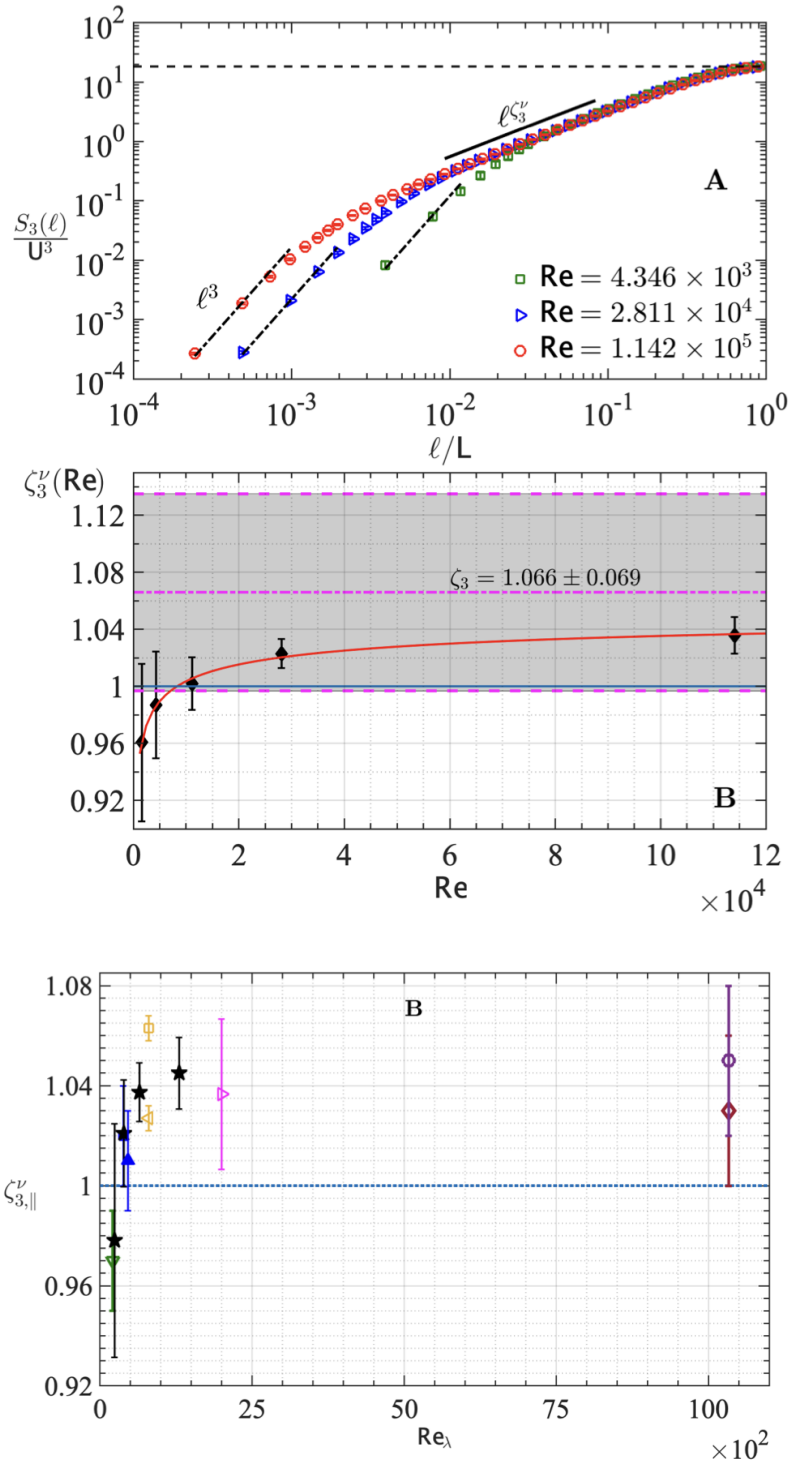
De Rosa, L., Drivas, T. D., Inversi, M., and Isett, P. (2025). Intermittency and Dissipation Regularity in Turbulence. arXiv preprint arXiv:2502.10032.

Sreenivasan, K. R., and Meneveau, C. J. F. M. (1986). The fractal facets of turbulence. Journal of Fluid Mechanics, 173, 357-386.



