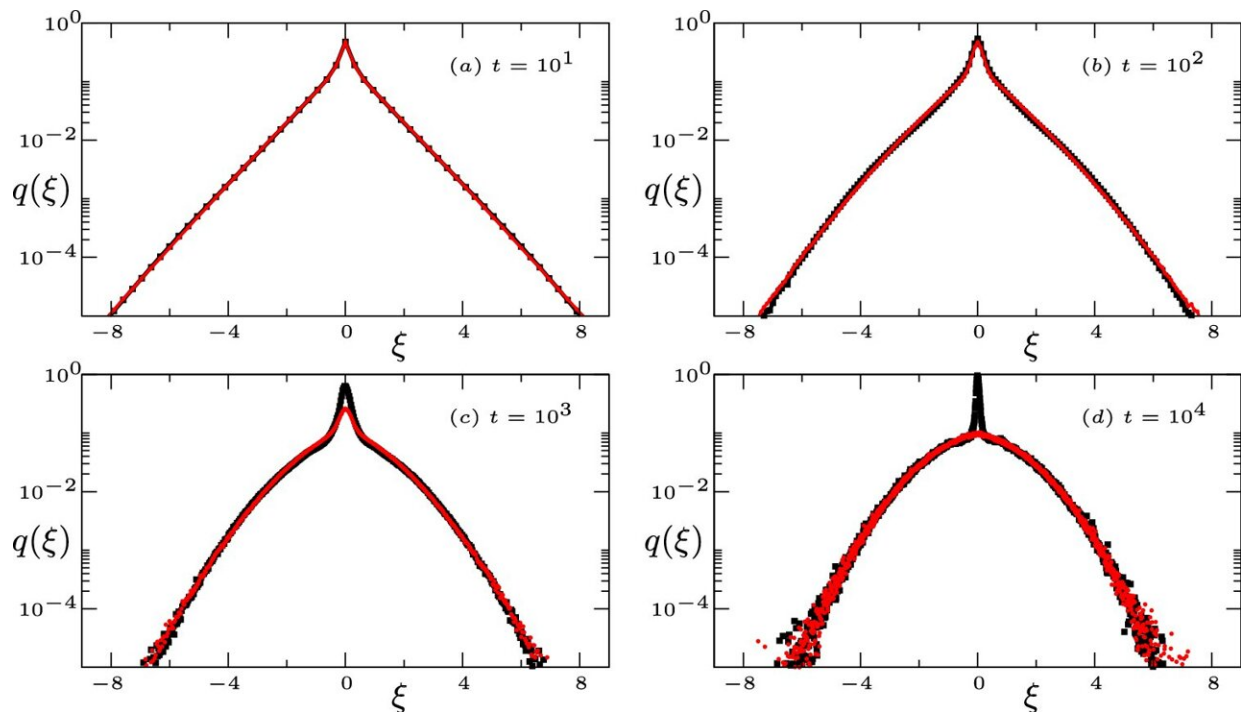


# Investigating the role of 'random walks' in particle diffusion

January 19 2024, by Samuel Jarman



Distribution curve with sharp central peak. Credit: *The European Physical Journal B* (2023). DOI: 10.1140/epjb/s10051-023-00621-z

Several recent experiments identify unusual patterns in particle diffusion, hinting at some underlying complexity in the process which physicists have yet to discover. Through [new analysis](#) published in *The European Physical Journal B*, Adrian Pacheco-Pozo and Igor Sokolov at Humboldt University of Berlin show how this behavior emerges through

strong correlations between the positions of diffusing particles traveling along similar trajectories.

Their results could help researchers to create better models of the diffusion process—ultimately drawing deeper insights into how fluids behave.

In many cases, diffusion occurs through [random fluctuations](#) in the positions of particles as they are jostled around by their neighbors. Known as Brownian motion, this effect can be visualized mathematically using normal distribution: a bell-shaped curve that illustrates the probability of finding a particle at any given displacement from its [starting position](#). Yet in some situations, this distribution can feature a sharp peak at its center—the very top of the bell curve—where the likelihood of finding particles is especially high.

This behavior has much in common with [theoretical models](#) characterized by [diffusion](#) rates that vary between localized regions—where in contrast to the expectation that the central peak will smooth out over time, it actually narrows and remains sharp.

In their study, Pacheco-Pozo and Sokolov investigated the nature of this persistent peak by considering the mathematics of 'continuous-time random walk' models. Here, a diffusing particle waits for a random amount of time before jumping to a new position—and the longer it waits, the further it jumps.

In this case, the duo showed that a sharp central peak emerges through strong correlations between the displacements of jumping particles following similar trajectories, both in time and space. All the same, the continuous-time random walk model couldn't fully match the shape of the sharp peak. This suggests the importance of more complex time-varying connections between particles, which the researchers now hope

to investigate in their future studies.

**More information:** Adrian Pacheco-Pozo et al, Random walks in correlated diffusivity landscapes, *The European Physical Journal B* (2023). [DOI: 10.1140/epjb/s10051-023-00621-z](https://doi.org/10.1140/epjb/s10051-023-00621-z)

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