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Linking Eulerian and Lagrangian structure functions' scaling exponents in turbulence

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In fully developed turbulence, intermittency is classically characterized in an Eulerain framework, using the scaling exponents of spatial structure functions. The same approach can be used in a Lagrangian framework to characterize the temporal intermittency of the velocity of a particle advected by a turbulent intermittent velocity field. An interesting question is then to know how to relate the scaling functions and explore the links between their scaling exponents $\zeta_L(q)$ and $\zeta_E(q)$. We first consider a simple relation obtained when time and space are related using a simple scaling law without intermittency effects. We then take into account intermittency and obtain a parametric relation between the two functions, already obtained by other means by Borgas (1993), but which is new in the context of structure functions' scaling exponents. Lagrangian experimental estimates have been published in several recent papers, so that theoretical relations can now be tested. We do this using experimental estimates for the two functions. For small and medium order of moments they are both close to data. For larger moments, none is fully satisfactory. We conclude that the discrepancy may come either from Lagrangian experimental estimates, or from uncorrect asumptions in the theoretical relations between scaling exponents.