

# Probabilistic sampling for physics: finding needles in a field of high-dimensional haystacks

ID de Contribution: 13

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## Anomalous thermal relaxations of physical systems

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Rapid cooling or heating of a physical system can lead to unusual thermal relaxation phenomena. A prime example of anomalous thermal relaxation is the Mpemba effect. The phenomenon occurs when a system prepared at a hot temperature overtakes an identical system prepared at a warm temperature and equilibrates faster to the cold environment. A similar effect exists in heating. Comparing two identical physical systems in their equilibration, we would expect that the system with a smaller mismatch between its and the environment's temperature will thermalize faster – yet it is not always the case.

I will present theoretical results on the Mpemba effect in over-damped Langevin dynamics and Markov jump processes. I will link the Mpemba effect's occurrence with the physical systems' properties and dynamics. In particular, I will derive the necessary conditions for the Mpemba effect in the small diffusion limit of one-dimensional over-damped Langevin dynamics on a double-well potential. Next, I will provide analytical results and insights on when the Mpemba effect happens in Markov jump processes as a function of the dynamics. I will explore the connections between the Mpemba effect and optimal transport. I will also discuss potential applications of anomalous thermal relaxations in MCMC sampling.

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