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MAGNETIC RELAXATION OF Gd^{3+} IN YTTRIUM IRON GARNET

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Abstract: Perturbed angular correlation has been used in the investigation of HFI of gadolinium ion diluted in YIG. Static magnetic HF and static electric quadrupole HF interactions of comparable strength as well as the magnetic relaxation effects had to be taken into account in this system. The PAC methodology approach appropriate to this situation is proposed. The agreement for the room temperature data is obtained. The system at low temperatures exhibits certain anomalies, which are discussed assuming the correlation time approaches the nuclear state life time at these temperatures.

1. The system and the model

HFI of a Gd^{3+} ion in different media has been the subject of many investigations. In this paper we report on PAC-experiments performed on this ion introduced in trace quantity into the ferrimagnetic lattice of a polycrystalline YIG (yttrium iron garnet). In this system we consider the following basic interactions

$$\mathcal{H} = 2\beta\vec{H}_{\text{exch}}\cdot\vec{S} - 2\beta\gamma_I\langle r^{-3}\rangle\varkappa\vec{S}\cdot\vec{I} + \frac{e^2qQ}{4I(2I+1)}3I_z^2 - \\ - I(I+1) + \eta(I_x^2 - I_y^2)]. \tag{1}$$

The first term accounts for the exchange interaction in a ferrite below the Neel temperature. Since in the case of Gd^{3+} — ion orbital motion vanishes, there is no 4f — field and only a much weaker internal field remains, originating in the inner core polarization (the second term in Equ. (1)). Its magnitude in iron garnets is $H_0 = 335$ kOe, in excellent agreement with the free ion value. Gd^{3+} has a half-filled 4f — shell and the $^8S_{7/2}$ configuration. It is only weakly perturbed by

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a crystalline field interaction and behaves like an almost ideal S-state ion. For this reason the CF-interaction is not considered here. Finally, due to the reduced magnetic HFI, it can be expected that the nuclear quadrupole interaction plays a more important role in GdIG than in other rare-earth iron garnets. This is indeed indicated by recent Mössbauer and NMR-experiments[1,2].

It is generally known that due to the absence of orbital motion the magnetic relaxation of a Gd^{3+} — ion is much slower than that of other rare earth ions. Hence it is not certain whether in the case of iron garnet at a given temperature the PAC-interaction of the 1.7 ns excited nuclear state is static or time-dependent. However, some conclusion can be drawn from the fact that a definite angular shift of the integral angular correlation pattern is observed in H . If a static interaction were involved, an unequal population of the ionic m-states would be required over the nuclear state life time. This is unlikely to occur since the β^- — recoil energy is high enough to wipe out any parent-ion polarization. An alternative possibility would be an unidentified ionic state left as a consequence of after effects. Such effects have not, however, been observed in case of other rare earth ions in iron garnet medium. Finally, many of the observed phenomena can be, to a high degree, »personalized« to the Gd^{3+} ion. Therefore we consider magnetic relaxation as the most likely phenomenon leading to the angular shift and other influences on the PAC experiments in the present system.

In this way we can summarize the physical model we are considering for the present system: Gadolinium nuclei are exposed to both the magnetic HF field set by the relaxing Gd^{3+} ions, partly aligned by the exchange interaction, and the nonvanishing EFG at their position in a garnet lattice. Within PAC methodology the influence of extranuclear perturbation state on the measurable angular correlation manifests itself in the perturbation factor $G_{kk}^{qq'}(t)$. We are interested in the case of a simultanously acting *static* magnetic and randomly oriented, axially symmetric, *static* electric quadrupole interaction (polycrystalline samples) extensively treated by Steffen, Matthias and Schneider[3]. These authors give numerical tables of perturbation coefficients $a_{k_1k_2}^{q}$ and $b_{k_1k_2}^{q}$, simply related to the real and imaginary parts of the perturbation factors $G_{k_1k_2}^{q_1q_2}$ (see Equ. (83) of Ref.[4]). They are given as functions of the parameters

