Levy statistics and dynamics in active cytoskeletons

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Seen as a material, the interior of biological cells is a very unique kind of matter, chemically driven away from equilibrium by the internal energy-dissipating and force-generating machinery. Reconstituted active cytoskeletal networks, consisting of an actin filament network driven by myosin motor proteins, have been shown to be a useful model system that mimics nonequilibrium situations in cells. Here we carried out microrheology study of this active reconstituted system. Being active driven, the fluctuation of the probe particle are orders of magnitude larger than that of thermal, which provides relevant information on the force generations and stress transmission which is profoundly influenced by the complex interaction with the surrounding materials.

In prior studies, the second moment of the athermal fluctuations has been investigated following the standard procedure established for the microrehology in homogeneous continuum in equilibrium where Gaussian fluctuations are expected. Here we investigate the full displacement distribution of the athermal fluctuations in active cytoskeletons which are found to be far from Gauss. We develop a model to investigate the origin of this non-Gaussian behavior based on the truncated Lévy statistics, as a general consequence of the randomly distributed effectors whose impact spatially decays as 1/r2, such as the gravitational mass, electric charges, and force dipoles.