Supplementary Material: Characteristic features of self-avoiding active Brownian polymers under linear shear flow*

Arindam Panda† and Sunil P. Singh‡
Department of Physics,
Indian Institute of Science Education and Research,
Bhopal 462 066, Madhya Pradesh, India

Roland G. Winkler§
Theoretical Physics of Living Matter, Institute of Biological Information Processing and Institute for Advanced Simulation,
Forschungszentrum Jülich, 52428 Jülich, Germany; E-mail: r.winkler@fz-juelich.de
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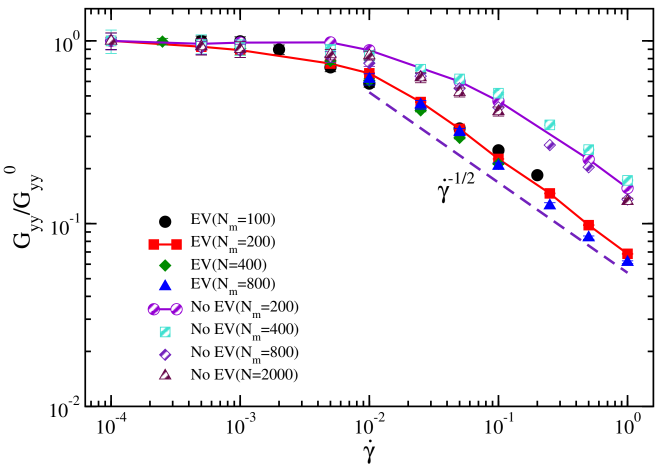

FIG. 1. The variation of normalized values of G_{yy}/G_{yy}^0 of a passive polymer as a function of shear rate($\dot{\gamma}$) for different polymer lengths ranging from $N_m = 100 - 800$ with EV and $N_m = 200 - 2000$ without EV (phantom polymer). The dash line indicates the power law variation of $G_{yy}/G_{yy}^0 \sim \dot{\gamma}^{-1/2}$, with an exponent $-1/2$.

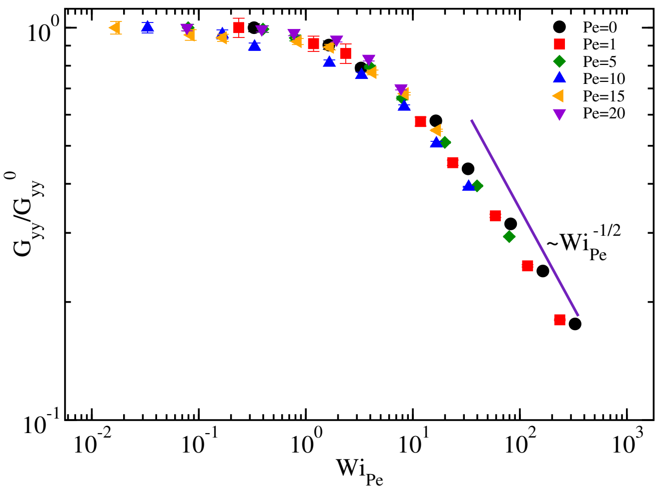

FIG. 2. The variation of G_{yy}/G_{yy}^0 for various Pe as a function of Wi_{Pe}. The solid line indicates the power law variation as $G_{yy}/G_{yy}^0 \sim Wi_{Pe}^{-1/2}$, with an exponent 1/2.

A. Radius of gyration:

We performed extensive simulations to analyze the behavior of passive polymers of various lengths, both with and without excluded volume (EV) interactions; specifically, we examine for polymer lengths $N_m = 100, 200, 400,$ and 800 with EV, and $N_m = 200, 400, 800,$ and 2000 without EV. In both cases, we observed a scaling exponent of 1/2 for the compression of the polymer along the gradient direction. Notably, in the asymptotic limit G_{yy}/G_{yy}^0 decreases according to the power law $G_{yy} \sim \dot{\gamma}^{-1/2}$ and remains the same regardless of real or phantom polymers, as depicted in Fig. 1.

Additionally, we also present the variation of the polymer compression in the gradient direction in the intermediate regime of the Péclet numbers $Pe = 1, 5, 10, 15$ and 20. In this limit, the variation of G_{yy}/G_{yy}^0 as a function of Wi_{Pe} for all the curves tend to converge and overlap with each other, displaying a universal behavior, see Fig. 2. This convergence suggests a minimal role of the active noise in this limit. The shear dominates over the active noise. Furthermore, a solid line depicts the power-law behavior in the graph, indicating a relationship described by $G_{yy}/G_{yy}^0 \sim Wi_{Pe}^{-1/2}$ with an exponent of 1/2 in the large shear regime.

