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# Heterogeneous local order in self-assembled nanoparticle films revealed by X-ray cross-correlations

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Accessing structure beyond pair correlation functions is expected to shed light on various open questions in condensed matter physics such as the glass transition phenomenon. Typically, it is governed by the appearance of dynamical heterogeneities, suggested to be closely connected to spatial heterogeneities. Such spatial motifs are believed to play a key role in the glass transition process, e.g., via geometrical frustration suppressing formation and growth of crystallites. In order to measure such structural heterogeneities, higher-order correlation functions have to be defined using e.g. the X-ray Cross Correlation Analysis (XCCA) technique [1,2].
Here, we will discuss our recent XCCA results on colloidal films and crystals [3,4]. A special focus is set on the self-assembly of functionalized gold nanoparticles [5]. Depending on the initial concentration of particles, structurally heterogeneous films are formed with dominating four- and six-folds symmetry. The amplitude of order parameters indicates that a minimum sample amount in necessary to obtain well-ordered structures. This richness of information cannot be achieved by standard microscopy techniques that are commonly used to characterize such nanoscale systems.
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[2] F. Lehmkühler et al. J. Appl. Cryst. 47, 1315 (2014).
[3] M.A. Schroer et al. Soft Matter 11, 5465 (2015).
[4] F. Lehmkühler et al. J. Appl. Cryst. 49, 2046 (2017).
[5] F. Lehmkühler et al. IUCrJ 5, 354 (2018).

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