Structure and phase transitions in a two-dimensional colloidal suspension in external fields

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We study the structure as well as the melting and the freezing transition of suspensions of superparamagnetic colloidal particles that interact via a magnetic, repulsive dipole-dipole interaction, which is induced and easily controlled by an external magnetic field. The two-step melting process via a hexatic phase was observed earlier in the case of a perpendicular magnetic field, and experiments were found to be in good agreement with KTHNY-theory [1]. Now we study the colloidal suspension under the influence of various additional external fields, which lead to changes of the known liquid, hexatic and crystal phases and also to new structures. By introducing a magnetic field in the sample plain the hexagonal crystal is distorted and the hexatic phase is found to broaden. When an inhomogeneous perpendicular field is applied, the interaction between the particles becomes anisotropic. This leads to a variation of the particle density and conformal crystal structures without defects are observed. In the case of a time dependent perpendicular magnetic field, we observed nucleation of colloidal crystals and grain growth after a sudden increase of the magnetic field.

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