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Neutron diffraction studies of crystal structure and orbital ordering in multiferroics, based on complex manganese oxides.

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The great interest of researchers over the past years has been caused by multiferroics - materials in which magnetic and electric dipole ordering are simultaneously observed. One of the typical representatives of this class of compounds is the complex oxides of the manganese of the BiMnO3 with a structure of perovskite type. The magnetic properties of the compound are determined by positive exchange interactions between manganese ions, which are due to the orbital ordering of Mn3+ ions. Since the magnetic properties of compound are determined by the geometry of chemical bonds between Mn - Mn, it is possible to control the magnetic characteristics of the compositions based on BiMnO3 by chemical replacement or by changing the stoichiometric composition of the initial compound. Compounds with a nominal excess of oxygen ions are characterized by the presence of vacancies in A- and B- sublattice of the structure of perovskite, while in order to comply with the principle of electroneutrality, the deficiency of cations leads to the formation of Mn ions with an oxidation state of 4+. Bismuth and manganese cations vacancies, as well as the presence of Mn4+ ions, lead to a distortion of the crystalline structure, as well as to a significant change in the nature of the exchange interactions. Neutron diffraction and synchrotron data show that compounds with excessive oxygen content at room temperature are characterized by a monoclinic structure, with an increase in oxygen content - with a two -phase state with a dominant orthorhombic and monoclinic phases. An increase in temperature leads to a structural phase transition to a non -polar orthorhombic phase. At the same time, magnetization is reduced due to the destruction of the orbital ordering of Mn3+ ions, and the magnetic state changes from ferromagnetic to the spin glass state.
During the chemical replacement of manganese ions into iron ions at room temperature, a structural transition occurs from the polar rhombohedra phase to the antipolar orthorhombic and then to the monoclinic phase through a two phase region. Accordingly, changes in the magnetic structure occur, in particular, the modulated antiferromagnetic phase passes into a noncollinear antiferromagnetic, and then into an orbital ordered ferromagnetic phase

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