Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Scaling exponents of energy dissipation, enstrophy and scalar dissipation in high-resolution direct numerical simulations of turbulence[1]

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— A central issue in the study of intermittency and refined similarity in turbulence is the behavior of higher-order moments of the locally-averaged energy dissipation rate (ϵ_r) within a domain of linear size r, especially for r in the inertial range. However, accurate determination of these quantities requires full-field knowledge of all components of velocity gradients which must be well-resolved in space, with the degree of difficulty increasing with the order of the moment. We examine a large DNS database in isotropic turbulence, with emphasis on well-resolved simulations up to 4096^3 at Taylor-scale Reynolds number 650. Efficient algorithms have been developed to extract the statistics of ϵ_r, and those of local averages of enstrophy and scalar dissipation rate, with averages taken both along a line of length r and within a cube of linear size r. Scaling exponents appearing in relations of the form $\langle \epsilon_r^p \rangle \propto r^{-\zeta_p}$ have been assessed, although the inference of a clear scaling range depends on numerical resolution in addition to Reynolds and Schmidt numbers. Data from 1D and 3D averages differ systematically, but both are useful for comparison with intermittency models in the literature.

[1]NSF Grants CBET-1139037 and OCI-0749223

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Date submitted: 13 Oct 2011

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