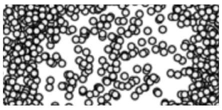

Equation of State and distribution of density defects for a quasi-condensate of dipolar excitons

Dipolar excitons of GaAs coupled quantum wells provide a model system to study collective phenomena that can emerge in two-dimensional semiconductors. Indeed, these are characterised by a large electric dipole moment and a long radiative lifetime allowing them to thermalise to sub-Kelvin temperatures. A gas of dipolar excitons can then realise a two-dimensional quasi-condensate marked by its macroscopic spatial coherence. At INSP, experiments have been performed, in collaboration with C2N and the University of Grenoble, in order to quantifythermodynamically the quasi-condensation of dipolar excitons, as well as the topology of the phase transition. These works constitute a promising step towards detecting the fingerprints of the Berezinskii-Kosterlitz-Thouless transition in semiconductors.

Applying an electric field perpendicular to a double GaAs quantum well allows one to impose a spatial separation between electrons and holes, which then become confined each in a different layer. Nevertheless, the Coulomb interaction between opposite charge carriers leads to a bound state, a dipolar exciton, characterised by its large electric dipole moment. For a few years, experiments realised at INSP have emphasised the quasi-condensation of dipolar excitons below a critical temperature of about 1Kelvin.

Here, the buildup of the quasi-condensed state is characterised thermodynamically, by measuring the excitons phase space density as a function of their chemical potential, i.e. by measuring the equation of state of a trapped gas. Thus, the dipolar interaction strength between excitons has been quantified for the first time. Moreover, correlating the degree of spatial coherence of the quasi-condensate with the spatial distribution of defects in the exciton density, it is shown that the quasi-condensation goes along a minimisation of the defects concentration. This correlation is expected by the Berezinskii-Kosterlitz-Thouless theory.

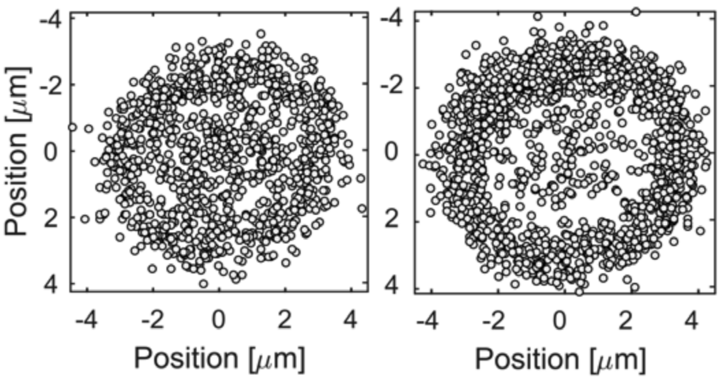

Figure 1
Spatial distribution of density defects for a gas of dipolar excitons confined in a 10 microns trap, in the normal state (a) and when a quasi-condensed forms at the center of the trap (b).

Further experiments may then provide direct signatures of this theoretical framework which was celebrated by the 2016 Nobel prize.

Reference

Defect Proliferation at the Quasicondensate Crossover of Two-Dimensional Dipolar Excitons Trapped in Coupled GaAs Quantum Wells
Suzanne Dang, Romain Anankine, Carmen Gomez, Aristide Lemaître, Markus Holzmann, François Dubin
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