Why Brownian yet Anomalous? The Importance of Pausing[1]

SERGEY PANYUKOV, P.N. Lebedev Physics Institute, Russian Academy of Sciences, Moscow 117924, Russia

Recently, many processes of random diffusion were reported with Brownian-like time dependence of observables (such as particle displacements), but with anomalous correlations between variations of these observables during different time intervals. We demonstrate that such behavior is a characteristic feature of a large class of random processes that can be described by a sequence of random events (such as particle displacements), separated by random time intervals (pausing times). We explain this phenomenon using a simple model of a particle hopping between adsorption sites. In this model, the particle is captured between hops in a potential well for a pausing time that depends on the depth of this well. The unexpected feature of our model is that the particle experiences Brownian random motion with diffusion coefficient that depends on prior history of the particle. Abnormal character of such Brownian diffusion is manifested in the exponential (non-Gaussian) distribution function of particle displacements and anomalous time dependence of their moments. Another interesting feature of this process is the memory of a displacement of the particle affecting its motion during later time intervals. We point out, that this phenomenon is a generic feature of dynamic systems with extremely wide distribution of pausing times.