B. Shear Viscosity

Now, we present the variation of the viscosity of the polymer for the longer polymers. The polymer lengths considered are $N_m = 100, 200, 400$ and 800 for the EV, and without EV (phantom), the polymer lengths are given as $N_m = 200, 400, 800,$ and 2000. In both cases, the shear viscosity in the asymptotic limit of the shear

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* A footnote to the article title
† arindam19@iiserb.ac.in
‡ spsingh@iiserb.ac.in
§ r.winkler@fz-juelich.de

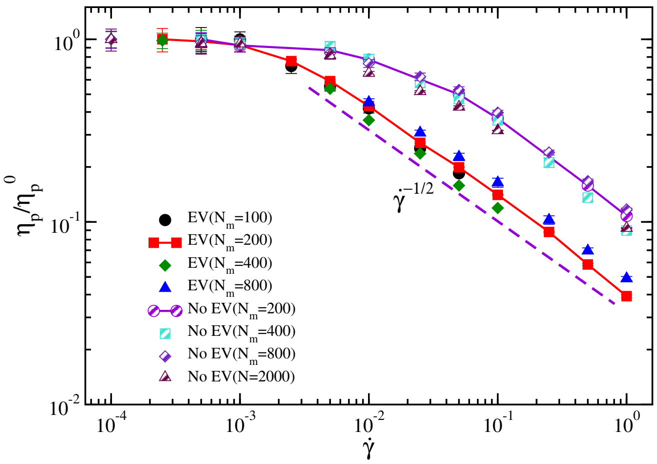

FIG. 3. The normalized shear viscosity η_p/η_p^0 of a passive polymer as a function of shear rate($\dot{\gamma}$) for different polymer lengths ranging from $N_m = 100-800$ with EV and $N_m = 200-2000$ without EV (phantom polymer). The dashed line displays the power law variation of the viscosity as $\eta_p/\eta_p^0 \sim \dot{\gamma}^{-1/2}$, with an exponent 1/2.

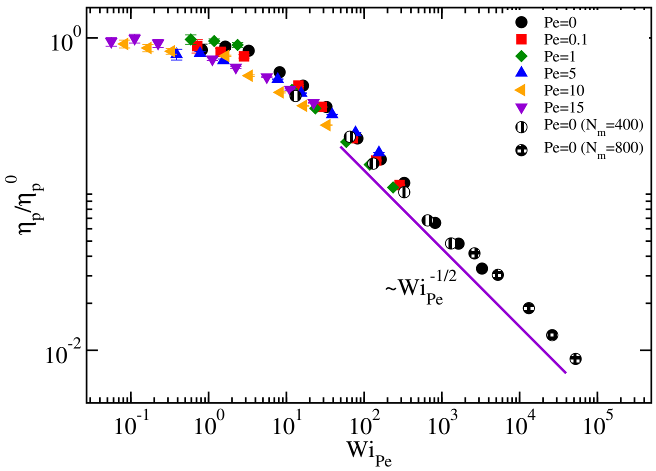

FIG. 4. The normalized shear viscosity η_p/η_p^0 as a function of Péclet number dependent Weissenberg number (Wi_{Pe}) for various Péclet number Pe (in the intermediate regime of Pe). The shaded symbols display viscosity for polymer lengths $N_m = 400$ and 800.

rates decreases according to the power law $\eta_p \sim \dot{\gamma}^{-1/2}$ similar to G_{yy}. The exponent of the real and phantom polymers are nearly identical, as indicated in Fig. 3. To distinguish the variation in the viscosity of the phantom and real polymers, they are plotted as a function of the shear rate ($\dot{\gamma}$).

The intrinsic viscosity of the polymer as a function of Wi_{Pe} in the intermediate regime of the Pe is displayed in Fig.4. In this regime, normalized viscosity can be described by a universal curve with Wi_{Pe} for the $Pe = 0.1, 1, 5, 10, 15$, suggesting that the role of the active noise in this regime accounts for the faster relaxation of the polymer. Therefore, the effect noise can be accounted for by renormalizing the Weissenberg number Wi_{Pe}.

C. Supporting movies

The movie files demonstrate the active Brownian polymer's conformational dynamics subjected to linear shear flow.

ESI-Movie S1: The movie reveals the polymer's conformational dynamics for $N_m = 200$, $Wi_{Pe} = 0.04$ and $Pe = 50$. During this process, the polymer undergoes stretching in all directions.

ESI-Movie S2: The movie reveals the polymer's conformational dynamics for $N_m = 200$ in the presence of active noise, at Weissenberg number $Wi_{Pe} = 4.0$ and $Pe = 50$.

ESI-Movie S3: The movie reveals the polymer's conformational dynamics for $N_m = 200$ in the presence of active noise at high shear rates given as Weissenberg number $Wi_{Pe} = 42$ and $Pe = 50$. The polymer is sufficiently stretched in the shear direction despite the strong active noise.