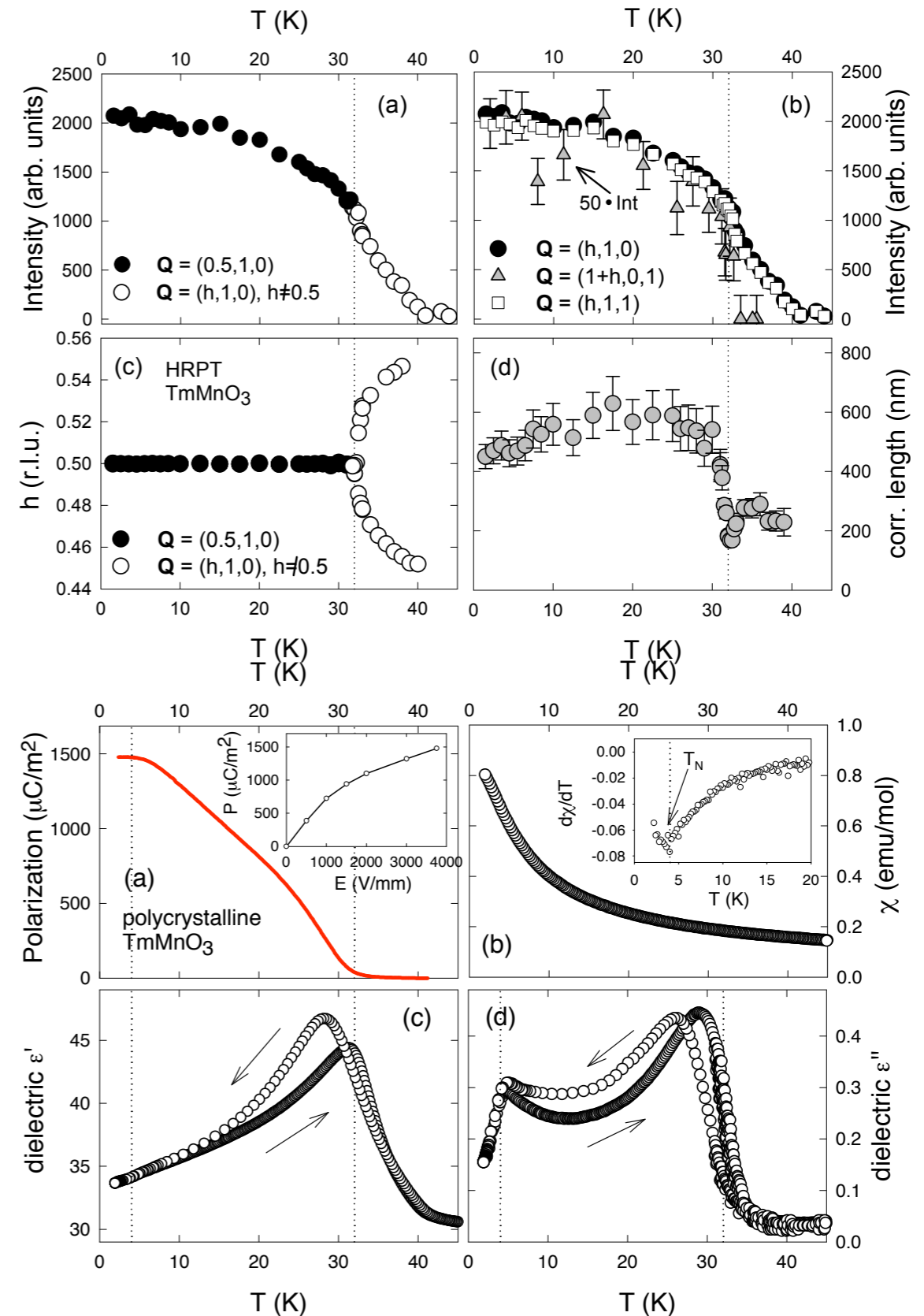


Evidence for large electric polarization from collinear magnetism in TmMnO₃

Abstract. 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(o) 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 1 $\mu\text{C cm}^{-2}$ threshold, as predicted by theory (Sergienko *et al* 2006 *Phys. Rev. Lett.* **97** 227204; Picozzi *et al* 2007 *Phys. Rev. Lett.* **99** 227201).



V.Yu. Pomjakushin, M. Kenzelmann, A. Dönni, A.B. Harris, T. Nakajima, S. Mitsuda, M. Tachibana, L. Keller, J. Mesot, H. Kitazawa and E. Takayama-Muromachi, *New Journal of Physics* **11**, 043019 (2009).