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Stroboscopic polarized experiments to study the domain dynamics in multiferroics

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In so-called type-II multiferroics, a complex magnetic structure of chiral character directly drives finite ferroelectric polarization resulting in a close coupling between magnetic and electric order parameters. Therefore, multiferroics allow one to fully control antiferromagnetic domains by external electric fields opening the path to the study of the corresponding domain dynamics. We use a stroboscopic method to analyze the domain relaxation following inversion of external field. Neutron scattering thereby permits the analysis of multiferroic domain relaxation over about 8 orders of magnitude in time. While a first experiment on MnWO4 revealed a strange temperature dependence of the multiferroic domain relaxation [1], our consecutive experiments on TbMnO3 [2] as well as on other type-II multiferroics revealed an astonishingly simple temperature and field dependence. In TbMnO3 the simple combination of an activation law and the Merz law known in ferroelectrics describes the relaxation times in a wide range of electric field and temperature with just two parameters, an activation-field constant and a characteristic time representing the fastest possible inversion [2]. Over the large part of field and temperature values corresponding to almost 6 orders of magnitude in time, multiferroic domain inversion is thus dominated by a single process, the domain wall motion. However when approaching the multiferroic transition other mechanisms yield an accelerated inversion. The combined Merz-activation law was also found to describe the multiferroic relaxation in Ni3V2O8, CuO, (NH4)FeCl5•H2O, and in NaFeGe2O6 [3]. Further perspectives of this technique for the study of multiferroics and of other materials will be discussed.
[1] M. Baum et al., Phys. Rev. B 89, 144406 (2014).
[2] J. Stein et al., Phys. Rev. Lett. 27, 097601 (2021).
[3] S. Biesenkamp et al., arXiv2105.06875.

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