Modification of exciton dispersion in transverse magnetic field

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Abstract

Propagation of an exciton with large wave vector in semiconductors in a transverse magnetic field, *B*, is accompanied by a modification of exciton dispersion [1, 2]. This modification reveals itself in polariton reflectance spectra of wide quantum wells (QWs) in the magnetic field as an energy shift of spectral features [1]. These features are observed in the spectra of high-quality heterostructures as quasiperiodic oscillations of reflectance, which correspond to quantization of the center-of-mass motion of the exciton across the QW. Analysis of the energy positions of the spectral oscillations allows one to restore the exciton dispersion [2].

Experiments have been performed with a heterostructure grown by molecular beam epitaxy. The heterostructure contains a GaAs/AlGaAs QW of width L = 240 nm. Strong shift of the spectral oscillations is observed in the transverse magnetic field. The shift decreases with the oscillation number so that the energy distance between the spectral oscillations decreases. The shift is caused by the diamagnetic effect well described by the quadratic dependence on *B*. The convergence of spectral oscillations qualitatively corresponds to an increase of the exciton effective mass.

Theoretical analysis of these effects is based on a standard Hamiltonian of exciton in the magnetic field [1, 2]. The oscillation convergence is due to the field induced mixing of the exciton s- and p-states. In the modeling, we consider the mixing of only the 1s- and 2p-states. The model well describes the convergence with one fitting parameter, L = 210 nm. At any magnetic field, the energy position of spectral oscillations quadratically depends on the exciton wave vector. The curvature of this dependence drops with magnetic field. Correspondingly, the exciton mass increases: M_x(B=3 T)/M_x(0) = 1.25.

[1] D. K. Loginov et al., Phys. Solid State 51, 1649 (2009).

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