$$x = \omega_E \tau_N \tag{2}$$

and

$$y = \frac{\omega_H}{\omega_E}, \tag{3}$$

where

$$\omega_E = \frac{1}{\hbar} e Q \frac{\partial^2 V}{\partial z^2} \frac{1}{4I(2I-1)}, \tag{4}$$

$$\omega_H = \frac{\mu H}{I \hbar}. \tag{5}$$

In the present case where both interactions are of an »internal« origin, the static magnetic field H in Equ. (5) can be interpreted as the quasi-static part of a magnetic HFI. At higher temperatures it can simply be derived from molecular

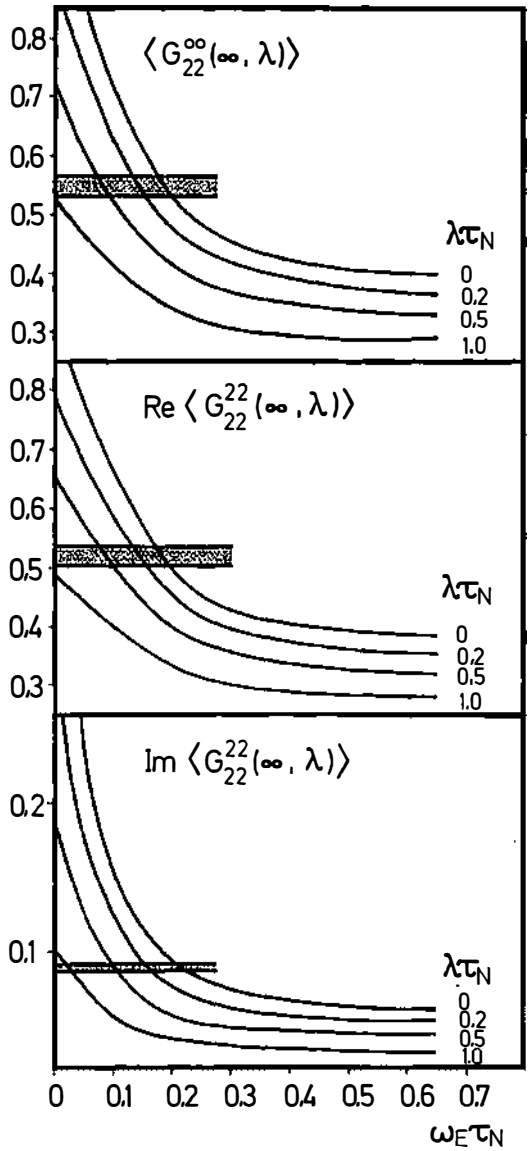

Fig. 1. Coefficients $\langle G_{22}^{00}(\infty, \lambda_2)\rangle$, Re $\langle G_{22}^{22}(\infty, \lambda_2)\rangle$ and $I_m \langle G_{22}^{22}(\infty, \lambda_2)\rangle$ as functions of $\omega_E\tau_N$ and $\lambda_2\tau_N$, calculated from Equs. (10) and (11). The set of initial parameters is $I = 2$, $g_N = 0.43$, $\tau_N = 1.73$ ns and $H^{int} = 58$ k0e (room temperature). The measured values are represented by the shadowed areas.

field theory. For instance, if it is assumed that the $^8S_{7/2}$ ground state of Gd^{3+} is split in the iron garnet by the exchange interaction only, the magnitude and the temperature dependence of the magnetic HF-field is

$$H_{(T)}^{int} = H_{(0)}B_S[(g_J - 1)\vec{S} \cdot \vec{H}_{exch(T)}/kT], \tag{6}$$

where $H_{(0)} = 335$ kOe, B_S — the Brillouin function and H_{exch} — the exchange field acting at the ion in a ferrite. The meaning of ω_E in (4) remains unchanged. It is assumed here that the EFG posses an axial symmetry. However, even a small departure from this requirement is not expected to change the results significantly, provided a time-integral angular correlation is observed.

