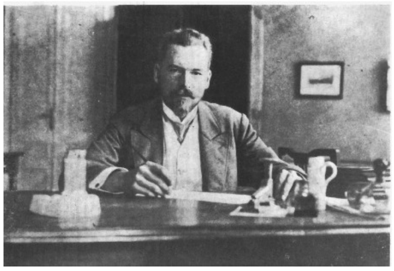

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Scale-dependent anomalous diffusion in spatially disordered environments

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Recent advances in single particle tracking techniques have led to a growing interest in the theoretical study of the motion of microscopic particles in biological environments. It is of key importance for the field of biology to characterize the diffusion of such particles. Many experimental observations have been linked to already existing frameworks such as the continuous time random walks, Lévy walks, … However, as we show in our work, if one faces a system with spatial disorder, the scale at which we are able to track the particles is a key factor for the characterization of its motion.

We exemplify this issue with a simple system, which allows us to create an anomalous diffusion process by means of the interaction of the particles and its environments. We consider a compartmentalized space, where each compartment is characterized by a size L and a transmittance of the boundaries T. We show that the motion of a Brownian particle moving in such environment, in the case in which we are able to follow its position at each time step - the microscopic scale - can be mapped to a CTRW.

In the other hand, we consider that we are only able to track the particle once it has exited a compartment - the macroscopic scale. This is often the case in biological systems. Then, the motion of the particle can be modeled as a Lévy walk, in which the step size has a length L (which in 2D is related to the area) and the time step is the time the particle takes to exit the compartment. This time is related to the size and the transmittance of such compartment.

To give a concrete example, we take power law distribution of the probability distribution functions of the sizes L and transmittances T. In our work, we show how the diffusion evaluated at the micro- and macroscopic scales, even coming from the same underlying process, show completely different behaviors. Moreover, these two are related as the variance in the position of the microscopic scale is the square root of the variance of the macroscopic scale. The previous proofs the importance of characterizing the different scales of a spatially disordered system before studying the diffusion process taking place on it.

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