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Separating Macro- and Nano-structural Effects in Intensity Correlation Measurements of Self-assembled Lipid Materials

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By correlating large ensembles of X-ray scattering data, fluctuation X-ray scattering can extract atomic and nanoscale structural information from a range of systems including colloidal glasses and crystals, liquid-crystal membranes, nanoparticles, and magnetic domains [1-4]. Real-space pair-angle distribution functions are higher order analogues of the basic pair-distribution functions and are rich in information about orientation and bond angles. This method maps fluctuations of scattered intensity into three- and four-atom correlation functions which encode two pairwise distances and one relative angle [5-7].

Here we present results of fluctuation scattering experiments on the inverted hexagonal phase of a model self-assembled lipid system (cetyltrimethylammonium bromide-water). Using newly developed semiautomated algorithms for big datasets (>1000 patterns) we uncover a macroscopic preferred orientation effect which masks the nano-structural signal due to intensity fluctuations. Texture phenomena such as a preferred orientation, strain and peak broadening are commonly encountered throughout materials science. By simulating distorted datasets, we explore how correlation plots are altered by macroscale effects and present methods for disentangling structural information at these two length scales, broadening the range of materials and phase transitions amenable to fluctuation scattering analysis.

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