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Dynamics of molecular motors with finite processivity on heterogeneous tracks

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The dynamics of molecular motors which occasionally detach from a heterogeneous track like DNA or RNA is considered.[1] Motivated by recent single-molecule experiments, we study a simple model for a motor moving along a disordered track using chemical energy while an external force opposes its motion. The motors also have finite processivity, i.e., they can leave the track with a position-dependent rate. We show that the response of the system to disorder in the hopping-off rate depends on the value of the external force. For most values of the external force, strong disorder causes the motors which survive for long times on the track to be localized at preferred positions. However, near the stall force, localization occurs for any amount of disorder. To obtain these results, we study the complex eigenvalue spectrum of the time evolution operator. Existence of localized states near the top of the band implies a stretched exponential contribution to the decay of the survival probability. A similar spectral analysis also provides a very efficient method for studying the dynamics of motors with infinite processivity.

1. Y. Kafri D. K. Lubensky and D. R. Nelson Phys. Rev. E 71, 041906 (2005).