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Polymer relaxation in flow: dynamical slowdown around the coil-stretch transition D. VINCENZI, E. BODENSCHATZ, MPIDS, Goettingen, Germany, A. PULIAFITO, UCSB, A. CELANI, INLN, Nice, France — We investigate polymer relaxation dynamics both in extensional and random flows. We show a significant slowdown of dynamics in the vicinity of the coil-stretch transition. The time needed for the probability density function of polymer extension to relax to the equilibrium distribution is much larger than the Zimm time scale. In other words, the effective Weissenberg number differs considerably from the "bare" one. For the elongational flow, this effect is related to conformation hysteresis. For random flows, we show that hysteresis is not present. Nonetheless, the amplification of the equilibration time persists, albeit to a lesser extent, due to the large heterogeneity of polymer configurations around the coil-stretch transition. In both cases, the dependence of the drag force on the polymer configuration plays a prominent role. This effect may be relevant for drag-reducing turbulent flows, where the strain rate often fluctuates around values typical of the coil-stretch transition. Our conclusions thus suggest that the conformation-dependent drag should be included as a basic ingredient of continuum models of polymer solutions. The problem is solved analytically in terms of the Fokker-Planck equation for the distribution of the extension of the polymer. The computation of the equilibration time of the polymer in the flow is recast as a central two-point connection problem for a generalized spheroidal wave equation. The results are confirmed by Brownian Dynamics simulations and by experiments in a random flow generated by elastic turbulence (S. Gerashchenko & V. Steinberg, private communication).

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