Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Turbulence structure and statistics in polymer-induced low vs. high drag reduction regimes: the origin of the maximum drag reduction asymptote[1] KYOUNGYOUN KIM, Hanbat National University, RADHAKRISHNA SURESHKUMAR, Syracuse University — Turbulent statistics and structure in polymer-induced low (20%) and high (66%) drag reduction (DR) regimes are studied via channel flow DNS at Re_τ =395. The initial hairpin eddy extracted from the conditional averages of the Q2 events is self-consistently evolved in the presence of polymer stresses using the FENE-P model. For low DR (Weissenberg number We_τ defined as the ratio of the polymer relaxation time λ to the viscous time scale = 50), large counter polymer torque is observed only near the vortex legs. This suppresses the auto-generation of new vortices primarily only in the inner layer. For high DR (We_τ $\geq$100), large counter polymer torque appears near the hairpin head and legs. This modifies both the inner and outer layer dynamics. When the Elasticity number E, defined as the ratio of λ to the eddy turnover time, approaches unity, the effect of the polymer encompasses the whole channel and DR approaches an asymptotic value. This distinction between low and high DR dynamics is not robustly captured by low Re simulations in which E remains $O(1)$.

[1]Supported by NSF Grant CBET 1055219 and by NRF Grant 2010-0007901.

Kyoungyoun Kim
Hanbat National University

Date submitted: 05 Aug 2011 Electronic form version 1.4