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Research Highlight

Confinement-Induced Orientational Alignment of Quasi-2D Fluids

Confinement is known to induce ordering of fluids, which in turn affects, e.g., their dynamic properties. Consequently, confinement-induced fluid ordering is of importance for drug delivery, lubrication, and nanofluidics applications, just to name a few examples. Understanding this phenomenon requires knowledge about both the average density profile and the local structure of the fluid. However, although theoretical studies have been available since the early 90's, experimental work has so far proven difficult because of the presence of the confining surfaces.

In "Confinement-induced orientational alignment of quasi-2D fluids" we report on an experimental approach for simultaneous determination of the density profile and local structure of confined fluids. The approach is based on studying artificial model systems: as sample we use colloidal fluids with a particle diameter of 50 nm, while for confinement we use periodic channel arrays, the latter also acting as diffraction gratings for the incident hard X-rays. Within our approach, the density profile of the confined fluid across the confining channel can be reconstructed from the X-ray diffraction data, while the local structure of the confined fluid can be determined from the diffuse X-ray scattering originating from the short-range density variations of the fluid. For demonstration purpose, we applied the technique on a fluid in extreme confinement, focusing on the structural transition from a monolayer to a bilayer with increasing fluid film thickness. The experiment shows how extreme confinement induces orientational alignment of the fluid, while still preserving a fluid-like structure.

The present approach allows structure determination of complex fluids in extreme confinement. Besides the structure of colloids, as demonstrated here, the method is also applicable, e.g., for studies on biologically relevant fluids confined between either hydrophobic or hydrophilic surfaces.

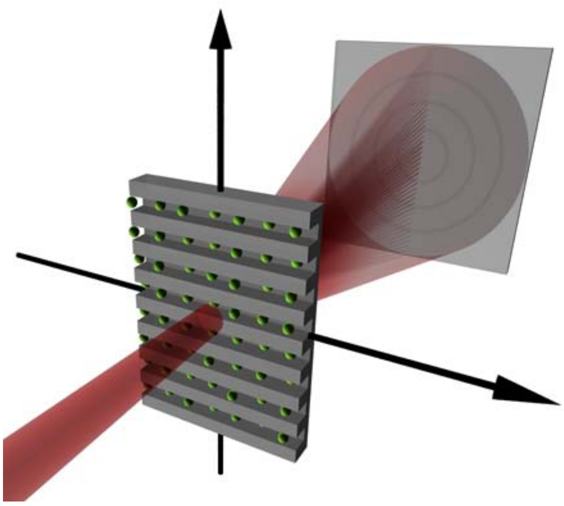

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Figure 1: Schematic of the experimental setup.

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Confinement-induced orientational alignment of quasi-2D fluids

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