A major problem arises if — in addition to the static interactions just mentioned — relaxation effects cannot be neglected. A theoretical treatment of combined magnetic and quadrupole interactions in a polycrystalline sample including relaxation effects (even of the rather simple type of magnetic relaxation) is not yet available. From Ref.[3] we infer at once that inclusion of damping effects would require lengthy numerical calculations. In view of the various experimental and theoretical uncertainties about the present system we have decided not to plunge into an intricate numerical treatment as a first step, but rather tried to account for relaxation effects approximately.

Let us assume that we encounter an isotropic magnetic relaxation process described by damping constants λ_k independent of q (k, q refer to multipole order and multipole components, resp.) within the framework of relaxation theory described in Ref.[5]. This assumption is expressed as

$$(kq \mid \mathscr{R} \mid k'q') = \lambda_k \delta_{kk'}, \tag{7}$$

which states that the relaxation operator $\mathscr{R}$ is independent of q and diagonal with respect to the irreducible tensor basis $\mid kq) \equiv \mid U_q^{(k)})$. The expressions we need to calculate are matrix elements of the evolution operator (here given in its time-integral form)

$$G_{kk'}^{qq'}(\infty, \lambda) = (kq \mid [\hat{1} + i\tau_N \hat{\mathscr{H}} + \tau_N \mathscr{R}]^{-1} \mid k'q'), \tag{8}$$

where $\hat{\mathscr{H}} = \hat{\mathscr{H}}_m + \hat{\mathscr{H}}_Q$. In a polycrystalline sample the principal axis of the internal — lattice induced quadrupole interaction is randomly distributed with respect to a fixed external magnetic field. This introduces an average over the angles between these two directions, which we denote by $\langle G_{kk'}^{qq'} \rangle$. Without relaxation, i.e. $\mathscr{R} = 0$,

$$\langle G_{kk'}^{qq}(\infty,0) \rangle = \frac{[(2k+1)(2k'+1)]}{2(2I+1)} \left\{ a_{kk'(x,y)}^{q} + i\, b_{kk'(x,y)}^{q} \right\}. \tag{9}$$

These are the expressions calculated in Ref.[3]. Assuming the influence of isotropic relaxation effects to be weak compared to the static interactions and crudely replacing angular averages of products by averages of the factors we arrive at

$$\operatorname{Re}\langle G_{kk}^{qq}(\infty,\lambda) \rangle = \frac{\operatorname{Re}\langle G_{kk}^{qq}(\infty,0) \rangle + \lambda_k \tau_N [(\operatorname{Re}\langle G_{kk}^{qq}(\infty,0) \rangle)^2 + (Im\langle G_{kk}^{qq}(\infty,0) \rangle)^2]}{(1 + \lambda_k \tau_N \operatorname{Re}\langle G_{kk}^{qq}(\infty,0) \rangle)^2 + (\lambda_k \tau_N Im\langle G_{kk}^{qq}(\infty,0) \rangle)^2}, \tag{10}$$

$$Im\langle G_{kk}^{qq}(\infty,\lambda)\rangle = \frac{Im\langle G_{kk}^{qq}(\infty,0)\rangle}{(1+\lambda_k\tau_N \operatorname{Re}\langle G_{kk}^{qq}(\infty,0)\rangle)^2 + (\lambda_k\tau_N\, Im\langle G_{kk}^{qq}(\infty,0)\rangle)^2}. \quad (11)$$

These expressions depend on the static perturbation factors $\langle G_{kk}^{qq}(\infty,0)\rangle$ and the relaxation parameter $\lambda_k\tau_N$.

2. *Experiments and results*

Sources used in these experiments consisted of a minute quantities of radioactive $^{154}Eu_2O_3$ atomically mixed with iron- and yttrium oxides and subsequently sintered to form a polycrystalline (^{154}Eu)YIG.

