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Origin of the magnetic-field controlled polarization reversal in multiferroic TbMn$_2$O$_5$

N. LEO, University Bonn, Germany, D. MEIER, UC Berkeley, USA, R.V. PISAREV, Ioffe Institute, St. Petersburg, Russia, S. PARK, S.-W. CHEONG, Rutgers University, USA, M. FIEBIG, University Bonn, Germany — The interplay of multi-dimensional complex magnetic order parameters leads to interesting effects like magnetically induced ferroelectricity. A particular interesting example is TbMn$_2$O$_5$ because of the associated magnetic-field controllable electric polarization. By optical second harmonic generation we show that the gigantic magnetoelectric effect originates in three independent ferroelectric contributions. Two of these are manganese-generated. The third contribution is related to the magnetism of the Tb$^{3+}$ sublattice and has not been identified so far. It mediates the remarkable magnetic-field induced polarization reversal. This model is verified by experiments on the isostructural YMn$_2$O$_5$ where Y$^{3+}$ ions are nonmagnetic and only two polarization contributions are present and no magnetoelectric coupling is observed. These results underline the importance of the 3$d$ – 4$f$-interaction for the intricate magnetoelectric coupling in the class of isostructural RMn$_2$O$_5$ compounds.

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