

Many-body interactions in the quantum well under strong optical excitation.

P. Płochocka, P. Kossacki, A. Golnik, W. Maślana, B. Piechal, and J.A. Gaj
Institute of Experimental Physics, Warsaw University, 69 Hoża, 00-681 Warszawa, Poland
S. Tatarenko
Laboratoire de Spectrométrie Physique, BP87, 38402 Saint Martin d'Hères cedex, France
J. Cibert
Laboratoire Louis Néel, CNRS, BP 166X, 38042 Grenoble

We report on time-resolved absorption studies on a modulation p-doped (Cd,Mn)Te quantum well. Three absorption lines were observed; neutral exciton (X), charged exciton (X⁺) and biexciton (XX). A spectrally broad fs probe pulse was used to record the temporal evolution of the spectra. The significant population of photo-created excitons (up to 10^{11} cm⁻²) was generated by a spectrally narrowed pump pulse. Its energy was tuned to resonance with charged or neutral exciton transitions. The density of the preexisting hole gas was controlled independently in the range from 10^{10} cm⁻² up to 10^{11} cm⁻².

The most striking effect is when the pump pulse is tuned to resonance with charged exciton. Then the intensity of the neutral exciton absorption increases. We interpret this surprising effect in terms of spin-dependent screening by free holes. This screening is efficient only if the holes are not bound into the charged excitons. Photocreation of the charged excitons reduces thus screening and enhances free exciton absorption line.

Moreover we analyzed the interaction between neutral excitons and biexcitons, in the case when the neutral exciton line dominated over the charged exciton line. The change of neutral exciton intensity under strong optical excitation is of the same order of magnitude for co- and cross-polarized pump and probe pulses. For co-polarized beams the neutral exciton decreases due to phase space filling. For cross-polarization the same effect is due to biexciton formation. However, the observed blue shift of neutral exciton line is different in both cases. It is due to the fact that formation of biexcitons is due to an attractive interaction, while Pauli exclusion principle leads to repulsive interaction between excitons of the same spin. Therefore blue shift observed for the same polarization of pump and probe beams is larger than for cross-polarized.