Magnetic-Field Control of Photon Echo from the Electron-Trion System:
Shuffling Coherence between Optically Accessible and Inaccessible States

L. Langer[1], S. V. Poltavtsev[1,2], I. A. Yugova[1,2], D. R. Yakovlev[1,3], G. Karczewski[4], T. Wojtowicz[4], J. Kossut[4], I. A. Akimov[1,3], and M. Bayer[1]

technische universität dortmund

[1] Experimentelle Physik 2, Technische Universität Dortmund, 44221 Dortmund, Germany
[2] Spin Optics Laboratory, St. Petersburg State University, 198504 St. Petersburg, Russia
[3] A.F. Ioffe Physical-Technical Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia
[4] Institute of Physics, Polish Academy of Sciences, PL-02668 Warsaw, Poland

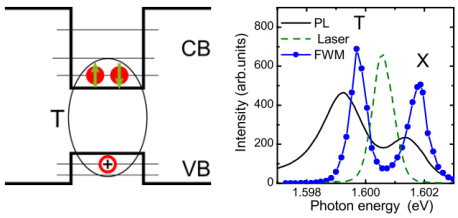
Ioffe Physical Technical Institute

Abstract

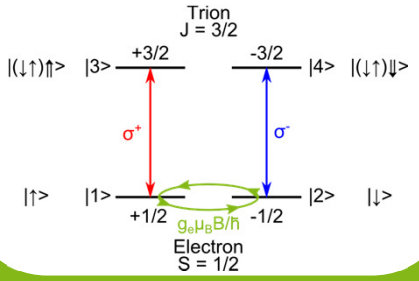
We report on magnetic field-induced oscillations of the photon echo signal from negatively charged excitons in a CdTe/CdMgTe semiconductor quantum well. The oscillatory signal is due to Larmor precession of the electron spin about a transverse magnetic field and depends sensitively on the polarization configuration of the exciting and refocusing pulses. The echo amplitude can be fully tuned from the maximum down to zero depending on the time delay between the two pulses and the magnetic-field strength.

QW sample

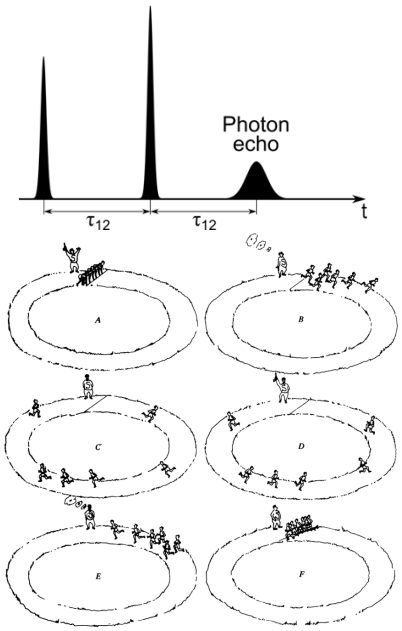
- five decoupled 20nm thick CdTe QWs separated by 110nm $Cd_{0,78}Mg_{0,22}Te$ barriers
- δ-doping with iodine donors produces low-density 2D electron gas (n~$10^{11}cm^{-2}$)



