Properties of a quasi-excitonic one-dimensional polariton condensate in ZnO microwires

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Exciton-polariton superfluid constitutes a unique experimental realization of a dissipative condensate in solid-state environment. In microcavities, where it is mostly studied, the polariton liquid has a bi-dimensional degree of freedom, a ~50% excitonic fraction, and the Coulomb interactions are enhanced by the excitonic confinement in quantum wells. In this system, the superfluid phase of polaritons has revealed a lot of interesting physics in the domain of quantum hydrodynamic [1].

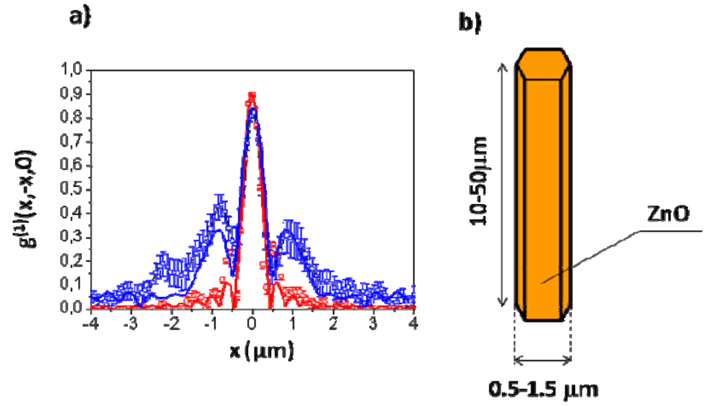

Figure 1. a) Time-integrated zero-delay first order spatial correlation function $g^{(1)}(x,-x)$ below the lasing threshold in red and above in blue. The hollow circles are the experimental measurements, and the solid lines the simulation. b) Schematic representation of a ZnO microwire with its typical dimensions. The hexagonal cross section is the result of the wurtzite crystalline structure.

Recently, new systems in the strong coupling regime like ZnO microwires (Fig.2.b) have been introduced [2], where polaritons have quite unusual characteristics: Owing to the large bandgap material they are robust at large density and temperature. They have a 1-dimensional degree of freedom and exhibit low thermal decoherence even at room temperature thanks to a large Rabi splitting of 300meV [3].

Here, we show that the differences are also striking regarding the condensate phase. At cryogenic temperature, under strong pulsed optical excitation, a transient polariton condensate is formed by stimulated relaxation into a state with 97% excitonic fraction. We show how this feature is the combined result of a large Rabi splitting and a gain mechanism likely provided either by biexcitonic relaxation or by free exciton/bound exciton scattering. To characterize the condensate phase, we examine the time integrated spatial correlation (Fig.1.a). We find that in spite of this very large excitonic fraction, resulting in much heavier and more strongly interacting polaritons, the coherence length is as large as 10µm. Using a mean field model based on a dissipative Gross-Pitaevskii [4], we find that the spatial correlation function $g^{(1)}(x,-x)$ is mostly determined by the disorder and that, at the considered condensate density, the interactions are in fact too weak to contribute.

References

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