

A simple model of a sequence-reading diffusion: non-self-averaging and self-averaging properties

Motivated by a question about the sensitivity of knots' diffusive motion to the actual sequence of nucleotides placed on a given DNA, here we study a simple model of a sequence-reading diffusion on a stretched chain with a frozen sequence of "letters" A and B, having different interaction energies. The chain contains a single distortion - a hernia - which brings the two letters at its bottom together such that they interact. Due to interactions with the solvent, the hernia performs a random hopping motion along the chain with the transition rates dependent on its actual position. Our two focal questions are a) the dependence of various transport properties on the letters' interaction energy and b) whether these properties are self-averaging with respect to different realizations of sequences. We show that the current through a finite interval, the resistance of this interval and the splitting probabilities on this interval lack self-averaging. On the contrary, the mean first-passage time through a finite interval with N sites and the diffusion coefficient in a periodic chain are self-averaging in the limit N going to infinity. Concurrently, two latter properties exhibit sample-to-sample fluctuations for finite N, as evidenced by numerical simulations.

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