An integral angular correlation of the 1278 keV — 123 keV cascade was recorded by an automatic set-up. Experiments were usually performed as the series of relative determinations of the angular correlation, where all but one parameter were kept constant. In this way any small difference in the attenuation, as a consequence of different temperature or state of magnetization of the ferrite, can be determined quite accurately. Special care was taken axial symmetry of the arrangement to be maintained throughout the measurement. The source- and the external scattering were kept as small as possible and identical in each pair of measurements. The experimental data reported below are defined in terms of the perturbed directional correlation ($k_{max} = 2$)

$$W_\perp(\theta,\infty,\lambda) = 1 + \frac{1}{4}A_{22}\langle G_{22}^{00}(\infty,\lambda)\rangle + \frac{3}{4}A_{22}[\operatorname{Re}\langle G_{22}^{22}(\infty,\lambda)\rangle\cos(2\theta) -$$

$$- Im\langle G_{22}^{22}(\infty,\lambda)\rangle\sin(2\theta)], \quad (12)$$

$$W_{||}(\theta,\infty,\lambda) = 1 + A_{22}\langle G_{22}^{00}(\infty,\lambda)\rangle P_2(\cos\theta). \quad (13)$$

In the Tables we have listed figures for following quantities

$$A_\perp = \frac{3}{2}A_{22}\frac{\operatorname{Re}\langle G_{22}^{22}(\infty,\lambda)\rangle}{1+\frac{1}{4}A_{22}[\langle G_{22}^{00}(\infty,\lambda)\rangle - 3\operatorname{Re}\langle G_{22}^{22}(\infty,\lambda)\rangle}, \quad (14)$$

$$A_{||} = \frac{3}{2}A_{22}\frac{\langle G_{22}^{00}(\infty,\lambda)\rangle}{1-\frac{1}{2}A_{22}\langle G_{22}^{00}(\infty,\lambda)\rangle}, \quad (15)$$

$$R = \frac{3}{2}A_{22}\frac{Im\langle G_{22}^{22}(\infty,\lambda)\rangle}{1+\frac{1}{4}A_{22}\langle G_{22}^{00}(\infty,\lambda)\rangle}. \quad (16)$$

Tables 1—7 contain about fifty independent correlation runs, arranged in several series of relative measurements. Thus in Table 1 the anisotropies of a liquid and garnet sources are compared at room temperature, with no external magnetic field applied. Table 2 presents the data on the attenuation and the angular shift of the correlation in the garnet magnetized perpendicularly to the counter plane at room temperature. Table 3 presents essentially the same quantities, but measured at different temperatures, etc. Each Table is explained by symbols which have the following meanings: $H\uparrow$, $H\downarrow$ and $H = 0$ — a ferrite magnetized »up«, »down« or not magnetized at all; $A_{\perp}$, $A_{||}$, $A_{(0)}$ — the anisotropy $\frac{W(180°)}{W(90°)} - 1$ of the angular correlation determined in a transverse, longitudinal or in zero external magnetic field respectively; R means $\frac{W(135°)}{W(225°)} - 1$ or $\frac{W(225°)}{W(135°)} - 1$; the symbols $(135° - 90°)$ and $(145° - 90°)$ refer to $\frac{W(135°)}{W(90°)} - 1$ and $\frac{W(145°)}{W(90°)} - 1$ as determined in a longitudinal magnetic field. The selection of these unusual angles is connected with experimental difficulties encountered in longitudinal-field experiments. We also present the attenuation of an unmagnetized garnet over a wide range of temperatures (Table 7).

TABLE 1.

Run	$LuCl_3$ in water sol. $H = 0$, 300 K, $A_{(0)}$	Run	(Eu) YIG H = 0, 300 K, $A_{(0)}$
1	0.285(3)	6	0.164(1)
2	0.286(3)	7	0.164(2)
3	0.285(5)	8	0.165(2)
4	0.288(2)		
5	0.286(1)		

TABLE 2.

