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Normal stress difference and drag reduction mechanism in Johnson-Segalman viscoelastic turbulence KIYOSI HORIUTI, Tokyo Institute of Technology, Japan, KAZUMA MATSUMOTO — The mechanism of turbulent drag reduction in the polymer- diluted flow is studied using the DNS data for homogeneous isotropic turbulence and pipe flow. The polymer stress τ is obtained by solving the non-affine Johnson-Segalman constitutive equation. The drag reduction is maximal when non- affinity is either minimum or maximum, but the largest reduction is achieved when non-affinity is maximum. The pressure force due to τ, ∇p_τ, tends to oppose to that due to the solvent ∇p_s, e.g., in the core of the vortex tube in which p_s is minimal, p_τ bulges out. The normal-stress difference (NSD) is obtained on the basis of new eigenvectors which span the isosurfaces of vortex tube and sheet. It is shown in both flows that the first NSD is predominantly positive and the second is negative along the sheets and tubes. Thus, an extra tension is exerted on the sheet and tube. With an increase of effective viscosity by an addition of elongation viscosity, resistance of the sheet and tube to their stretching is enhanced. When non-affinity is maximum, the transformation of the sheet into the tube is restrained because the sheet tends to snap back to the original flat form due to viscoelastic effect. When non-affinity is minimum, the tubes are created but its stretching is suppressed. In both cases, cascade of the energy into the small scales is restricted leading to the reduction of drag.

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