Multi-\( q \) crystal and magnetic structure in TbMnO\(_3\): Evidence for a Soliton-lattice

N. ALIOUANE, D.N. ARGYRIOU, S. LANDSGESELL, C.J. MILNE, Hahn-Meitner-Institut, Glienicker Strasse 100, D-14109 (Germany), J. STREMPFER, Max Planck Institute for Solid State Research, Heisenbergsse 1, D-70569 Stuttgart (Germany), W. CALIEBE, NSLS Brookhaven National Laboratory, P.O. Box 5000, Upton, NY 11973-5000 (USA) — In TbMnO\(_3\), Mn-spins order with a sinusoidal antiferromagnetic (AF) propagation wave vector \( Q_{Mn}=[0,k+/-q,l] \) (\( q \sim 0.288b^* \)) at \( T_N(Mn)=41 K \). The propagation vector \( Q_{Mn} \) varies with temperature on cooling until \( T_{Lock}(Mn) \sim 30 K \), which coincides with a ferroelectric transition. In addition to \( Q_{Mn} \) reflections we find magnetic reflections at \( 3Q_{Mn} \). Our X-ray measurements show that the magneto-elastic coupling gives rise to a structural modulation at twice the magnetic wavevector (\( 2Q_{Mn} \)). Field cooling the sample under a magnetic field oriented along the a-direction with \( H>9 T \) shows that all magnetic wavevectors for Mn and Tb collapse to a single \( q \) structure with \( Q=[0,1/4,0] \), an up-up, down-down phase, and coincide with anomalies in the polarization. We argue that the temperature and field dependence of the magnetic and superlattice reflections are consistent with a soliton formalism which predicts a stable commensurate single \( q=1/4 \) phase [1]. [1] Kimura et al., PRB 68, 60403(2003).