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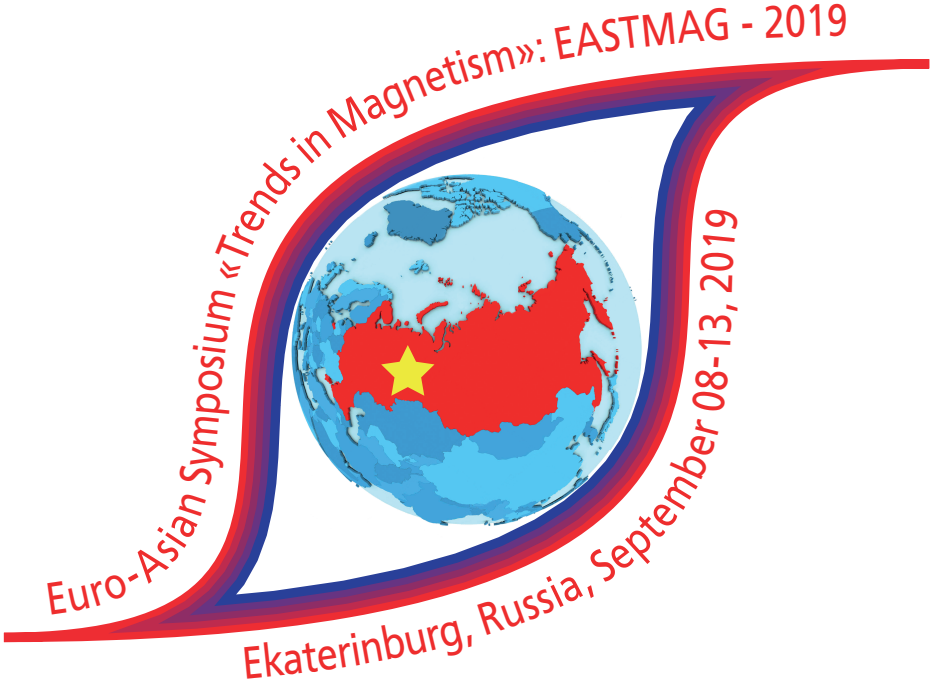

BOOK OF ABSTRACTS. VOLUME I

E.P2

MAGNETIC CIRCULAR DICHROISM OF $^5I_8 \rightarrow {}^5F_5$ TRANSITION IN $HoAl_3(BO_3)_4$ AND $HoFe_3(BO_3)_4$ CRYSTALS

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$HoAl_3(BO_3)_4$ and $HoFe_3(BO_3)_4$ are trigonal crystals with huntite-like structure. $HoAl_3(BO_3)_4$ crystal possess $R32$ space symmetry at all temperatures. HoFe3(BO3)4 crystal undergoes the structural phase transition from $R32$ to $P3_121$ (D_3^4) symmetry below 360 K. Correspondingly, the local symmetry of the Ho^{3+} ion decreases from D_3 to C_2 one. $f - f$ transitions in $HoFe_3(BO_3)_4$ were earlier studied in the region of 8500–24500 cm^{-1} in the temperature range including the spin-reorientation in Ref. [1] and as a function of magnetic field in Ref. [2]. Present work is devoted to the comparative study of the diamagnetic magnetic circular dichroism (MCD) and absorption spectra of $^5I_8 \rightarrow {}^5F_5$ transition in Ho^{3+} ion in two crystals.

Absorption and MCD spectra of the $HoAl_3(BO_3)_4$ crystal are shown in Fig. 1.

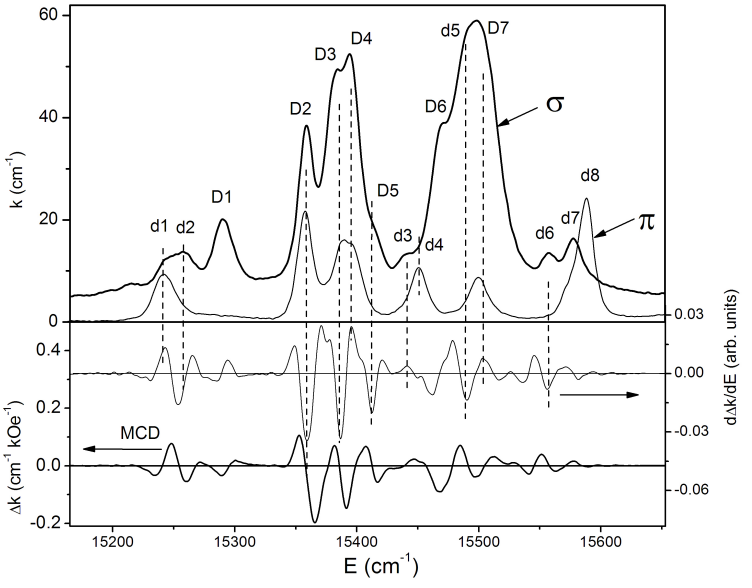

Figure 1. Polarized absorption and MCD spectra of $HoAl_3(BO_3)_4$ single crystal at 90 K

