Characterization of non-ergodic systems through advanced light scattering

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Much of the research interest in the field of soft matter focuses on studying slow relaxation processes in systems that are close to a phase transition or are dynamically arrested. Gels, glasses and aging soft materials are example of such systems. In some cases, accessing dynamic properties in time scales of seconds or even minutes is crucial.

A method that allows for studying slowly relaxing systems is to perform many dynamic light scattering (DLS) measurements, providing a series of time averaged correlation functions. Between each measurement the sample is rotated such that a different speckle is observed. The measurements are then summed to provide the ensemble average [1]. Additionally, when working with concentrated samples, which is frequently the case for non-ergodic samples, the suppression of multiple scattering is required to obtain meaningful results. This is achieved through 3D modulated cross-correlation [2,3], where two temporally separated light scattering experiments are performed at the same scattering vector on the same sample volume in order to extract only the single scattering information common to both.

In this work, we present modulated 3D static and dynamic light scattering measurements on Polystyrene particles suspended in a transparent gel matrix. Through a sample goniometer, we rotate the sample to record a subsection of the configuration phase space. We then average over many sub-ensembles to capture the full phase space.

We demonstrate that to follow slowly relaxing or fully arrested systems, modulated 3D cross-correlation combined with a sample goniometer is a very powerful experimental tool that can record information not accessible by traditional approaches.

[1] P.N. Pusey and W. Van Megen*, "Dynamic light scattering by non-ergodic media*", Physica A 157 (1989)
[2] Patent EP2365313 A1
[3] Ian D. Block and Frank Scheffold, *"Modulated 3D cross-correlation light scattering: Improving turbid sample characterization"*, Rev. Sci. Instrum. 81, 123107 (2010).