

THE HEXATIC PHASE IN A 2D COLLOIDAL SYSTEM

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The theory of two-dimensional melting, developed by Kosterlitz, Thouless, Halperin, Nelson and Young (KTHNY-theory) has been a matter of debate over decades. Previously we demonstrated the softening of a crystal due to the appearance of dislocations close to the crystal \rightarrow hexatic phase transition. Here we focus on the breaking of the orientational symmetry at the hexatic \rightarrow isotropic liquid transition. Using positional data from video-microscopy of a colloidal system we calculate the bond-order correlation function G_6 . We verify quantitatively that the decay of G_6 switches from algebraic to exponential during melting at the hexatic-liquid transition. For the hexatic phase the temperature dependent exponent η of the algebraic decay is extracted and analyzed. It is related to the modulus of rotational stiffness, Frank's constant F_A . Indeed, F_A becomes $72/\pi$ at the hexatic \rightarrow isotropic liquid phase transition as predicted by KTHNY-Theory. This is a quantitative test for the mechanism of breaking the orientational symmetry due to disclination unbinding. (Fig. 1) shows the structure factor $S(q)$ of the two-dimensional system at various temperatures as obtained from video microscopy data. This demonstrates the characteristic symmetries of the distinct thermodynamic phases.

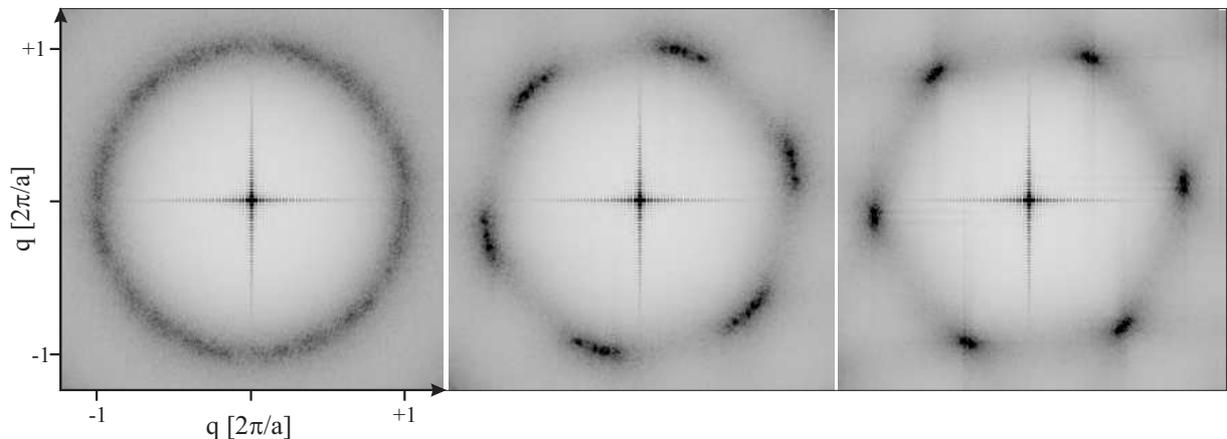


Figure 1: structure factor of a colloidal system for various temperatures: isotropic liquid, hexatic and crystalline phase (from left to right).