Time resolved study of magnetic fluctuations in CdTe/ZnTe quantum dots containing a few Mn^{2+} ions.

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CdTe/ZnTe quantum dots doped with Mn^{2+} ions have been shown to be an interesting system to study various spin related phenomena. For example, in extremely diluted case with only one Mn^{2+} ion in the dot, the possibility to optically write and read-out the spin state of the magnetic impurity has been demonstrated [1,2]. For quantum dots with higher concentration of Mn^{2+} ions (about 50 ions or more per dot) the time resolved measurements revealed the formation of magnetic polaron [3].

Here we explore the system of a quantum dot containing a few magnetic ions. In nonmagnetic quantum dots the recombination of neutral exciton gives rise to a single sharp line in the photoluminescence (PL) spectrum, which spectral width equals to about 300μeV. In the presence of a single Mn^{2+} ion in the dot the anisotropy of the heavy hole and exchange interaction with the Mn^{2+} spin causes the sixfold splitting of the neutral exciton PL line. In the case of dots with a few Mn^{2+} ions, the individual PL lines, which correspond to different spin states of Mn^{2+} ions cannot be spectrally resolved. The neutral exciton recombination forms a broad feature with the width of about 2 meV (*figure **(a)***). The PL signal monitored at different values of emission energy corresponds to different averaged spin projections of Mn^{2+} system on the growth axis, parallel to the direction of exciton (heavy hole) anisotropy. We employ the time-resolved single photon correlation technique to study the magnetization fluctuations of the Mn^{2+} spin system at different values of external magnetic field.

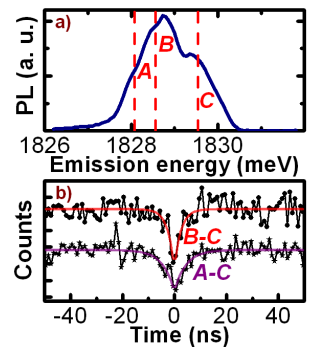

Figure. *The neutral exciton PL line of a quantum dot containing a few Mn^{2+} ions (a) and the exemplary correlation functions measured for 3 chosen values of emission energy (b).*

The samples were grown by MBE technique. The PL measurements were done in μPL setup equipped with seven avalanche photodiodes, which detected photons dispersed by the spectrometer. Therefore we could simultaneously, under the same experimental conditions, measure the correlations between photons emitted at 7 different wavelengths corresponding to 7 configurations of Mn^{2+} ions spins.

The characteristic time of the magnetization fluctuations derived from antibunching in the correlation functions was determined as a function of energetic distance between the diodes. We have established that this time increases with the greater energetic mismatch between analyzed states (*figure **(b)***). For a given energy difference the application of external magnetic field causes the slowdown of the magnetization dynamics. At the field of 4T the reconfiguration times were an order of magnitude larger than those obtained without the external magnetic field.

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[3] Ł. Kłopotowski, *et al.*, Phys. Rev. B **83**, 081306(R) (2011).