Anomalous Diffusion Evidenced by Particle Tracking at High Frame Rates

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Diffusion is a common phenomenon in nature and generally is associated with a system trying to reach a local or a global equilibrium state, as a result of highly irregular individual particle motion. Therefore it is of fundamental importance in physics, chemistry and biology. Particle tracking in complex fluids can reveal important characteristics of its properties. In living cells, we coat the microbead with a peptide (RGD) that binds to integrin receptors at the plasma membrane, which connects to the CSK. This procedure is based on the hypothesis that the microsphere can move only if the structure where it is attached move as well. Then, the observed trajectory of microbeads is a probe of the cytoskeleton (CSK), which is governed by several factors, including thermal diffusion, pressure gradients, and molecular motors. The possibility of separating the trajectories into passive and active diffusion may give information about the viscoelasticity of the cell structure and molecular motors activity. And also we could analyze the motion via generalized Stokes-Einstein relation, avoiding the use of any active techniques. Usually a 12 to 16 Frames Per Second (FPS) system is used to track the microbeads in cell for about 5 minutes. Several factors make this FPS limitation: camera computer communication, light, computer speed for online analysis among others. Here we used a high quality camera and our own software, developed in C++ and Linux, to reach high FPS. Measurements were conducted with samples for 10× and 20× objectives. We performed sequentially images with different intervals, all with 2 µs exposure. The sequences of intervals are in milliseconds: 4, 5, 14, 25, 50 and 100 FPS. Our preliminary results highlight the difference between passive and active diffusion, since the passive diffusion is represented by a Gaussian in the distribution of displacements of the center of mass of individual beads between consecutive frames. However, the active process, or anomalous diffusion, shows as long tails in the distribution of displacements.

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