

# Berezinskii-Kosterlitz-Thouless crossover for Dipolar excitons

Suzanne Dang <sup>a\*</sup>, Romain Anankine <sup>a</sup>, Carme Gomez <sup>b</sup>, Aristide Lemaître <sup>b</sup>, Markus Holzmann <sup>c</sup> et François Dubin <sup>a</sup>

a. Institut des Nanosciences de Paris, Sorbonne University, 4 place Jussieu, 75005 Paris.

b. C2N, University Paris-Saclay, Route de Nozay, 91460 Marcoussis, France.

c. Laboratoire de Physique et Modélisations des Milieux Condensés, 25 avenue des Martyrs, 38042 Grenoble, France.

\* [suzanne.dang@insp.upmc.fr](mailto:suzanne.dang@insp.upmc.fr)

Indirect excitons confined in GaAs double quantum wells (DQW) constitute a model system to investigate the quantum phases accessible to dipolar gases. Indirect excitons result from the Coulomb attraction between spatially separated electrons and holes, a situation which is directly achieved by applying an electric field perpendicular to the plane of a DQW. In recent experiments we have reported signatures of quantum coherence and quantized vortices in the photoluminescence radiated by indirect excitons confined in a two-dimensional trap [1]. Here we show that in this geometry the excitons quantum phase transition obeys the Berezinskii-Kosterlitz-Thouless (BKT) mechanism, as expected theoretically. We show that the crossover occurs in a very unique way, due to strong dipolar interactions between excitons and also their underlying four-component spin-structure.

In our experiments, the BKT transition is accessed by unveiling the exciton equation of state, at thermal equilibrium, together with its scale invariance (Fig. 1). Using Monte-Carlo simulations we quantify this behavior and then localize the crossover, precisely its critical temperature and density. These physical parameters are then confirmed quantitatively by analyzing the excitons quantum spatial coherence and the spatial distribution of density fluctuations. The latter analysis allows us to reveal the expected defect-driven nature of the excitonic superfluid transition at two-dimensions [2].

[1] R. Anankine et al. , Phys. Rev. Lett. , 2017, 118, 127402.

[2] S. Dang et al., submitted

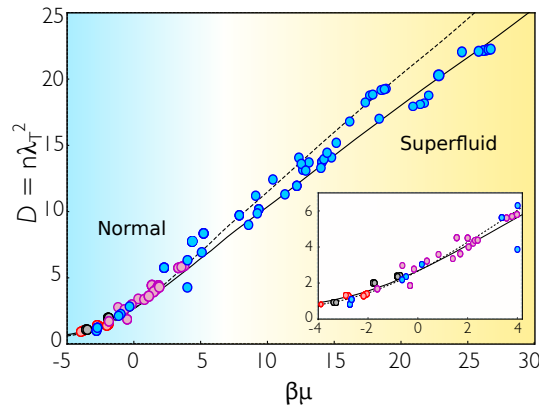


Figure 1: Phase space density  $D=n\lambda_T^2$  as a function of the scaled chemical potential  $\beta\mu = \mu/k_B T_b$  measured at  $T=0.33, 1.2, 2.5$  and  $3.5$  K (blue, pink, black and red respectively).