Superexchange theory in magnetic semiconductors with a variable spin under optical pumping.

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We investigated the optical pumping effects on the exchange interaction in magnetic semiconductors with an arbitrary spin at frequencies v<Eg. To derive the effective spin Hamiltonian we use the initial Hamiltonian in the Hubbard operators representation (LDA+GTB approach [1]) and method of the projection operators [2]. The effective Hamiltonian contains not only spin-spin interactions involving optical excited states but more complicated interactions of non-Heisenberg type accompanied with exciton or biexciton. The Hamiltonian is nonadditive over the ground and optical excited states, but it is additive to the virtual excited states. To test our approach, we have calculated the superexchange interaction and the Dzyaloshinskii-Moriya (DM) interaction in FeBO3 under optical pumping at a frequency of *d-d* transitions. The initial AFM superexchange changes its character to FM due to the spin forbidden optical d-d excitations. The initial DM interaction undergoes a significant perturbation since the mutual orientation of the spins and the DM vector is changed by the optically induced FM contribution. The magnitude of the induced DM interaction depends on the nature of the forbidden optical *d-d* transitions. In particular, the nonzero DM interaction is induced at the optical forbidden *d-d* transition in one of the ions of the exchange-coupled (*i,j*)th pair with a center of inversion. A spectral dependence of modified superexchange and should coincide with the *d-d* absorption spectra in the transparency window. In fact, we obtained also useful microscopic interpretation of the Goodenough-Kanamori rule for a 180-degree superexchange [3-4] in semiconductor with an arbitrary magnetic moment.

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