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Multiple phase transitions in HoFeO3 determined by single crystal neutron diffraction in applied magnetic field

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The scientific interest the rare-earth orthoferrites RFeO3, known over decades, relive significantly in the last years due to the discovery of multiferroicity or magnetocaloric effect in this family of compounds. Their remarkable magnetic properties result from complex interactions between the 3d electrons of the transition metal and the 4f electrons on the rare-earth. HoFeO3 is one of the most interesting representatives of RFeO3 family with strong magnetic interactions and a number of reorientation transitions. It has centrosymmetric space group Pnma, and Fe sub-lattice orders AFM at TN = 640 K. At zero field the Fe sub-lattice starts to polarize Ho magnetic order at about 60 K. The magnetic structure has several different phases described by magnetic irreducible representations: Γ4 = Γ_(4+)Fe ⊕ Γ_(4-)Ho, Γ1 = Γ_(1+)Fe ⊕ Γ_(1-)Ho, Γ2 = Γ_(2+)Fe ⊕ Γ_(2-)Ho. Our results, obtained under application of magnetic field along crystal axis c, show, that at low field the transition from phase Γ4 to Γ1, where Fe3+ moments rotates from c to a direction take place not directly in the ac plane, but over an intermediate phase with moments along b axis braking the centrosymmetry. The magnetic phase Γ1 disappears completely in magnetic fields above 2.5 T. Further intermediate magnetic phase in the temperature range of 8-25 K is suppressed by magnetic fields above 1 T. This behavior of HoFeO3 in weak magnetic fields makes it a good candidate for research on magnetocaloric effect.

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