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Superposition States of the Two-Dimensional Magnetoexcitons with Dirac Cone Dispersion Law and Quantum Interference Effects in Optical Transitions

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The exchange electron-hole (e-h) Coulomb interaction changes essentially the properties of the two-dimensional (2D) magnetoexcitons, whose electron structure is mainly determined by the action of the Lorentz force and by the direct e-h Coulomb interaction. The exchange interaction leads to the mixing of the two bare magnetoexciton states with total angular momentum projections $F = \pm 1$. As a result instead of them two new superposition states one symmetric and another asymmetric appeared. The symmetric state acquired a Dirac cone dispersion law in the range of the small in-plane wave vectors $|\vec{k_{\|}}| l_0 < 1$, where l_0 is the magnetic length, with group velocity proportional to the magnetic field strength. The quantum transitions to this state from the ground state of the crystal under the influence of the light with both circular polarizations have the equal probabilities, being strongly dependent on the direction of the light propagation as regards the plane of the layer. The probability is maximal in the Faraday geometry and vanishes in the Voigt one. In difference on it, the asymmetric state is characterized by the usual dispersion law inherited from the bare magnetoexciton states, is dipole active in both circular polarization, but does not depend on the direction of the light propagation. In the case of light with linear polarizations the both symmetric and asymmetric states reveal the quantum interference effects.