The absorption spectra were decomposed into the Lorenz shape components and their intensities were determined (see Table 1). The capital letters in Figs. 1 and in Table 1 indicate transitions from the ground state and the lower case characters indicate transitions from the upper states of the ground multiplet or vibronic transitions. The $HoFe_3(BO_3)_4$ spectra were subjected to the same treatment. Anomalously strong vibronic transitions (d^6, d^7, d^8 in Fig. 1) were observed in $HoAl_3(BO_3)_4$, but not observed in $HoFe_3(BO_3)_4$, that testified to the strong non diagonal vibronic interaction in $HoAl_3(BO_3)_4$. Comparison of the absorption band splitting and transitions intensities in the crystals has shown that even and especially odd part of the crystal field in the $^5F_5$ state are larger in $HoAl_3(BO_3)_4$ than those in $HoFe_3(BO_3)_4$, that corresponds to smaller lattice constants of the $HoAl_3(BO_3)_4$ crystal.

Signs of extremums of the first derivative of the MCD at positions of the absorption lines (Fig. 1) give signs of the Zeeman splitting $\Delta\omega_0$ and of the corresponding changing of the Landé factor Δg_C during transitions (Table 1).

Table 1. Energies (E) and intensities (I) of transitions. Symmetries of states or types of transitions are shown in brackets. Δg_C is the experimental change of the Landé factor along the C_3 axis during transition.

Levels, transitions	$HoAl_3(BO_3)_4$				$HoFe_3(BO_3)_4$			
	E (cm^{-1}) (90 K)	I_π (cm^{-2})	I_σ (cm^{-2})	Δg_C	E (cm^{-1}) (90 K)	I_π (cm^{-2})	I_σ (cm^{-2})	Δg_C
D1	15291 (A_1)	0	329	(–)	D1a 15405 15412 (A_1)	214 0	0 677	–10.2
D2	15359 (E_2)	422	538	–1.5	15420 (E)	533	534	(+)
D3	15382 (E_1)	326	727	(–)	15430 (E)	250	σ	
D4	15396 (E_2)	177	1014	(+)	15446 (E)	π	σ	
D5	15413 (A_2)	0	40	(–)	15474 (A_2)	0	1320	(+)
D6	15467 (A_2)	0	326	(–)?	15500 (A_2)	0	237	
D7	15503 (E_1)	218	1616	(-)?	15574 (E)	97	102	
d1	15241.3 (Gr6-D2)	291	164	+3.5	15299	126	407	-14.6
d2	15260 (Gr5-D2)	0	114	(–)?	15322	240	0	
d3	15439.5 (?)	0	50(?)	(+)	15329	97	42	
d4	15450.5 (Gr3-D6)	228	0	0	15354	200	575	
d5	15489 (?)	0	1376	(-)	15367	0	228	
d6	15557.1 (D6+87,1)	0	39	**-2.1**	15385	306	1305	

If MCD spectra of transitions are good resolved, it is possible to find values of $\Delta\omega_0$ from the absorption and MCD spectra [3] and values of the corresponding Δg_C (Table 1). In particular, from the vibronic transition d^6 in $HoAl_3(BO_3)_4$ and electron transition D1 in $HoFe_3(BO_3)_4$ into singlet states (Table 1) we found the Landé factors g_C of the Ho^{3+} ion ground state in these crystals: $g_C \approx 2$ and 10, respectively (Table 1). Value of the ground state Landé factor in $HoAl_3(BO_3)_4$ was confirmed by the EPR measurements, and that in $HoFe_3(BO_3)_4$ is consistent with the estimation made earlier in Ref. [1].

MCD spectra were analyzed in approximation of the $|J, \pm M_J\rangle$ wave functions of the free atom and using conception of the crystal quantum number μ [4]. Peculiarity of application of this conception to ions with integer moments was revealed and modification of the conception was suggested. In particular, the selection rules for the circularly polarized light in terms of the crystal quantum number μ, consistent with the experiment and with the selection rules for the linear polarizations, were suggested.

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