Conditional Eulerian and Lagrangian velocity increment statistics of fully developed turbulent flow

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Conditional statistics of homogeneous isotropic turbulent flow is investigated by means of high-Reynolds number direct numerical simulations performed with 2048^3 collocation points. Eulerian as well as Lagrangian velocity increment statistics under several conditions are analyzed and compared. In agreement with experimental data longitudinal probability density functions $P(\delta^{||}_l u|\epsilon_l)$ conditioned on a scale-averaged energy dissipation rate are close to Gaussian distributions over all scales within the inertial range of scales. Also transverse increments conditioned on either the dissipation rate or the square of the vorticity have quasi-Gaussian probability distribution functions (PDFs). Concerning Lagrangian statistics we found that conditioning on a trajectory averaged energy-dissipation rate ϵ_τ significantly reduces the scale dependence of the increment PDFs $P(\delta_\tau u_i|\epsilon_\tau)$. By means of dimensional arguments we propose a novel condition for Lagrangian increments which is shown to reduce even more the flatness of the corresponding PDFs and thus intermittency in the inertial range of scales. The conditioned Lagrangian PDF corresponding to the smallest increment considered is reasonably well described by the K41-prediction of the PDF of acceleration. Conditioned structure functions show approximately K41-scaling with a larger scaling range than the unconditioned ones.

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