Polymer translocation driven by transversal and time-dependent end-pulled forces.

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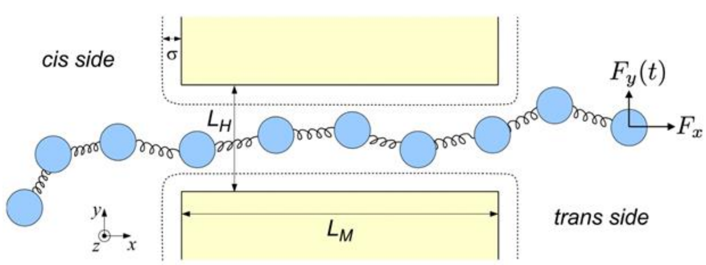
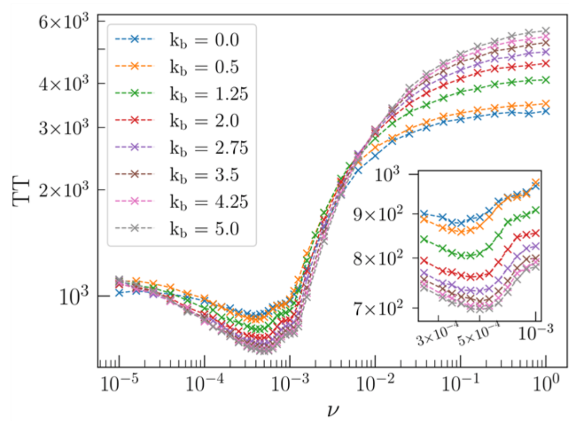
Polymer translocation has long been a topic of interest in the field of biological physics given its relevance in both biological (protein and DNA/RNA translocation through nuclear and cell membranes) and technological processes (nanopore DNA sequenciation, drug delivery) [1,2]. In this work, we simulate the translocation of a semiflexible homopolymer through an extended pore, driven by both a constant and a time-dependent end-pulled force, employing a model introduced in previous studies [3]. The time dependence is simplistically modeled as a cosine function, and we distinguish between two scenarios for the driving -- longitudinal force and transversal force-- depending on the relative orientation of the force, parallel or perpendicular, with respect to the pore axis. We investigate the effects of this periodic driving on the translocation times. We find a large minimum region of the mean translocation times as function of the frequency of the force that is typical of the Resonant Activation effect [4], with key differences between the two considered driving regimes. This minimum is present independently of the physical characteristics of the polymeric chains and reveals a linear relation between the optimum translocation time and the corresponding period of the driving. We propose an explanation for the mechanism behind this relation, its connection to the driving regime considered, as well as the values of the coefficients involved. The behavior of the translocation times when changing parameters of the chains were recorded, finding key differences in the responses between both driving regimes, and revealing a scaling law of the translocation times for chains of different lengths. Lastly, an analytical expression for the low frequency range of the translocation curves is derived, in clear agreement with the simulation results.





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