SYAT 1: Anomalous Transport in Heterogeneous Media I

Time: Wednesday 14:30–16:00 Location: H1

Invited Talk SYAT 1.1 Wed 14:30 H1

Aging, ergodicity breaking and universal fluctuations in continuous time random walks: Theory and (possible) experimental manifestations — •Igor Sokolov — Institut für Physik, Humboldt-Universität zu Berlin

We consider some peculiarities of subdiffusive transport within the continuous time random walk (CTRW) model as appearing in the mean-field description of particles' motion in random potentials (energetic disorder). The anomalous diffusion under CTRW is a process with non-stationary increments. This non-stationarity introduces explicit dependence of observables on the time elapsed from preparing the system in its present state, and corresponds to aging of the process. Aging leads to such unusual properties of the system's time evolution as death of linear response to an external stimulus or as intrinsic ergodicity breaking. The last can have different manifestations, like the explicit dependence of the moving time averages on the interval of averaging or like universal fluctuations in kinetic coefficients in different realizations of the process. These properties lead to several interesting effects, which are specific for energetic disorder and which can be used for distinguishing this mechanism of anomalous subdiffusion from other possible mechanisms (like the existence of slow modes or diffusion in geometrically disordered systems). We discuss how these properties were (or can be) used in interpretation of experimental or numerical findings, and also consider some cases of anomalous diffusion of mixed origin (e.g. involving geometric and energetic disorder at the same time).

Invited Talk SYAT 1.2 Wed 15:00 H1

Distinguishing anomalous from simple diffusion in crowded solutions and in cells with fluorescence correlation spectroscopy — •Cecile Fradin, Daniel Banks, Shyemaa Shehata, Felix Wong, and Robert Peters — Dept. of Physics and Astronomy, McMaster University, Hamilton, Canada

The diffusion of proteins in cells is at the core of many important biological processes, in particular signal transduction and pattern formation. Yet, whether and why protein diffusion in cells may deviate from simple diffusion remains a matter of debate. One model often proposed to explain the experimental results is that this diffusion is anomalous, where the mean-squared displacement of the particles scales with time as $\sim t^{\alpha}$ (instead of $\sim t$ for simple diffusion). It has often been suggested that anomalous diffusion could arise due to the crowding of the cellular environment. To test this hypothesis, we have performed variable length scale fluorescence correlation spectroscopy experiments, where the size of the detection area was varied, allowing to check whether the apparent diffusion coefficient varied with the scale of observation, a non-ambiguous indication of anomalous behavior. In cross-linked gels, we observed as expected that the diffusion of tracer particles was anomalous. In crowded polymer solutions and in live C. elegans embryos, on the other hand, and although single length scale fluorescence correlation spectroscopy experiments point to a strong anomalous behavior, variable length scale analysis failed to detect anomalous diffusion.

Invited Talk SYAT 1.3 Wed 15:30 H1

Exploring Diffusion in Nanostructured Systems with Single Molecule Probes: From Nanoporous Materials to Living Cells — •Christoph Bräuchle — Department of Chemistry and Biochemistry and Center for Nanoscience (CeNS), LMU München, Butenandtstr. 11, D-81377 München/Germany

Molecular movement in confined spaces is of broad scientific and technological importance in areas ranging from molecular sieving and membrane separation to active transport along intracellular networks. Whereas measurements of ensemble diffusion provide information about the overall behaviour of the guests in a nanoporous host, tracking of individual molecules provides insight into both the heterogeneity and the mechanistic details of the molecular diffusion as well as into the structure of the host. Here we show how single dye molecules act as beacons while they diffuse through the different structural phases of the host. A unique combination of transmission electron microscopy and single molecule tracking reveals unprecedented details of the movement of a molecule, how it varies its mobility and bounces off a domain boundary or travels through various defect structures and adsorption sites. Furthermore, investigations of the uptake and trafficking of artificial viruses in living cells will show three different phases of mobility of these nanoparticles during their transfection pathway into a living cell.