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Multi-scale study on process of contravariant and covariant polymer elongation and drag reduction in viscoelastic turbulence KIYOSI HORIUTI, SHU SUZUKI, Dept. Mechano-Aerospace Engineering, Tokyo Institute of Technology, Japan — We study the elongation process of polymers released in the Newtonian homogeneous isotropic turbulence by connecting a mesoscopic description of ensemble of elastic dumbbells using Brownian dynamics (BDS) to the macroscopic description for the fluid using DNS. The dumbbells are allowed to be advected non-affinely with the macroscopically-imposed deformation. More drastic drag reduction is achieved when non-affinity is maximum than in the complete affine case. In the former case, the dumbbell is convected as a covariant vector, and in the latter as a contravariant vector. We derive the exact solution for the governing equation of the motion of dumbbells. The maximum stretching of dumbbell is achieved when the dumbbell aligns in the direction of vorticity in the contravariant case, and when the dumbbell directs outward perpendicularly on the vortex sheet in the covariant case. Alignment in the BDS-DNS data agrees with the theoretical results. In the mixture of contravariant and covariant dumbbells, the covariant dumbbells are transversely aligned with the contravariant dumbbells. Compared with the cases without mixture, stretching of covariant dumbbell is enhanced, while that of contravariant dumbbell is reduced. Application of this phenomenon is discussed.

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