Stochastic acceleration implies ballistic motion

Stephan De Bièvre (Université Lille 1)

We study the long time motion of fast particles moving through time-dependent random force fields with correlations that decay rapidly in space, but not necessarily in time. The time dependence of the averaged kinetic energy $p^2(t)/2$ and mean-squared displacement $q^2(t)$ is shown to exhibit a large degree of universality; it depends only on whether the force is, or is not, a gradient vector field. When it is, $p^2(t) \sim t^{2/5}$ independently of the details of the potential and of the space dimension. The stochastically accelerated particle motion is then superballistic in one dimension, with $q^2(t) \sim t^{12/5}$, and ballistic in higher dimensions, with $q^2(t) \sim t^2$. These predictions are supported by numerical results in one and two dimensions. For force fields not obtained from a potential field, the power laws are different: $p^2(t) \sim t^{2/3}$ and $q^2(t) \sim t^{8/3}$ in all dimensions $d \geq 1$. 