Run	(Eu)YIG $H\uparrow$, 300 K, $A_\perp$	Run	(Eu)YIG $H\uparrow$, 300 K, R
9	0.154(3)	11	0.022(1)
10	0.156(2)	12	0.022(4)
		13	0.023(2)
Run	**(Eu)YIG $H\downarrow$, 300 K, $A_\perp$**	**Run**	**(Eu)YIG $H\downarrow$, 300 K, R**
14	0.158(2)	16	−0.027(2)
15	0.156(1)	17	−0.028(1)
		18	−0.027(1)

TABLE 3.

Run	(Eu)YIG $H\uparrow$, 300 K, $A_\perp$	Run	(Eu)YIG $H\uparrow$, 78 K, $A_\perp$
19	0.147(3)	23	0.118(5)
20	0.139(4)	24	0.115(6)
21	0.148(2)	25	0.122(4)
22	0.152(3)		
Run	**(Eu)YIG $H\uparrow$, 300 K, R**	**Run**	**(Eu)YIG $H\uparrow$, 78 K, R**
26	0.028(3)	29	0.015(3)
27	0.025(2)	30	0.015(5)
28	0.025(3)	31	0.012(6)
		32	0.016(3)

TABLE 4.

Run	(Eu)YIG $H_{\|\|}$, 300 K, (145° − 90°)	Run	(Eu)YIG $H = 0$, 300 K, (145° − 90°)
39	0.099(3)	41	0.096(2)
40	0.102(3)	42	0.097(3)

TABLE 5.

Run	(Eu)YIG $H_{\|\|}$, 300 K, $A_{\|\|}$	Run	(Eu)YIG $H_{\|\|}$, 78 K, $A_{\|\|}$
43	0.161(5)	44	0.169(4)
Run	**(Eu)YIG $H_{\|\|}$, 300 K, (135° − 90°)**	**Run**	**(Eu)YIG $H_{\|\|}$, 78 K, (135° − 90°)**
45	0.085(4)	47	0.085(4)
46	0.080(4)	48	0.083(3)

TABLE 6.

Run	(Eu)YIG $H = 0$, 300 K, $A_{(0)}$	Run	(Eu)YIG $H = 0$, 78 K, $A_{(0)}$
33	0.162(3)	36	0.145(4)
34	0.163(4)	37	0.140(3)
35	0.160(3)	38	0.140(3)

TABLE 7.

(Eu)YIG $H = 0$, 300 – 1200 K, $A_{(0)}$		
Run	Temp. K	$A_{(0)}$
49	297	0.164(1)
50	446	0.179(2)
51	635	0.177(2)
52	815	0.172(2)
53	1043	0.170(2)
54	1168	0.172(2)

The raw data from Tables 1–7 were corrected for the finite angular resolution of the system and the scattering in the source and vicinity. The absolute values of the attenuation were determined by taking $A_{22} = 0.227 \pm 0.006$ as the unperturbed angular correlation coefficient of the 1278 keV – 123 keV cascade[6].

Finally, Table 8 contains the experimentally determined perturbation factors at two different temperatures

3. *Discussion*

The complex perturbation of the angular correlation in the system investigated depends essentially on the quasi-static part of the magnetic field, $H_{(T)}^{int}$, the gradient of an axially symmetric electric field, V_{zz}, and the magnetic relaxation parameter λ_2. The perturbation factors defined in Equs. (10) and (11) and the numerical tables of Steffen et al.[3] depend on the parameters x, y and $\lambda_2\tau_N$. In the subsequent analysis we make use of the established facts on the exchange and quadrupole interactions of the system under study and focus interest on the most uncertain point – that of the magnetic relaxation.

