Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Turbulent 2-Particle Dispersion Laws in Kinematic Simulations

DAMIEN BENVENISTE, GREGORY EYINK, Johns Hopkins University — Kinematic Simulations (KS) are often used as a shortcut for studying Lagrangian properties of turbulence (e.g. Elliott & Majda, 1996) but have been criticized by Thomson & Devenish (2005), who pointed out that KS sweeping effects are very different from true turbulence. We study numerically by a Monte Carlo method a Richardson-like diffusion equation recently derived analytically by us for KS models, which exhibits such sweeping effects. With moderate inertial-ranges like those achieved in current KS, our model is found to reproduce the $t^{9/2}$ power-law for pair dispersion predicted by Thomson & Devenish and observed in those KS. However, for much longer ranges, our model exhibits three distinct pair-dispersion laws in the inertial-range: a Batchelor t^2-regime, followed by a Kraichnan-model-like t^1 diffusive regime, and then a t^6 regime. Finally, outside the inertial-range, there is another t^1 regime with particles undergoing independent Taylor diffusion. These scalings are exactly the same as those predicted by Thomson & Devenish for KS with large mean velocities, which we argue hold also for KS with zero mean velocity. Our results support the basic conclusion of Thomson & Devenish (2005) that sweeping effects make Lagrangian properties of KS completely different from true turbulence for very extended inertial-ranges.

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Date submitted: 02 Aug 2012

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