Multiscale Image Processing Method for Investigating Giant Concentration Fluctuations in Nanocolloids

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Colloidal suspensions are ideal systems for investigating the spatial-temporal evolution of density fluctuations using dynamic light scattering since they strongly interact with light and produce strong shadowgraph images. Non-equilibrium concentration-driven fluctuations in iron oxide magnetic nanoparticles were visualized using the shadowgraph method. The multiple spatial and temporal scales of fluctuations can be effectively separated using the Bidimensional Empirical Mode Decomposition (BEMD) technique. The resulting orthogonal decompositions for each spatial scale are represented by an Intrinsic Mode Function (IMF) image. The thermophysical properties for each spatial scale were extracted using the Dynamic Differential Microscopy (DDM), which allows the structure factor's computation and the intermediate scattering function (ISF) of nanocolloids. The structure factor carries information about the morphology and size distribution of nanoparticles. The ISF gives the correlation time of fluctuation, which determines the thermal diffusion coefficient. Understanding these magnetic nanoparticles could have broad applications on medical vectors, cancer treatment, and gene therapy.