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Magnetic Order and Spin Dynamics in Ferroelectric $HoMnO_3$ and $TbMnO_3$

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Although there are many ferroelectric and magnetic materials, very few have simultaneous magnetic and ferroelectric order. Only a select few of these materials, known as multiferroics, exhibit significant coupling between the magnetic and ferroelectric properties, and the nature of these interactions is not well understood. We have performed neutron scattering studies of two multiferroics which exhibit significant magnetic-ferroelectric coupling, hexagonal $HoMnO_3$ [1] and perovskite $TbMnO_3$ [2]. In $HoMnO_3$, inelastic neutron scattering measurements of the Mn^{3+} spin-wave spectrum and Ho^{3+} crystal field excitations reveal a significant coupling between magnons and the crystal field levels which may contribute to the complex phase diagram and strong magnetic-ferroelectric coupling. In $TbMnO_3$, extensive neutron diffraction studies show that the magnetic transition from a spin density wave to an incommensurate spiral order phase breaks the inversion symmetry of the lattice and induces the onset of ferroelectric distortion. Our results should help lead to a fuller understanding of the interaction between magnetism and ferroelectricity in multiferroics. [1] O.P. Vajk et al., Phys. Rev. Lett. 94, 087601 (2005) [2] M. Kenzelmann et al., Phys. Rev. Lett. 95, 087206 (2005)