

Complex systems in heterogeneous environments

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Many complex driven nonequilibrium systems are effectively described by a superposition of several statistics on different time scales, in short a ‘superstatistics’[1-2]. A simple example is a Brownian particle moving in a spatially inhomogeneous medium with temperature fluctuations on a large scale, or a collection of different Brownian particles with different diffusion constants, but the concept is much more general. Superstatistical systems typically have marginal probability distributions that exhibit fat tails, for example power law tails or stretched exponentials. In most applications one e

nds up with three relevant universality classes: Lognormal superstatistics, chi-square superstatistics and inverse chi-square superstatistics. These can be effectively described by methods borrowed from nonequilibrium statistical mechanics.

In my talk I will provide an easy-going introduction to these types of statistical mechanics methods relevant for heterogeneous or inhomogeneous environments, and discuss some recent examples of applications. These applications are from very different subject areas, but we will see what is common to all of them. The applications that I will discuss will be (time permitting) from turbulent flows (both classical and quantum turbulence), share price dynamics, diffusion processes of cancerous cells, rainfall statistics, fluctuations of demand and supply in local electricity markets, high energy scattering processes, and magnetic flux noise phenomena [3-5].

In these applications there is always a local parameter that fluctuates on a much larger spatial or temporal scale than the local relaxation time of the system. This parameter can be a local inverse temperature, a local variance parameter of a time series, a fluctuating mobility, or a fluctuating energy dissipation rate. Occasionally one also observes a transition from one type of superstatistics to another when a system parameter is varied.

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