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Quantum Effect of Ring-Exchange Interaction in Orbital Degenerated System JOJI NASU, SUMIO ISHIHARA, Department of Physics, Tohoku University — Orbital degree of freedom is one of the recent attractive themes in transition-metal oxides. In contrast to the spin degree of freedom, orbital interaction explicitly depends on the bond direction, and a certain kind of frustration exists. The doubly degenerate e_g orbitals are represented by the pseudo-spin (PS) operator, and the orbital interaction is described by the nearest neighbor (NN) interaction. This model in a cubic lattice shows a macroscopic degeneracy in the classical ground state. This degeneracy is lifted by the quantum fluctuation and the antiferro-type quadrupole (AFQ) order is realized. Beyond the NN interaction, we study the ring-exchange interaction (REI) in this system, and in particular, focus on its quantum effects. We derive the REI through the fourth-order perturbation with respect to the electron transfer t under the on-site Coulomb repulsion U in the two-orbital Hubbard model. This interaction includes the magnetic octupole operator which does not appear in the NN interaction. To examine the quantum effect of this interaction, we adopt the extended Bethe approximation, the spin-wave approximation and the exact diagonalization methods in a cluster. In small t/U region, the AFQ order is realized by the quantum fluctuation. The canted quadrupole order and the ocutupole order are stabilized by the REI. Reduction of the PS moment due to the quantum fluctuation is seen in large t/U region.

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