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Large deviation of a tagged particle in 1D symmetric exclusion process

The one-dimensional symmetric simple exclusion process (SEP) is a simple and well-known stochastic interacting particle system in which many particles perform symmetric random walk with exclusion interaction.

We study the fluctuation properties of a tracer (tagged particle) in the one-dimensional SEP for a uniform density stationary initial condition. The mean position is zero and the anomalous fluctuation of order $t^{1/4}$ has been known for a long time. The large deviation principle (LDP) has been established by Sethuraman and Varadhan in 2013. We will present an exact formula for the rate function for this LDP. Our results can be generalized to the step initial condition with different densities in both direction, and can also be translated to the large deviation of the integrated current at an arbitrary position.

This is a generalization of a previous work on the current at the origin studied by Derrida and Gershenfeld, and also of another work on the single file diffusion of Brownian particles by Krapivsky, Mallick and Sadhu. Our approach uses recently developed techniques to study the one dimensional KPZ equation and asymmetric exclusion process, such as the Bethe ansatz, stochastic duality and nested contour formula for the deformed moments.

Reference: T. Imamura, K. Mallick, T. Sasamoto, Large deviations of a tracer in the symmetric exclusion process, Phys. Rev. Lett. 118, 160601 (2017).