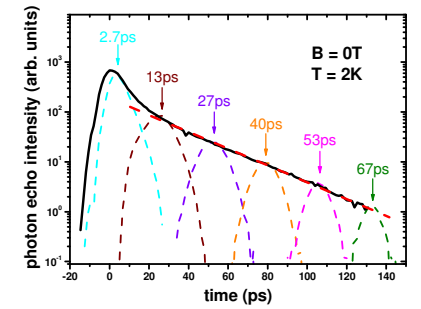
Energy structure of localized trion

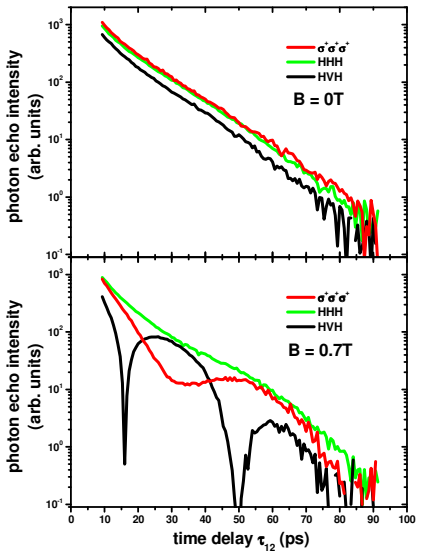


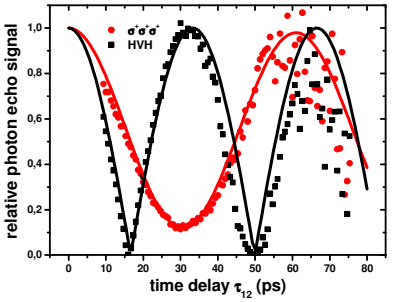
Photon Echo



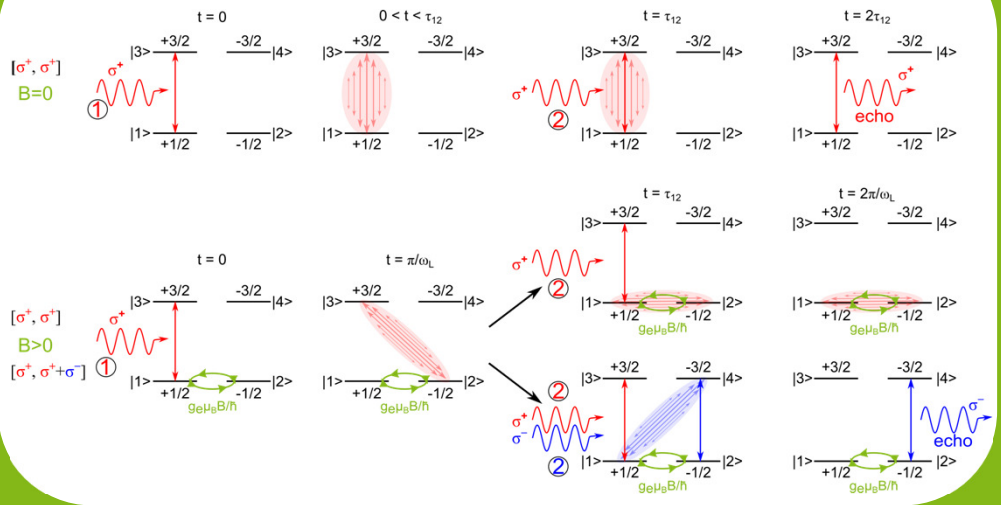
Results



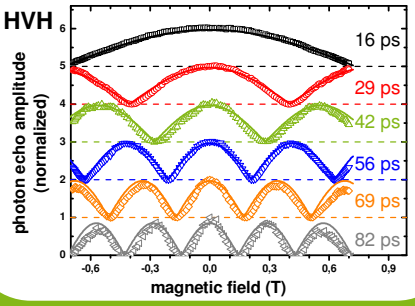




Schematic of photon echo in the electron-trion system



Magnetic field dependence



Optical Bloch equations

The signals in different polarization configuration can be well described by the optical Bloch equations taking into account the spin level structure of electron and trion.

Polarization configuration	Photon echo polarization σ^+	σ^-
$\sigma^+\sigma^+$	$\cos^2(\omega_L\tau_{12}/2)$	0
$\sigma^-\sigma^-$	0	$\cos^2(\omega_L\tau_{12}/2)$
σ^+H	$\frac{1}{2}\cos^2(\omega_L\tau_{12}/2)$	$\frac{1}{2}\sin^2(\omega_L\tau_{12}/2)$
σ^-H	$\frac{1}{2}\sin^2(\omega_L\tau_{12}/2)$	$\frac{1}{2}\cos^2(\omega_L\tau_{12}/2)$

Summary

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- Magnetic-field control of photon echo from electron-trion system in semiconductor quantum well is accomplished
- Exploiting the Larmor precession of electron spins in a transverse magnetic field, we demonstrate the transfer of coherence between optically accessible and inaccessible state superpositions
- The results are explained in terms of the optical Bloch equations accounting for the spin level structure of electrons and trions