Determination of crystal field splitting of single cobalt ion in a CdTe QD

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Quantum dots with single magnetic impurities are perspective structures for an emerging field of solotronics [1], i.e. optoelectronics of solitary dopants. One of the materials belonging to this class are single CdTe quantum dots in ZnTe barrier containing single cobalt ion [2]. For such dots the excitonic emission line splits into 4 components corresponding to the spin states of cobalt ion in the exchange field of exciton. Since the occupation of the states is temperature dependent, so are the line intensities. We present a spectroscopic study of this system, leading to determination of crystal field splitting of 3/2 and 1/2 states of cobalt ion for several different quantum dots.

Samples were grown using molecular beam epitaxy on GaAs substrate covered with ZnTe buffer layer. Self-assembled quantum dots were formed with amorphous tellurium method. We studied low temperature photoluminescence of single dots excited with 458 nm argon laser using a microscope objective with a resolution better than 1 µm. The observed emission lines for neutral exciton line components, which are attributed to 3/2 and 1/2 spin states of cobalt ion, showed different intensities. We interpret the differences as a consequence of the energy splitting of those states. This observation is supported by measurements of emission spectra for increasing temperatures. The higher the temperature, the smaller the difference between intensities of the exciton line components. By performing measurements of temperature dependence of emission lines intensity (Fig. 1), we calculated the value of the energy difference using Boltzmann distribution. The values of splitting are of the order of 1-2 meV, depending on QD under investigation.

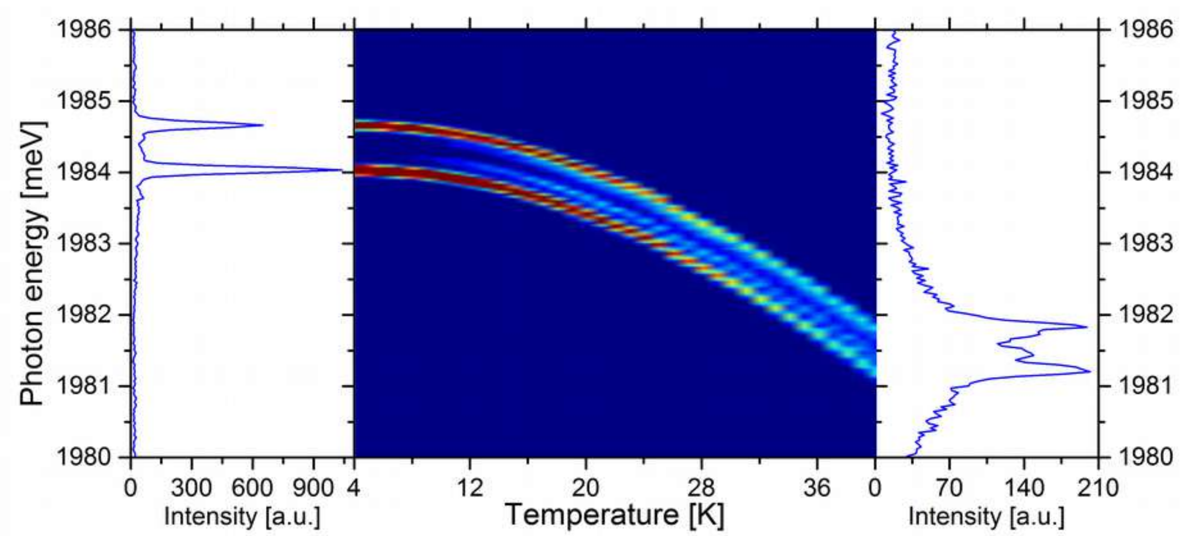

Fig. 1. Map of photoluminescence intensity of neutral exciton line for increasing temperatures.

[1] P. M. Koenraad, M. E. Flatté, *Nature Materials* **10**, 91 (2011)

[2] J. Kobak, T. Smoleński, M. Goryca, M. Papaj, K. Gietka, A. Bogucki, M. Koperski, J.-G. Rousset, J. Suffczyński, E. Janik, M. Nawrocki, A. Golnik, P. Kossacki, W. Pacuski, *Nature Communications* **5**, 3191 (2014)