Iyer, K. P., Schumacher, J., Sreenivasan, K. R., and Yeung, P. K. (2018). Steep cliffs and saturated exponents in three-dimensional scalar turbulence. PRL, 121(26), 264501.

Third order scaling subcritical?



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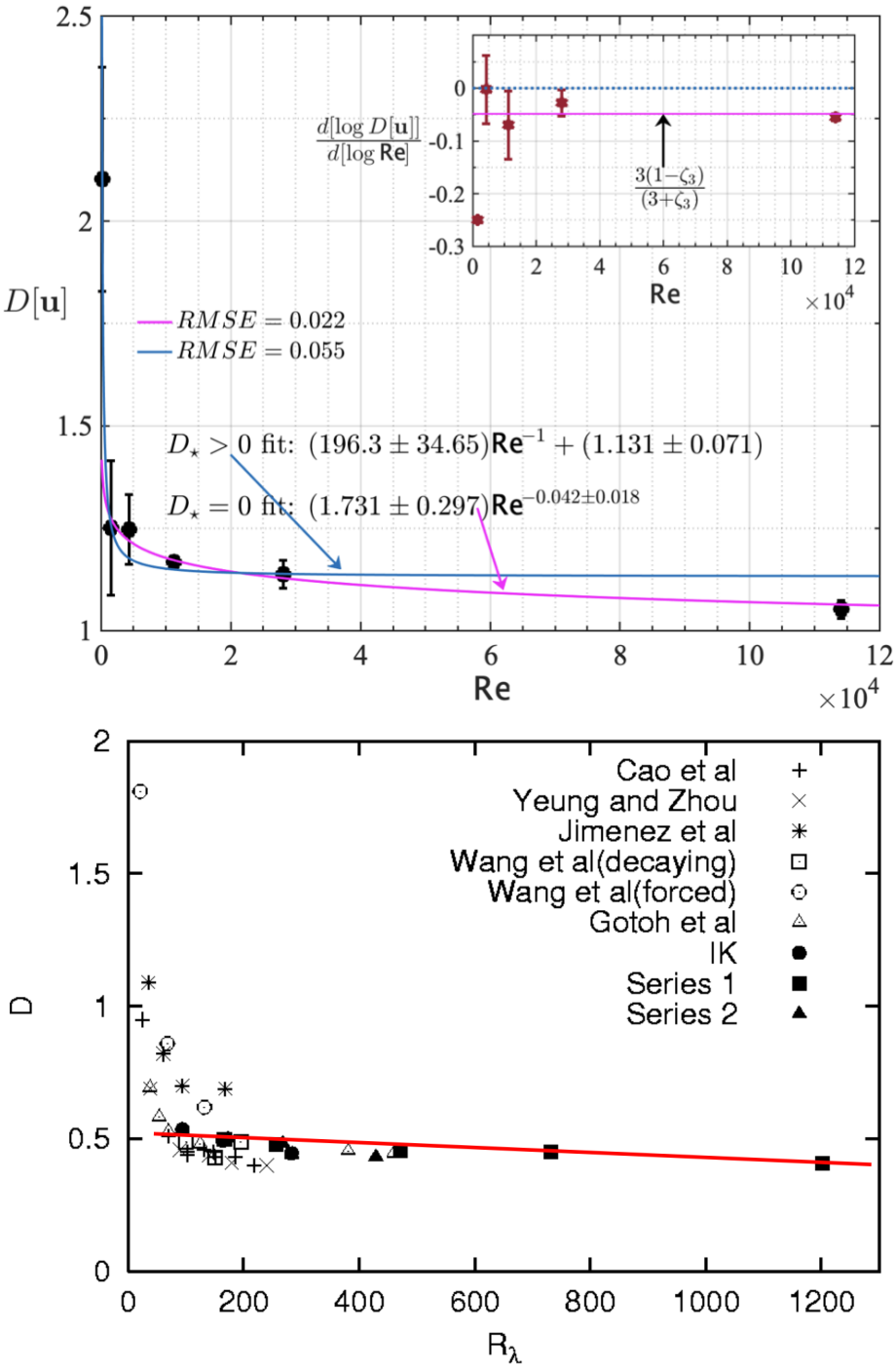
Zeroth law of turbulence: there are zero laws in turbulence



