Magnetic structures of magnetoelectric RMn_2O_5 (R=Tb,Y,Ho,Dy)

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The regain of interest in magnetoelectric materials has been largely due to the work of Tokura ($TbMnO_3$) whom identify competing magnetic interaction as a key ingredient to promote this coupled state. In $TbMn_2O_5$ and analogue compounds, the complex crystal structure lead to 5 different competing antiferromagnetic interactions. A weak ferroelectric state appears below 40K and coexists with a long range ordered antiferromagnetic ground state. On cooling below T_N, there are a series of anomalies in the variation of the dielectric constant and spontaneous polarization, all correlated to the magnetic properties, either to changes in the magnetic propagation vector or to the onset of rare-earth magnetic ordering. The magnetic structures were studied in detail using neutron diffraction on powder and single crystals. The evolution of the magnetic structures with temperature for different compounds gives a clear view of the strong correlation with electric anomalies. We propose a model of atomic displacement, based on the symmetry of the observed spin structure, that explains the onset of ferroelectricity in these systems. In addition, we will review our recent magnetic diffraction study under magnetic field and the correlation between magnetic properties and the sign reversal of the polarization observed at low temperature.