Energy spectrum of two-dimensional magnetoexcitons and combined optical quantum transitions with the participation of two-dimensional magnetoexcitons

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The combined exciton–electron processes involving three particles were observed in the presence of magnetic field perpendicular to the two-dimensional semiconductor layer [1].

An incident photon creates an exciton in its ground state and simultaneously it excites one of the resident electron from the lowest to one of the higher Landau levels. The energy of this transition is equal to the sum of the magnetoexciton energy and a multiple of the electron cyclotron energy.

The present paper is devoted to the systematic study of these combined, Auger processes. The Hamiltonian describing the scattering quantum processes of electrons and holes due to their Coulomb interaction in the case of two-dimensional layer in the presence of a strong perpendicular magnetic field was deduced in [2]. It was supplemented by the Hamiltonian describing the electron-photon interaction in similar conditions. Two cases of simple band structure and a special case of heavy and light holes in GaAs crystal were studied.

The deduced Hamiltonian shows that the absorbtion of one photon with circular polarization $\frac{1}{\sqrt{2}}\left(\bar{e}_x - i\bar{e}_y\right)$ creates an electron-heavy-hole pair $\left(e\uparrow; hh, -\frac{3}{2}\right)$ with electron spin up projection and a heavy hole with full magnetic moment $J = \frac{3}{2}$ and its projection $J_z = -\frac{3}{2}$, as well as an electron-light-hole pair $\left(e\downarrow; lh, -\frac{1}{2}\right)$ with electron spin down projection and a light hole with $J_z = -\frac{1}{2}$. A circularly polarized photon with polarization $\frac{1}{\sqrt{2}}\left(\bar{e}_x + i\bar{e}_y\right)$ can create the electron-hole pairs $\left(e\downarrow; hh, \frac{3}{2}\right)$ and $\left(e\uparrow; lh, \frac{1}{2}\right)$.

The deduced Hamiltonian contains also antirezonant terms side-by-side with the resonant ones.

The probabilities of the discussed Auger optical quantum transitions are investigated.

[1] D.R. Yakovlev, V.P. Kochreshko, R.A. Suris et. al. Phys. Rev. Lett. 79, 3974, (1997).
[2] S.A. Moskalenko, E.V. Dumanov, Ig.V. Podlesny, M.I. Shmiglyuk. Proc. SPIE v. 6256, p. 285-298, ICONO 2005.

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