Brownian Particles in Non-Markovian Baths: Memory, Fluctuations, and various Protocols

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Brownian particles suspended in simple Newtonian fluids are an important paradigm of statistical physics, as they are almost pefect random (drunken) walkers. In contrast, when suspended in complex fluids – for example a polymer- or micellar solution – Brownian particles display memory, and hence allow for a variety of new phenomena and challenges: These "half-drunken" walkers partly remember their past steps, which makes them ideal candidates to explore fundamental properties of non-equilibrium statistical physics: Due to memory (large relaxation times) these walkers can easily be driven far from equilibrium. We can hence study in a systematic manner stochastic systems far from equilibrium, including non-linear responses as well as non-equilibrium fluctuations. Notably, despite its complexity, this system can to a large extend be described with simple bath particle models [4], which makes it an even better model system.

In this presentation, we will discuss several recent observations for this system. i) When a Markovian particle faces a high potential barrier, it will overcome it with the famous Kramers escape time. A non-Markovian particle notably shows two time scales when overcoming the barrier [2]. ii) Turning to non-equilibrium, the non-Markovian particle shows the phenomenon of recoil [3, 1], which intriguingly allows to analyse the different fluctuation eigenmodes of the fluid. iii) When rotating the Brownian particle (or particle clusters), we observe an effect reminiscent of the Magnus effect known in fluids at high Reynolds numbers.

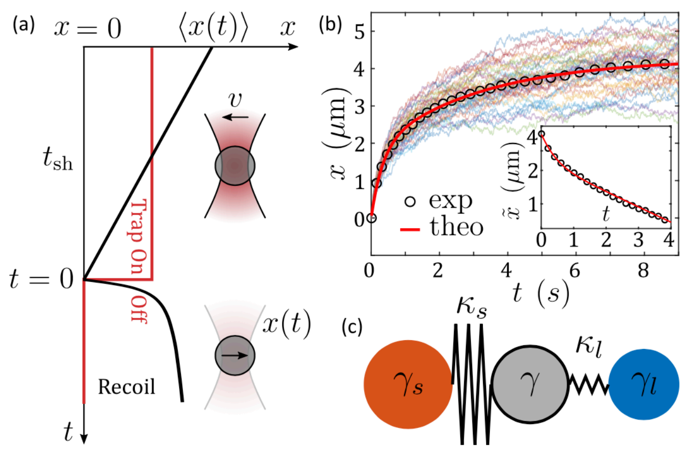

Fig. 1: *Protocol, experimental and theoretical curves of recoil of a Brownian particle in a non-Markovian fluid [3], as studied in [3] and [1].*

References:

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