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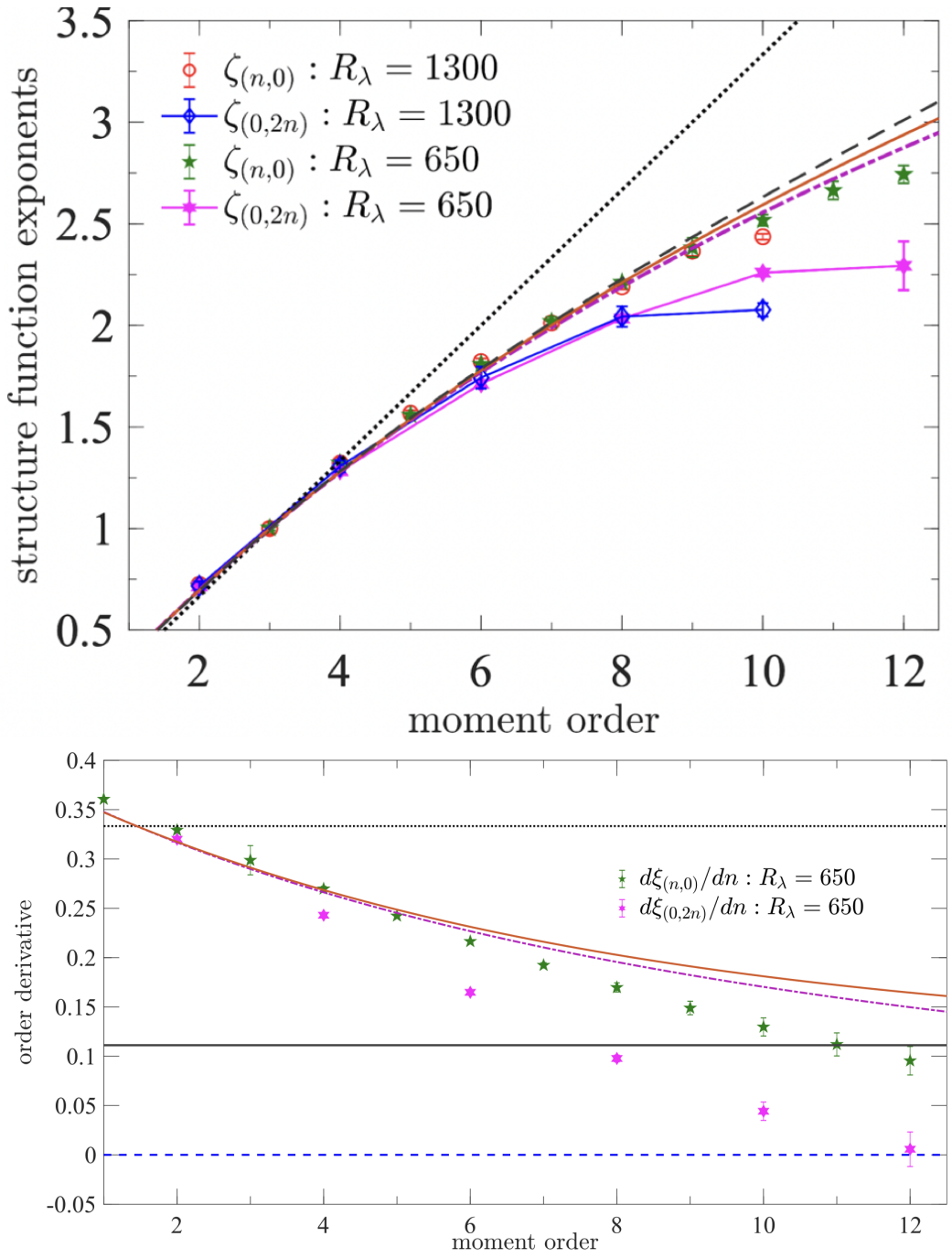
Evidence for unbounded moments at large p?



Iyer, K. P., Sreenivasan, K. R., and Yeung, P. K. (2020). Scaling exponents saturate in three-dimensional isotropic turbulence. Physical Review Fluids, 5(5), 054605.