k-SPACE SCATTERING IMAGE CORRELATION FROM GOLD NANOSTARS INTRACELLULAR MOTIONS REVEALS INTERMITTENT-TYPE TRANSPORT PHENOMENA

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The characterization of nanoparticles intracellular trafficking pathways is essential to rationally design experiments exploiting them for in vivo imaging, photothermal therapy, and drug delivery, thanks to their plasmon-enhanced absorption and scattering cross sections, ease in synthesis and functionalization, and controlled cytotoxicity.
In this work, we exploit live-cell time-lapse confocal reflectance microscopy and spatio-temporal image correlation on the tens-of-seconds timescale in both direct and reciprocal space, to investigate the complex intracellular transport of branched gold nanostars (GNSs). Together with numerical simulations and with a Bayesian (hidden Markov model-based) analysis of single particle tracking data, our experimental results reveal the presence of sub-ballistic superdiffusion, ascribed to a two-state switching between Brownian diffusion in the cytoplasm and molecular motor-mediated active transport.
An analytical theoretical framework for Fourier-space image correlation spectroscopy (kICS) is derived to investigate these intermittent-type transport phenomena, and the influence of the dynamic and kinetic parameters on kICS is evaluated.
Since the kICS approach is capable also of identifying even simpler transport phenomena, whether purely diffusive or ballistic, allowing an exhaustive investigation of the dynamics of GNSs and biological macromolecules, a protocol is outlined to derive whole-cell maps for each parameter underlying the GNSs intracellular dynamics.