Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Statistical closure for homogeneous turbulent shear flow of a dilute polymer solution SHI JIN, DARIO VINCENZI, T. VAITHIANATHAN, LANCE COLLINS, Cornell University, EBERHARD BODENSCHATZ, Max Planck Institute for Dynamics and Self-Organization — Dilute polymer solutions exhibit macroscopic behaviors that distinguish them from ordinary Newtonian fluids. For example, minute concentrations of polymers (parts per million on a weight basis) can lead to impressive reductions in the drag on solid surfaces (by up to 80%). Numerical simulations of viscoelastic flows are generally based on an evolution equation for the conformation tensor of the polymer, $C_{ij} = \langle r_i r_j \rangle$, where $\mathbf{r}$ is the separation vector between the ends of the molecule and the angle brackets indicate an average over the Brownian configuration space of the molecule. Direct numerical simulations (DNS) of viscoelastic turbulence are able to reproduce the key phenomenology found in experiments; however, they are limited to modest values of the Reynolds number. An alternative approach is to seek a closed equation for the average configuration tensor that could be coupled to a Reynolds averaged Navier Stokes (RANS) solver. We propose a set of effective equations of motion for the mean conformation tensor rooted in the analysis of Lagrangian stochastic models with independent correlation times for velocity rate-of-strain and rate-of-rotation tensors. The proposed closure is compared with numerical simulations of Gaussian stochastic flows and DNS of homogeneous turbulent shear flows.

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Date submitted: 11 Aug 2005 Electronic form version 1.4