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(POS-22) Diffusion coefficient scaling of a fast Brownian particle

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When a Brownian particle moves too rapidly for the medium to effectively absorb its kinetic energy, the standard Einstein theory of diffusion with a constant viscous friction becomes invalidated. A natural description of this kind of Brownian dynamics is to take the friction as a decreasing even function of the particle's velocity. The stochastic equation of motion is formulated within this approach, in which a broad class of physically relevant functions describing the velocity-dependent friction is considered. An analytical formula for the diffusion coefficient D is derived. It is shown that D as a function of temperature T may exhibit only three scaling types: (i) $D \propto T$, corresponding to the standard Einstein relation with velocity-independent friction; (ii) $D \propto T^{\alpha+1}$, corresponding to a power-law decrease of the friction coefficient with the velocity of the particle, $\gamma(v) \propto 1/v^{2\alpha}$ at high v; (iii) $D \propto 1/\sqrt{T - T_c}$, corresponding to a Gaussian relation between friction coefficient and velocity.

Keyword-1

Surface diffusion

Keyword-2

Long flights

Keyword-3

Diffusion coefficient

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