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Effects of polymer stresses on eddy structures in drag-reduced turbulent channel flow KYOUNGYOUN KIM, Arizona State University, CHANG -F. LI, Jiangsu University, R. SURESHKUMAR, Washington University, Saint Louis, S. BALACHANDAR, University of Florida, RONALD ADRIAN, Arizona State University — The effects of polymer stresses on the near-wall turbulent structures are examined by using DNS database of fully developed turbulent channel flows ($Re_\tau = 395$) with and without polymer stress. The stresses created by adding polymer are modelled by a finite extensible non-linear elastic, dumbbell model. Both low (18%) and high drag reduction (61%) cases are investigated. The conditionally averaged flow fields for Reynolds-stress- maximizing Q2 event show that the near-wall vortical structures are weakened and elongated in the streamwise direction by polymer stresses. The conditionally averaged fields for the events with large contribution to the polymer work are also examined. The vortical structures in drag-reduced turbulence are very similar to those for the Q2 events, i.e., counter-rotating streamwise vortices near the wall and hairpin vortices above the buffer layer. The three-dimensional distributions of conditionally averaged polymer force around these vortical structures show that the polymer force components oppose the vortical motion. The observations extend concept of vortex retardation by viscoelastic stress to fully turbulent wall flow, and offer an explanation of the mechanism of drag reduction by dilute polymers. Supported by ONR through contract N000140510687.

Kyoungyoun Kim
Arizona State University

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