Cross-over from reptation to Rouse dynamics in a 1-dimensional model

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Abstract

It is known that the universal properties of long polymers can be obtained from stochastic lattice models. The reason is that long polymers are critical and in critical systems the universal properties are independent of the microscopic details. There are basically two modes of motion for polymers. One is reptation, which is the mechanism for polymers dissolved in a gel and to a lesser extent for dense polymer melts. Here the polymer is strongly confined and the main degree of freedom is motion inside the confining tube. The other mode applies to dilute solutions where the polymers can also move freely sideways. This is usually called Rouse dynamics.

We are interested in studying two parameters characterizing a polymer motion: the renewal time and the diffusion coefficient. For the reptation the first one scales with the size of the polymer N as a cubic power N^3, whereas the second one as N^{-2}. For Rouse dynamics we have N^2 and N^{-1} dependencies, respectively. It is therefore interesting to study the cross-over between these two mechanisms and to find out how a mixing-in of Rouse dynamics changes gradually the polymer behaviour.

We propose a 1-dimensional model based on Rubinstein-Duke motions and calculate all quantities by means of the density-matrix renormalization numerical technique (DMRG), which is very accurate for these stochastic processes.