Magneto-photoluminescence studies of charged exciton localization in GaAs/$Al_xGa_{1-x}As$ quantum wells

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Since the very first observation of charged excitons (trions) in quasi-two-dimensional structures there has been considerable controversy about trion localization. In many papers trions were considered as mobile, free particles [1]. However it was also suggested that being charged and massive, trions (both negative and positive: X^- and X^+) are necessarily localized by ionized donors (D^+) or acceptors (A^-), always present in the barriers of the quantum well.

We report on extensive experimental and theoretical studies of the degree of localization of different excitonic complexes confined in high-mobility asymmetric GaAs quantum wells.

In low-temperature, polarization-resolved, high-magnetic-field (up to 23T) photoluminescence experiments we have detected two strong emission lines of the neutral and positively charged exciton (X and X+) and a series of weaker lines identified as the excitonic complexes bound to ionized acceptors (AX^-). From the Zeeman splitting of emission lines detected in σ^+ and σ^- polarizations we have determined the hole *g*-factor (g_h) of different complexes (Fig. 1).

For X and X^+, g_h initially grows with the increase of magnetic field and then saturates at g_h=0.88 and 1.55, respectively. For the AX^- complexes g_h begins from a high value (between 6 and 11 at zero field) and decreases with field growth. This contrasting behavior is traced to the structure of valence band Landau levels, calculated numerically within the Luttinger model (beyond axial approximation). We realize the fact that in all asymmetric structures, electrons and holes are separated by a built-in electric field. The field-induced band bending shifts heavy holes closer to the interface than light holes. We found that *g*-factors of heavy and light holes reveals similar behavior as the experimentally detected g_h of X and X^+. They both grow in low magnetic fields and saturate at higher fields at values g_h=0.82 and 2.65 for light and heavy holes, respectively. This indicates that g_h of X comes predominately from the light hole levels, g_h of X^+ reveals balanced occupation of light- and heavy-hole levels, and g_h of AX^- comes mainly from the heavy-hole states.

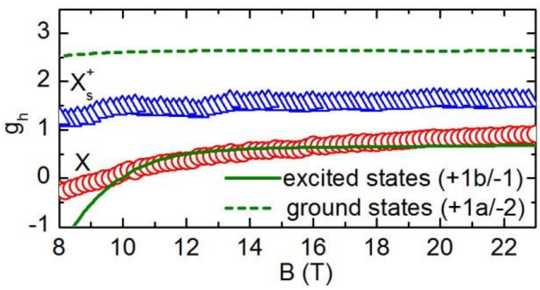

Fig.1 Measured hole *g*-factors of X and X+ (symbols) compared with the values calculated theoretically for two lowest eigenstates of a free hole (from [3]).

These results allow unambiguous identification of X and X^+ as nearly free objects, and the multiple AX^- states as excitons bound by Coulomb interaction to ionized acceptors placed on subsequent crystallographic planes in the doped barrier [1].

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