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Effects of the mean velocity field on the renormalized turbulent viscosity and correlation function ABHISHEK KUMAR, MAHENDRA VERMA, IIT Kanpur, India — We perform renormalization group analysis of the Navier Stokes equation in the Eulerian framework in the presence of mean velocity field U_0, and observe that that the renormalized viscosity $\nu(k)$ is independent of U_0, where k is the wavenumber. Thus we show that $\nu(k)$ in the Eulerian field theory is Galilean invariant. We also compute $\nu(k)$ using numerical simulations and verify the above theoretical prediction. The velocity-velocity correlation function however exhibits damped oscillations whose time period of oscillation and damping time scales are given by $1/kU_0$ and $1/(\nu(k)k^2)$ respectively. In a modified form of Kraichnan's direct interaction approximation (DIA), the "random mean velocity field" of the large eddies sweeps the small-scale fluctuations. The DIA calculations also reveal that in the weak turbulence limit, the energy spectrum $E(k) \sim k^{-3/2}$, but for the strong turbulence limit, the random velocity field of the large-scale eddies is scale-dependent that leads to Kolmogorov's energy spectrum.[1]

[1]M. K. Verma and A. Kumar, arXiv:1411.2693 (2015).

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