It is well known that the magnetic behaviour of most of the rare earth ions in iron garnets at higher temperatures can be described very well by molecular field theory. It should be particularly true in the case of Gd^{3+}, where the crystalline field effects practically vanish. Taking the dominant role of the a–c sublattices interaction in iron garnets into account, it seems reasonable to transfer to our system the precise pulsed-EPR results for $H_{exch(T)}$ on Gd^{3+} in GdIG[7]. In this way, by subsequent use of (6), the value of the quasi-static magnetic field can be determined at all temperatures of interest. It is, however, to be remembered that the implicit requirement of a full thermal equilibrium with the lattice has to be

fulfilled. By applying the molecular field procedure the overall analysis is greatly simplified. It shall be performed first at 300 K. The temperature dependence will be discussed separately.

Room temperature. At this temperature the molecular field procedure gives $H^{int}_{(300)} = 58$ kOe. On the basis of this value the magnitudes $\langle G^{00}_{22}(\infty, \lambda)\rangle$, $\mathrm{Re}\langle G^{22}_{22}(\infty,\lambda)\rangle$ and $Im\langle G^{22}_{22}(\infty, \lambda)\rangle$ are calculated from Equs. (10) and (11) and plotted in Fig. 1 as functions of $x = \omega_E \tau_N$ and $\lambda_2 \tau_N$. On the same figure the experimental values of these perturbation factors are presented. Each of the experimentally measured quantitites intercepts the family of $\lambda_2 \tau_N$ — curves and thus determines the particular $x - \lambda_2 \tau_N$ dependence. These are plotted separately on Fig. 2. Notice that the values of $A_\perp$, $A_{||}$ and R yield almost the same $x - \lambda_2 \tau_N$ dependence. Recently, the existence of EQI of nuclei in S-state rare earth ions at c-position in iron garnets has been proven independently. Mössbauer and NMR studies performed by an Israeli group[1,2] on GdIG and recent PAC investigations on LuIG[8] confirm that the EFG on these ions is produced by the lattice and give rather consistent values of its magnitude. The best estimate of the strength of EQI of the 2 + state of ^{154}Gd in iron garnet at 300 K is indicated in Fig. 2 by the shaded area in the vicinity of $\omega_E \tau_N = 0.10$. Corre-

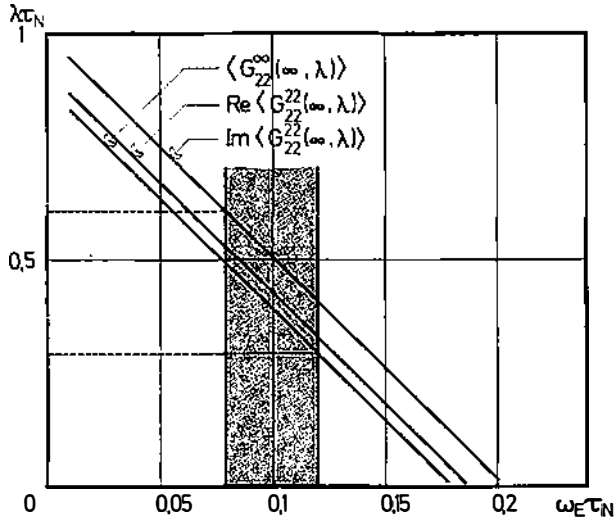

Fig. 2. $\lambda_2 \tau_N - \omega_E \tau_N$ dependence derived from the intercept of experimental values with the curves from Fig. 1.

sponding values of the relaxation parameter $\lambda_2 \tau_N$ are then in the range from 0.3 to 0.6. According to the theory of time-dependent interactions in ferrimagnetic solids (high temperature approximation), this corresponds to a correlation time τ_c form 0.2 to 0.4 ns. These values are close to the ionic relaxation time reported for the Gd^{3+} ion in a water solution[9].

