Interpretation of Specular XPCS Measurements of Smectic Liquid Crystal Membranes

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We present a comprehensive account of the dynamics of layer-displacement fluctuations in smectic liquid-crystal membranes as studied by x-ray photon correlation spectroscopy (XPCS) [1-3]. The relaxation behaviour in smectic membranes can be divided into three regimes, characterized by oscillatory relaxation, surface dominated exponential and bulk-elasticity dominated exponential relaxation, respectively. A transition from oscillatory to exponential relaxation is determined by a crossover wave vector q_c with only fluctuations with wave vectors $q > q_c$ showing exponential relaxation.

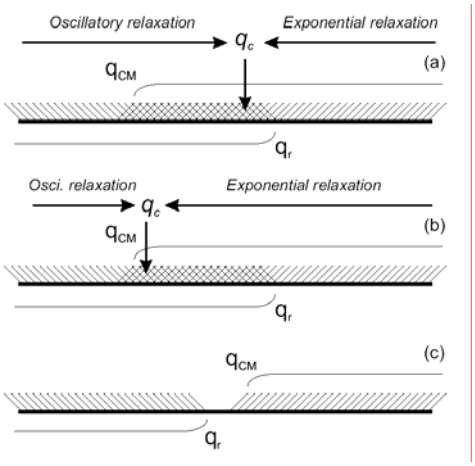

Figure 1: Schematic representation of the window defined for specular XPCS measurements.

XPCS measurement at specular positions are dominated by a window of wave vectors cutting larger and smaller values [3]. This window results from a combination of the finite mosaic of the smectic membranes (as given by the with qr of the rocking curve) selecting long wavelength fluctuations ($q < q_r$), and the size of the coherence volume inside which short wavelength fluctuations ($q > q_{CM}$) perturb the density profile, and is given by the overlap of these two regimes. For thin membranes this window is dominated by fluctuations with $q < q_c$, resulting in oscillatory behavior of the intensity correlation function (Fig. 1a). For thicker membranes the cross-over wave vector q_c shifts towards smaller values and the window of contributing fluctuations is dominated by exponential relaxation (Fig 1b). For extremely well-ordered membranes characterized by a narrow rocking curve < 1 mdeg, the wave vector window is empty, which results in the absence of any contrast in the specular correlation function (Fig. 1c).

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References

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