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Dynamical slowdown of polymers in laminar and random flow
DARIO VINCENZI, EBERHARD BODENSCHATZ, Max Planck Institute for Dynamics and Selforganization, Goettingen, Germany, ALBERTO PULIAFITO, ANTONIO CELANI, INLN, Nice, France — The dynamics of an isolated polymer in a flow field forms the basis of constitutive models for dilute polymer solutions. We investigate the influence of an external flow on the relaxation dynamics of a single polymer theoretically and numerically. We show that a pronounced dynamical slowdown occurs in the vicinity of the coil–stretch transition, especially when the dependence on polymer conformation of the drag is accounted for. For the elongational flow, relaxation times are exceedingly larger than the Zimm relaxation time, resulting in the observation of conformation hysteresis. For random smooth flows hysteresis is not present. Yet, relaxation dynamics is significantly slowed down because of the large variety of accessible polymer configurations. In both cases, the dependence of the drag force on the polymer configuration plays a prominent role. This suggests the necessity of improving current models of polymer solutions in turbulent flows to account for such effect.

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