# Magnetic phase diagram in rare-earth orthoferrite $HoFeO_3$ from single crystal neutron diffraction in external magnetic field.

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$HoFeO_3$ is one of the most interesting representatives of the $RFeO_3$ family with orthorhombic structure. At low temperatures, strong magneto-caloric effect makes the compound to a promising candidate for the magnetic cooling in the cryogenic gases liquefying technology. The temperature dependent magnetic structure in $HoFeO_3$ from single crystal neutron diffraction at zero field has been reported recently [1]. Starting from this model, here we concentrated on the evolution of the magnetic order on Fe and Ho in external magnetic field applied along crystallographic c direction. A number of representative Bragg reflections for each type of magnetic ordering: A (h + l even, k odd), C (k odd, h+l even), F (h + l even, k even) and G (h + l odd, k odd), correspondingly, have been measured between 2 and 70 K with 2 K step at seven discrete magnetic field values up to 8 T. The measurements were performed on two-axes single crystal diffractometer POLI at MLZ [2]. Figure 1a shows the temperature dependences of G type reflection (011) for all measured fields as example. Using the deflection and extrema points from different peaks (fig. 1b) the phase boundaries could be traced, resulting in a reach magnetic phase diagram with multiple phases. The obtained diagram is in a good agreement to the physical picture of competing magnetic interactions [3] between the different magnetic sublattices, wich will be discussed.

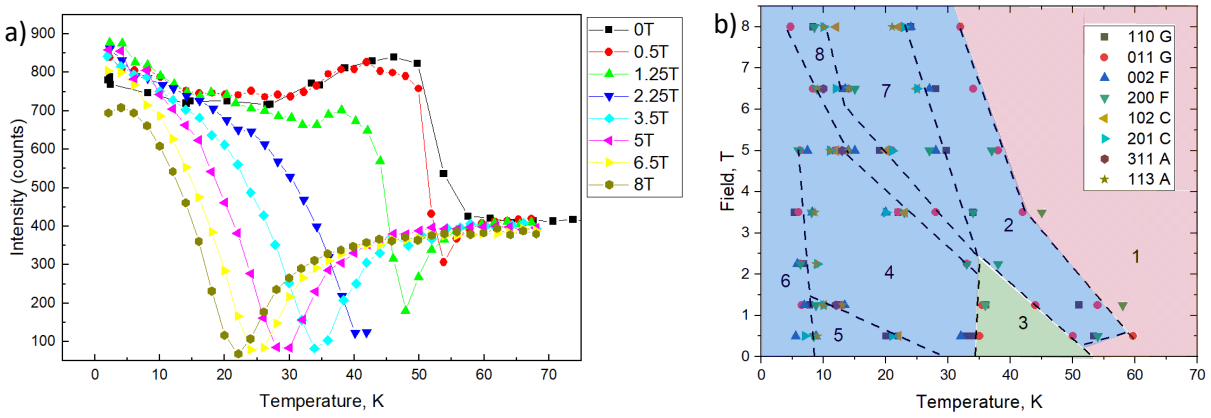


Fig. 1 a) Temperature dependence of the integrated intensities of reflection 011 type G in different magnetic fields. b) Magnetic phase diagram of HoFeO3. Dotted line – phase boundaries. Color area – region that are describe by different magnetic representation of the Fe subsystems: red –$\Gamma_4^+$, green – $\Gamma_1^+$, blue – $\Gamma_2^+$. The numbers indicate phases.

[1] T. Chatterji et al., AIP Adv. 7 (2017) 045106.
[2] V. Hutanu, Journal of large-scale research facilities, vol. 1, p. A16, 2015.
[3] A.K.Ovsianikov et al., JMMM, Volume 507, 166855, 2020