Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Wavelet analysis of spectral energy transfer in viscoelastic turbulent channel flow[1] ALEXIA MARTINEZ IBARRA, University of Nebraska - Lincoln, MIRALIREZA NABAVI BAVIL, JEONGLAE KIM, Arizona State University, JAE SUNG PARK, University of Nebraska - Lincoln — Direct numerical simulation (DNS) database of a viscoelastic turbulent channel flow is analyzed using the wavelet multiresolution analysis (WMRA) to study drag-reduction mechanisms by polymer additives. At the friction Reynolds number $Re_\tau = 145$, DNS of a viscoelastic channel flow is conducted using the finitely extensible nonlinear elastic-Peterlin (FENE-P) model. A Newtonian channel flow is also simulated at the same Reynolds number to examine the effects of viscoelasticity and validate the analysis framework. For the viscoelasticity, different Weissenberg numbers, which is the product of a polymer relaxation time and a characteristic strain rate in the flow, are considered. In-plane WMRA is performed to evaluate wavelet statistics of turbulence kinetic energy (TKE) and spectral energy transfer as a function of wall-normal distance. Spectrally and spatially local wavelet statistics show distinctly different characteristics of turbulence between the viscoelastic and Newtonian channel flows. Strong amplification of spectral energy is observed for viscoelastic flows, as well as substantially increased anisotropy and near-wall intermittency. Cross-scale transfer of TKE by the triadic interactions further characterizes the roles of polymer additives in turbulence modulation.

[1]This work was supported in part by the National Science Foundation, Grant No. OIA-1832976.

Jae Sung Park
University of Nebraska - Lincoln

Date submitted: 31 Jul 2020 Electronic form version 1.4