The superexchange interaction in overdoped manganites

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The Jahn-Teller magnets with manganese sublattice are widely investigated as compounds with lattice, charge, orbital and magnetic subsystems interaction. The main application of CMR properties in these crystals awoke a vivid interest to some fundamental features including low-dimensional and frustrated magnetic structures. The pseudoperovskite $R_{1-x}A_xMnO_3$ manganites (where R^{3+} is a rare earth ion, A^{2+} is an alkaline earth ion, and x is a doping level) are distorted to orthorhombic or nearly-orthorhombic crystal structure [1–6]. The Mn^{3+} magnetic sublattice is orbitally degenerated in the non-distorted ideal crystal. The Jahn-Teller effect removes degeneration and causes the spatial ordering of superpositions of ^5E-eigenfunctions. It leads to the complicated superexchange interaction [7]. In doped rare-earth manganites at some doping levels x=2/3, 3/4, 4/5 [3–6], the competition of superexchange parameters is possible because of charge-orbital ordering. This kind of magnetic non-geometric frustration leads to low-dimensional and essentially non-collinear magnetic structures.

The current study is aimed to evaluate the superexchange parameters within the framework of orbitally-dependent superexchange interaction [8]. The possible regular magnetic structures are discussed, the choice between collinear and non-collinear magnetic ordering is explained. The magnetic trimers Mn^{4+}–Mn^{3+}–Mn^{4+} and their arrangements in overdoped manganites are discussed.

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