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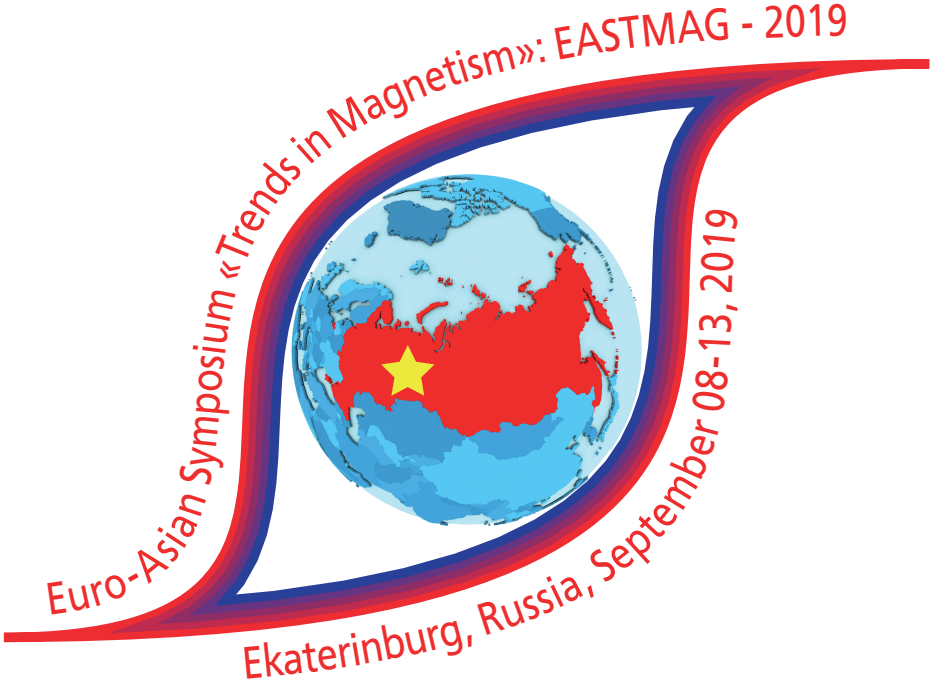

BOOK OF ABSTRACTS. VOLUME I

E.P5

MAGNETIC LINEAR DICHROISM OF $^5I_8 \rightarrow {}^5F_3$ TRANSITION IN $HoFe_3(BO_3)_4$ CRYSTAL

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$HoFe_3(BO_3)_4$ crystal is distinguished among the rare-earth ferroborates family by its non-trivial magnetic properties [1]. It orders antiferromagnetically at 38-39 K, forming easy-plane magnetic structure. At lowering temperature to 4.7 K, a spontaneous spin-reorientation phase transition from the easy-plane to the easy-axis state occurs. At the easy-axis phase, applying external magnetic field both along the trigonal axis c and perpendicular to it leads to reorientation of the magnetic moments to the basal plane. The critical fields of the reorientation phase transition are about 5.7 kOe for $\mathbf{H} \parallel c$ and 9.2 kOe for $\mathbf{H} \perp c$ at 2 K [1]. Structural phase transition at 360 K changes the space symmetry of the crystal from $R32$ to $P3_121$, reducing the local symmetry of Ho^{3+} ion from D_3 to C_2 one.

Here we present the study of the spectra of magnetic linear dichroism (MLD) of the optical transition $^5I_8 \rightarrow {}^5F_3$ of Ho^{3+} ion in $HoFe_3(BO_3)_4$ crystal. The sample was cut parallel to the *ab* plane and the light propagated along the crystallographic axis *c*. Magnetic field was directed along *a* or along *b* axis and changed from zero till 65 kOe. Difference of the absorption for the light polarized parallel and perpendicular to the magnetic field was measured at $T = 2$ K (Fig. 1).

At the conversion from a free atom to that in octahedron and further to the D_3 symmetry position, the $^5F_3$ state of the Ho^{3+} ion is transformed like this:

$$J = 3 \rightarrow A_2 + T_1 + T_2 \rightarrow A_2(F1) + (A_2 + E)(F2) + (A_1 + E)(F3). \quad (1)$$

The transition F1 is very weak. Local symmetry of the Ho^{3+} in the $HoFe_3(BO_3)_4$ is C_2 and therefore the F2 and F3 bands are split in a first approximation into three lines [2].

