Interaction of distant quantum emitters mediated by a delocalized cavity mode

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Realization of strong coupling between spatially separated, and thus selectively addressable, semiconductor quantum emitters is essential for practical implementation of quantum information technology protocols.

The work presents the results of the studies on light matter interaction effects in a system comprising of two mutually coupled optical microcavities. The photon confined in such a structure is delocalized over the two microcavities. As a result, coupling of the emitter to the light in one of the microcavities enables its interaction with an emitter coupled to the light in the other microcavity.

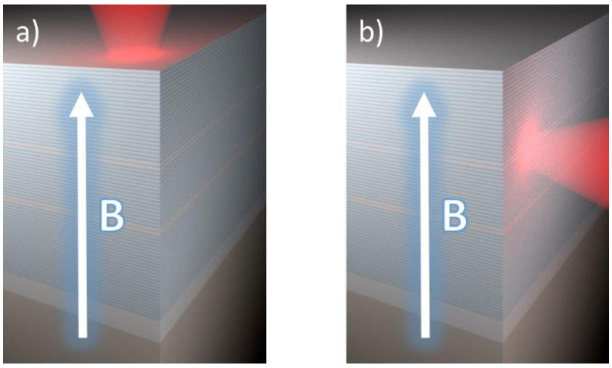

Fig. 1: Schematic of measurements in magnetic field with excitation and detection: a) from the surface b) from the edge of a sample.

In order to observe the interaction between two quantum emitters mediated by the photon delocalized over the two microcavities, a quantum well (QW) is embedded in each microcavity. A non-magnetic QW is placed in one of the microcavities, whereas the other microcavity contains a QW doped with manganese ions. This allows for manipulating optical properties of the second emitter by the application of the external magnetic field and observing the impact on the other emitter. The samples are manufactured with a parallel gradient of microcavities that allows for maximal interaction strength between microcativies for every place on the sample surface. At the same time it is possible to tune the interaction strength between cavity modes and QWs by changing the place on the sample.

The experiments conducted in external magnetic field in which the sample is observed from the surface, show that the levels of excitons confined in QWs are mutually repelled, i. e., they interact with each other only when the optical cavity modes are in spectral vicinity of the QWs. Furthermore, the measurements in which the sample is observed from the side, in the direction perpendicular to the sample's growth axis, allows for excitation of a selected microcavity and spatially selective observation of emission from both microcavities at the same time. The experiments confirm that when cavity modes are in resonance with QWs, the QWs interact with each other, that is their wavefunctions mix and non-magnetic QW gains semimagnetic behavior inherited from the second, magnetically doped QW. Such behavior is absent in non-resonant case, when there is a significant mismatch between energies of cavity modes and QWs.

[1] M. Sciesiek, W. Pacuski, J-G. Rousset, M. Parlińska-Wojtan, A. Golnik, J. Suffczyński, *Cryst. Growth Des.* **17**, 7 (2017).