Spin-lattice relaxation in diluted magnetic (Cd,Mn)Se quantum dots

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Diluted magnetic II-VI nanostructures have attracted much interest as these systems allow one to examine exchange interactions between individual carrier spins and localized moments of magnetic ions. Optically, these properties become manifested in the giant Zeeman Effect in an external magnetic field, and broad emission lines of confined individual excitons [1,2]. Beyond this, the coupling between the Mn spin- and the phonon subsystem is of fundamental interest. The spin-lattice relaxation describes the time scale for an excited spin system to relax towards the equilibrium state. To observe the dynamics of this process we use a photo induced heating technique monitored by optical detection of the photoluminescence (PL) at liquid helium temperature: With the aid of a high speed acousto-optical modulator, the excitation intensity is modulated by a rectangular pulse profile, variable in width, height, and repetition rate. This allows us to deposit a well defined energy into the system and introduce a temperature disequilibrium between the subsystems. The Zeeman splitting of the PL follows a Brillouin function, very sensitive to magnetic field and temperature. By systematically analyzing the PL dynamics in terms of the magnetic field, the excitation wavelength, and the energy deposited, it is possible to distinguish between direct heating of the lattice via absorption and Mn spin heating. After the pulse, the equilibrium is regained with a time constant in the µs range. No hint for a non-exponential long term component as in [3] has been found.

For comparison, the experiments are performed on a quantum well sample with the same Mn content $x = 0.07$. No specific zero-dimensional behaviour for the quantum dots can be deduced. We attribute this to a local character of the spin lattice relaxation, i.e. spin diffusion is of minor importance.

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[2] G. Bacher *et al.*, Appl. Phys. Lett. **79**, 524 (2001), A. Hundt *et al.*, submitted to PRB.
[3] A.V. Scherbakov *et al.*, phys. stat. sol. (b) **229,** 723 (2002).