A number of features were revealed in the MLD spectra. The relative MLD is rather small (about 0.1) that corresponds to the strong crystallographic anisotropy in the considered excited states [2]. Shape of the MLD spectra of the F2b, F2c, F3b and F3c lines at $H = 9$ kOe (Fig. 1) testifies that these lines are split into two close lines with the opposite linear polarizations. The excited states F2 and F3 can not be split on more than three states. However, the ground state is the doublet *E*-state in the D_3 symmetry approximation [3]. Its splitting in the C_2 local symmetry of the $HoFe_3(BO_3)_4$ was not earlier observed. The splitting of lines observed in Fig. 1 can be referred to the splitting of the ground *E*-state. The F2a and F3a lines are not split. This means that the splitting of the ground state depends on the transition. Indeed, the electron transition occurs due to the mixing of the initial and final states by the electromagnetic excitation of light. As a result the initial state and its interaction with the environment are changed. The discussed splitting disappears at 9.5 kOe above the reorientation transition (Fig. 1). This means that the observed phenomenon is connected with the magnetic state of the crystal.

The integral MLD of the F2 and F3 bands as a function of magnetic field (Fig. 2) reveals singularity at the reorientation phase transition. The MLD demonstrates substantial anisotropy in the basal plane (Fig. 2), while magnetic properties reveal only small anisotropy [4]. Anisotropy of the MLD is strongly different for F2 and F3 transitions (Fig. 2). This means, that the MLD and its anisotropy are due to the excited states. The integral MLD of the F2 as a function of the magnetic field of the both orientations crosses zero (Fig. 2), but this does not mean that the MLD as a function of the light wave length is zero in these points. Redistribution of the MLD between components of the F2 band occurs at these points.

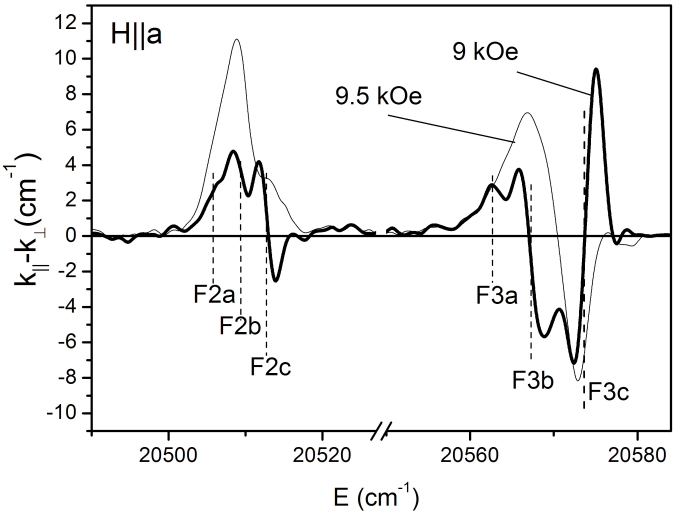

Figure 1. MLD spectra of $HoFe_3(BO_3)_4$ crystal in the magnetic field parallel to the *a*-axis

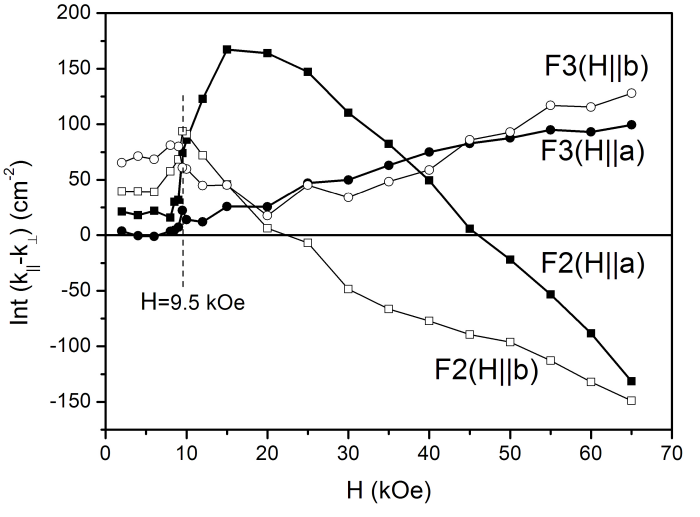

Figure 2. Integral MLD of the F2 and F3 absorption bands as a function of magnetic field

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