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Exploiting the time resolved Faraday rotation technique we have studied spin coherence and energy fine structure of excitons and resident electrons in n-doped InGaAs/GaAs quantum wells (QW) and quantum dots (QD).

First, the attention is turned to the investigation of spin-related phenomena in QWs. This study gives us a hint, that stronger localization of carriers lead to longer spin coherence times. Therefore, the main part of this work is concentrated on the studies of the ensemble of QDs.

In QDs, the detailed studies of the electron g-factor uncover the fact, that the spin is described by a complex g-factor tensor with pronounced anisotropies. With this knowledge we have addressed the coherent manipulation of the spin and show very efficient technique by which the spin can be initialized by laser pulses.

It is known, that one of the serious arguments against the functionality of devices containing ensembles of QDs is the fast dephasing of spin coherence, even for the case when spin coherence in individual dots is held for a long time. This limitation is absent in single-dot devices, but there are many factors which make this system difficult, even for basic studies. Among them: The difficulty in controllable growth of self-organized dots with specified energy and with low dot density; very low signal intensity; systematic noise problems in single-electron devices. We have shown that the electron spin can be phase synchronized with the periodic laser protocol. With this effect, we are able to exploit the long spin coherence time of single QDs, but use all advantages of working with a dot ensemble: (i) a strong detection signal with relatively small noise; (ii) changes of external parameters like laser repetition rate and magnetic field strength can be accommodated to phase synchronization condition due to the broad distribution of electron spin precession frequencies in the ensemble and the large number of involved quantum dots; (iii) high temperature stability.

We have then succeeded with a first demonstration that this method also allows a far-reaching coherent control of the spins: A two-pulse protocol allowed us to clock the electron spin such that periodic bursts appear in the Faraday rotation signal. Further, by tailoring the laser protocol we can control the pattern of Faraday rotation bursts, and induce π phase changes.