Seminar of SFB 910

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Stochastic processes with finite propagation velocity

Stochastic processes play a key role for modeling a huge variety of transport problems out of equilibrium, with manifold applications throughout the natural and social sciences. To formu- late models of stochastic dynamics, the conventional approach consists in superimposing random fluctuations on a suitable deterministic evolution. These fluctuations are sampled from probability distributions that are prescribed a priori, most commonly as Gaussian or Lvy (power laws). While these distributions are motivated by (generalized) central limit theorems, they are nevertheless un- bounded, meaning that arbitrarily large fluctuations can be obtained with finite probability. This property implies the violation of fundamental physical principles such as special relativity and may yield divergencies for basic physical quantities like energy. My talk will provide an introduction to stochastic processes possessing physically realistic finite propagation velocity. I will start by briefly reviewing simple random walks on the line and Wiener processes. On this basis I will discuss infinite velocity Lvy flights and their finite velocity counterpart, called Lvy walks. As an example, I will present their different first passage and first arrival properties [1]. I will then introduce to Poisson-Kac processes, which form the finite velocity counterpart of Wiener processes. This setting motivates to construct a general theory, which we call extended Poisson-Kac theory, that includes Wiener processes, Poisson-Kac processes and Lvy walks as special cases. It thus yields a general framework to invent and study finite velocity stochastic processes featuring spatio-temporal correlations, as is illustrated by three examples [2].

1. V. V. Palyulin, G. Blackburn, M. A. Lomholt, N.W. Watkins, R. Metzler, R. Klages, and A. V. Chechkin, New J. Phys. 21, 103028 (2019).
2. M.Giona, A.Cairoli, R.Klages, Phys. Rev. X 12, 021004 (2022).

The event is part of the group seminar of AG Klapp at TU Berlin.
For information on how to access the event, please contact: henning.reinken@itp.tu-berlin.de

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