First-passage statistics of a confined Brownian particle

Guirec de Tournemire, Nicolas Fares, Yacine Amarouchene, Thomas Salez

Abstract

The encounter of diffusing entities underlies a wide range of natural phenomena. The dynamics of these first-passage processes are strongly influenced by the geometry of the system, for example through confining boundaries. Confinement, which alters the diffusion of micrometric particles through hydrodynamic interactions, emerges as a key ingredient for modeling realistic environments. In this study, we investigate the impact of confinement on the first-passage statistics of a diffusing particle. This diffusive motion is probed, with nanometric precision, by combining *state-of-the-art* holographic microscopy with advanced statistical inference methods. Our numerical and experimental results provide a comprehensive understanding of this process, which is governed by the coupling between static and dynamic surface interactions, and thermal fluctuations. We further show that, depending on the relative position between the particle and the target, confinement can slow down or enhance first-passage kinetics. Such a boost appears to be reminiscent of non-Gaussian displacement distributions and the associated increased probability of the particle's largest displacements — *i.e.* the rarest events — and thus may be relevant to rationalize chemical reactions in crowded media, or biological *winners-take-all* processes.