It is interesting to note that the direction of the angular shift of the angular correlation pattern for a fixed direction of $H_\perp$ permits an easy determination of the direction of internal field H^{int} acting at the nucleus. In the present case it is found to be positive in the temperature range from 78 K to the Neel point. (By convention a positive internal field produces an angular shift in the same direction as an external field used to magnetize the ferrite would do). This result fits correctly into the adopted picture: $\vec{S}$ of Gd^{3+} ion is coupled antiferromagnetically to the net iron magnetization, while the core-polarization field is of an opposite direction to $\vec{S}$. Hence, H^{int} is parallel to the direction of the magnetizing field.

Temperature dependence of perturbation. Above the Neel temperature there is no exchange interaction and the static componet of a magnetic HFI vanishes. The origin of perturbation then results from the simultaneous action of a static EQI and a time-dependent magnetic HFI. It has been shown recently[8] that in the case of ^{177}Hf in iron garnet the EQI is practicaly temperature-independent between 78 K and 1200 K. Being a S-state ion, it is likely that the Gd^{3+} behaves the same way in the same lattice. This is indeed very close to the observed pattern (Fig. 3). However, the observed attenuation factor cannot be explained by a pure static EQI, of the same strength as discussed earlier. If it is assumed that the additional attenuation is due to a time dependent magnetic interaction, it follows from (10) and (11) that

$$\mathrm{Re}\langle G_{22}^{00}(\infty,\lambda)\rangle = \frac{\langle G_{22}^{00}(\infty,0)\rangle}{1+\lambda_2\tau_N\langle G_{22}^{00}(\infty,0)\rangle}. \tag{17}$$

The fit is now obtained by allowing $\lambda_2\tau_N = 0.35$, together with the strength of EQI as derived at room temperature, i.e. $\omega_E\tau_N = 0.10$. According to this explanation the attenuation has its origin in a dominant static EQI and a smaller time-dependent magnetic HFI. This explanation requires the ionic relaxation time to depend weakly on temperature in the range investigated.

TABLE 8.

Temp.	$\langle G_{22}^{00}(\infty,\lambda)\rangle$	$\mathrm{Re}\langle G_{22}^{22}(\infty,\lambda)\rangle$	$I_m\langle G_{22}^{22}(\infty,\lambda)\rangle$
300 K	0.55±0.02	0.52±0.02	0.089±0.003
78 K	0.58±0.02	0.44±0.02	0.054±0.004

Below the Néel temperature, actually at 300 and 78 K, the measurements of angular correlation were performed in $H_\perp$, $H_{||}$ and $H = 0$. The results are presented in Fig. 3 and in a more detailled way in Table 8.

All attempts to explain the data at 78 K by the same model as used at 300 K have failed so far. Assuming the internal field of $H_{(78)}^{int} = 204$ kOe, as derived from molecular field theory, it was impossible to achieve an acceptable agreement with

the entire set of experimental data. The temperature dependence of $\langle G_{22}^{00}(\infty)\rangle$, $\mathrm{Re}\langle G_{22}^{22}(\infty)\rangle$ and $Im\langle G_{22}^{22}(\infty)\rangle$ contradicts the predictions of the model. For instance, the angular shift at 78 K is *decreased* (in spite of a considerable increase of the internal magnetic field), the real part of G_{22}^{22} is also decreased, but the G_{22}^{22} remained the same, or even is increased. The present model is obviously inadequate to describe the low-temperature results.

This difficulty may well be due to an increase of the ionic relaxation time by lowering the temperature. Since τ_c is already in the range 0.2—0.4 ns at 300 K, any further increase would lead to $\tau_c \approx \tau_N$, where the present approximate model does not apply. Since the complete non-Markoffian calculations appropriate to the case of combined interactions including relaxation effects are complicated and not yet available, we consider here only the qualitative behaviour of the tem-

