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Spherical neutron polarimetry in multiferroics under external stimuli

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Study of multiferroics, materials simultaneously having more than one primary ferroic order parameter, is a hot topic of material sciences. The most extensively studied class of these compounds is the family of magnetoelectric multiferroics, where ferroelectricity can be induced by various types of magnetic orderings via the relativistic spin-orbit interaction. As a consequence of the cross coupling between spins and electric polarization, the spectacular control of the ferroelectric polarization by external magnetic field and the manipulation of the magnetic order via electric field can often be realized in these systems. Depending on the symmetry and microscopic mechanism of the multiferroicity the coupling energy between magnetic and electric ordering parameters can significantly vary. Classical neutron diffraction often fails in the precise determining of the complex magnetic structure in the multiferroics due to the presence of the statistically distributed domains in the macroscopic sample. Using spherical neutron polarimetry (SNP), known also as 3D polarization analysis, it is possible not only to precisely determine the complex magnetic structure, but also to investigate in-situ its evolution with external parameters and to control the magnetic domains distribution under the influence of the external electric or/and magnetic field. Here we will present some SNP results on few different multiferroic materials. In some of them, e.g. square lattice 2D antiferromagnet Ba2CoGe2O7, even strong electric field does not change the magnetic order. However rater week magnetic field is sufficient to create a mono-domain structure and to rotate spins in the plane. In other e.g. incommensurate (spiral) magnetic structure of the TbMnO3, solely electric field is sufficient to fully control the chirality of the magnetic structure. In the case of Cr2O3 both electric and magnetic fields should be applied in parallel in order to switch between the different antiferromagnetic domains.

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