Ladder of exciton-polariton resonances in magnetic field

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Starting from the first prominent demonstration of strong coupling between the cavity confined photon and the excitonic resonance in quantum well (QW) by C. Weisbuch et al. [1], the research on light-matter interaction attracted significant attention. The coupling between the photon and the semiconductor excitation requires the non-zero electric dipole moment which determines the selection rules for optical transitions. The strongest dipole moments have pure states of anti-symmetric wave function and those are the most typically observed in the optical experiments. This is for example the ground state of exciton in QW coupled to the cavity photon forming the exciton-polariton.

In our work we demonstrate that the strong coupling regime can be reached also for number of higher excited states, including the 2s heavy hole excitons and 1s light-hole excitons with its excited states (Figure).

The sample under investigation consists of a single 8 nm-thick $In_{0.04}Ga_{0.96}As$ QW with extremely narrow 1s excitonic resonance placed in the GaAs lambda microcavity sandwiched between two AlAs/GaAs distributed Bragg reflectors (DBR). The exciton (inhomogeneous) linewidth is measured to be $\gamma_x = 500\mu eV$. The cavity mode FWHM is measured at large exciton-photon detuning to be $\gamma_c = 220\mu eV$, corresponding to a quality factor of $Q = 7 \cdot 10^3$ [2]. We constructed particular optical microscopy setup to have the access to a full polariton dispersion. We observe multiple anti-crossings for high wavevectors (figure). We attribute this anti-crossings to a strong coupling of cavity photon with ground and excited excitonic resonances in QW. We trace the change of the coupling strength in magnetic field and determine the exciton oscillator strengths for subsequent transitions.

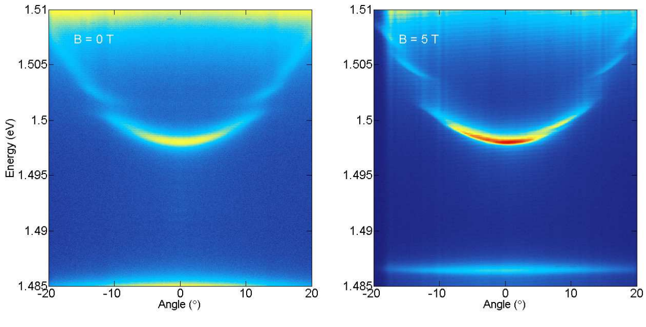

Figure: Angularly resolved photoluminescence maps of exciton polaritons in magnetic field. The multiple anti-crossings are well resolved for high wavevectors.

[1] C. Weisbuch, et al., *Phys. Rev. Lett.* **69**, 3314 (1992). [2] G. Nardin, PhD Thesis, EPFL, Lausanne, Switzerland.

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