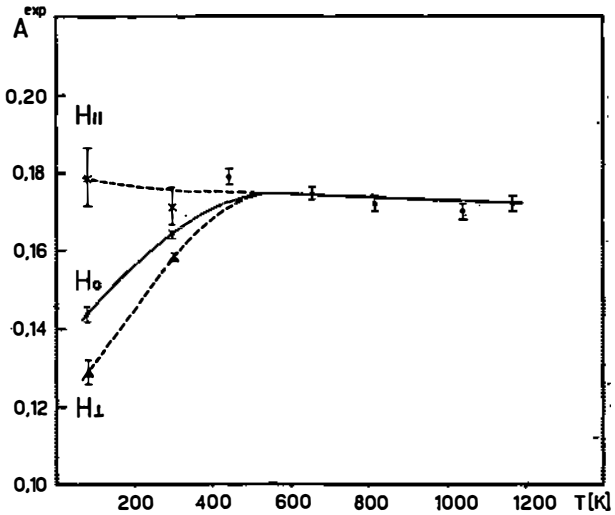

Fig. 3. Temperature dependence of $A^{exp} = \dfrac{W(180°) - W(90°)}{W(90°)}$ measured in an unmagnetized sample ($H = 0$), magnetized perpendicularly to the counters plane ($H_\perp$) and magnetized along the direction of one of detectors ($H_{||}$).

perature dependence of our system. In the limit $\tau_c > \tau_N$ both interactions (electric and magnetic) would be static. The static magnetic HFI would further be »decoupled« by the very strong longitudinal exchange field H_{exch}, leaving $\langle G_{22}^{00}(\infty)\rangle_{LIM}$ to be determined by the randomly oriented, axially symmetric EQI only. This is in the present case $\langle G_{22}^{00}(\infty)\rangle_{LIM} = 0.70$. The $Im\langle G_{22}^{22}(\infty)\rangle_{LIM}$ vanishes, since there is no preferred direction of the internal magnetic field. It can be observed that both experimental coefficients (Table 8) indeeed tend toward the »static« limit at the low temperature. But, since even at 78 K a definite angular shift is observed, presumably there are still some magnetic relaxations occuring during the nuclear state life time.

It can be observed that the general pattern of Fig. 3 at lower temperatures resembles the well-known experiments of Stiening and Deutsch[9] on the»decoupling« of Gd^{3+} ions in water solution by the external magnetic fields $H_{||}$ and $H_{\perp}$. However, in two systems markedly different phenomena are involved. In the garnet system there is a strong static EQI which influences greatly the overall PAC pattern. There is also a strong exchange field acting at the gadolinium ions below the Neel temperature. Its magnitude is much larger than that of an external magnetic field used in experiments of Stiening and Deutsch. As a consequence, a very useful new parameter — the angular shift of the correlation pattern — becomes experimentally accessible.

The exchange field increases only 17 % from 300 to 78 K and it is unlikely that the observed low-temperature phenomena originate in this little change only. It seems more likely that the suggested change of τ_c with temperature is associated with other aspects of the Gd^{3+} ion coupling in a ferrite. Large increase of the gadolinium relaxation frequency has been observed in a GdIG in the broad vicinity of the compensation point of this ferrite[10]. Similar effects could be responsible for the change of τ_c in our system as well, but evidently fuller information on the relaxation mechanism is required in order to arrive at a decisive answer.

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MAGNETSKE RELAKSACIJE JONA Gd^{3+} U GRANATU ITRIJUM-GVOŽĐE

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Sadržaj

Pomoću perturbiranih ugaonih korelacija gama-zraka izučavana je hiperfina interakcija jona gadolinijuma razblaženog u rešetci ferita itrijum-gvožđe sa strukturom granata (YIG).

Pored statičke magnetske i statičke električne kvadrupolne hiperfine interakcije, pokazano je da se u sistemu moraju uzeti u obzir i magnetske relaksacije.

Teorija perturbiranih ugaonik korelacija proširena je na takav slučaj. Na višim temperaturama dobijeno je dobro slaganje merenih vrednosti sa teorijom. Anomalno ponašanje sistema na nižim temperaturama razmatrano je u svetlosti približnih vrednosti korelacionog vremena i vremena života nuklearnog intermedijernog stanja.