Subordination processes for non-Gaussian diffusion: a modelling framework for transport in complex media

Vittoria Sposini[1]
[1]University Of Padova, Padova, Italy

Transport phenomena in soft matter systems play a fundamental role in a wide range of biological and industrial processes. Over the last decades, it has become clear that the motion of diffusive tracers in complex and disordered environments often deviates from classical Gaussian statistics of standard Brownian motion, instead exhibiting (almost) universally a non-Gaussian behaviour. Both analytical and numerical studies have linked non-Gaussian diffusion to sample-to-sample variability and/or spatio-temporal heterogeneity inherent to the system. I will present a general theoretical framework based on the concept of subordination that captures the emergence of non-Gaussian diffusion across a broad class of complex systems. Building on this formalism, two dynamical regimes, characterised by distinct scaling properties of the subordinator's probability density function, naturally arise. In particular, I will show that these regimes can be linked to the concepts of dynamical large deviations and self-similarity. Finally, I will discuss applications of this modelling framework in the context of standard and extreme first-passage phenomena.

References:

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