Evidence for large electric polarization from collinear commensurate magnetism in multiferroic TmMnO₃

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There has been tremendous research activity in the field of magneto-electric (ME) multiferroics after Kimura et al (2003 Nature 426 55) showed that antiferromagnetic and ferroelectric orders coexist in orthorhombically distorted perovskite TbMnO₃ and are strongly coupled. It is now generally accepted that ferroelectricity in TbMnO₃ is induced by magnetic long-range order that breaks the symmetry of the crystal and creates a polar axis (Kenzelmann et al 2005 Phys. Rev. Lett. 95 087206). One remaining key question is whether magnetic order can induce ferroelectric polarization that is as large as that of technologically useful materials. We show that ferroelectricity in orthorhombic (c) TmMnO₃ is induced by collinear magnetic order, and that the lower limit for its electric polarization is larger than in previously investigated orthorhombic heavy rare-earth manganites. The temperature dependence of the lattice constants provides further evidence of large spin–lattice coupling effects. Our experiments suggest that the ferroelectric polarization in the orthorhombic perovskites with commensurate magnetic ground states could pass the 5000 μC m⁻² threshold, as predicted by theory (Sergienko et al 2006 Phys. Rev. Lett. 97 227204; Picozzi et al 2007 Phys. Rev. Lett. 99 227201).