Probe and control the non-equilibrium dynamics of nanoparticles using nano-optical tools

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In Nature, living organisms are driven from the bottom-up: molecular motors drive cells, which in turn organize at larger scale. Inspired by such complexity, active systems have been widely studied in the lab using microscopic colloids. However, the dynamics of artificial motors at the nanoscale remains elusive, despite their potential to design novel hierarchical materials. Such study has been hindered by challenges inherent to small scale processes, hardly observable and subject to strong thermal noise. Here, we show an approach to probe the dynamics of an active fluid composed of active nanoparticles (10 – 100 nm). The nanoparticles are activated by light, using largescale photothermal heating. In order to probe their dynamics, we have built a custom-made confocal microscope and harness optical correlation techniques, namely Confocal Scattering Spectroscopy, coupled to fast imaging. Our setup allows us to examine the dynamics on a wide range of timescales, from ~0.1µs to ~1s, and to locate the different excitation regimes where activity becomes significant vs thermal noise, while simultaneously controlling optical forces, inherently present in optical experiments. Our results initiate an upcoming study on collective effects in assemblies of active nanoparticles.

Key-words: active matter, thermophoresis, nanoparticles, nano-optics, time-correlated spectroscopy

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