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New laws of anomalous superslow diffision

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Intensive investigations of diffusive and transport phenomena show that a wide range of various stochastic processes which can be of quite different nature and complexity often demonstrate anomalous average behavior [1]. The main feature of the latter consists in the fact that a large number of random variables which characterize these systems are not normally distributed (even approximately) that gives rise to the non-linear diffusion laws. In other words, at long times the variance of these processes differs from the classical linear one.

One of the most useful and flexible approaches that are used to describe and analyze such anomalous stochastic systems is based on the continuous-time random walks (CTRWs) theory. Widespread use of this framework is reached due to the fact that many random processes are characterized by two typical for CTRWs random variables, namely, the measure (length) of transition (jump) and the waiting time between successive transitions. The interesting case of CTRWs is the one characterized by superheavy-tailed distributions (which have infinite moments of any fractional order) of waiting time. Therefore, the former one can be represented as the model of superslow diffusive processes whose variance increases slowly than any positive power of time. Using the CTRW approach in the case of superheavy waiting time densities and jump densities with finite second moment, it has been obtained a broad class of superslow diffusive laws [2].

In the present work we concern ourselves with the question of the existence of other anomalous diffusion laws generated by CTRWs. Based on our recent results on the asymptotic behavior of CTRWs with superheavy-tailed waiting time and asymmetric heavy-tailed jump length distributions (whose first and/or second moments are infinite) [3], we find the conditions of superslow diffusion and establish corresponding laws by analytical methods and provide a verification using numerical simulation.

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