Modelling Langevin equation

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The Langevin equation describes the motion of particles under the influence of both deterministic forces (e.g., friction) and stochastic forces (random noise), linking Brownian motion and diffusion to the system's damping characteristics. In this study, we numerically calculated the mean squared displacement (MSD) and compared the obtained diffusion coefficient with known analytical expression, which connects the diffusion coefficient to the friction coefficient and temperature. Additionally, we examine the velocity distribution over time to analyze system dynamics. To further investigate the impact of stochastic forces, we introduce different types of noise, such as pink and white noise, and evaluate their effects on the system. Pink noise, characterized by a spectral exponent of 1, exhibits dominant lower frequencies and can represent long-range correlations, whereas white noise, with a spectral exponent of 0, distributes power equally across all frequencies and models uncorrelated random forces. Computational programs, particularly MATLAB, are employed to visualize these processes and compare numerical results with theoretical expectations.

References

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