varying the ignition currents I_c and I_a in the cathode and anode units and by varying the delay τ_d of the pulsed anode voltage.

Figure 2 shows oscillograms of the total current I_{tot} = 58 mA (a) and of the current to the Faraday cylinder I_{Fc} = 52 kA (b) and $I_a = I_c$ = 700 A, τ_d = 0.8 μsec, and an accelerating voltage 80 kV. It is seen from the oscillogram that the current to the Faraday cylinder reaches 90% of the total current. The high current transmission coefficient is due to the cancellation of the space charge by the ions of the dense anode plasma and to the pinching of the high-intensity beam by its own magnetic field. The scatter of the maximum values of the current to the Faraday cylinder does not exceed ±10%.

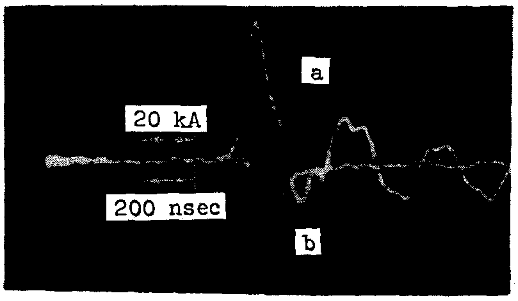

Fig. 2. Oscillograms of the total current (a) and of the current to the Faraday cylinder (b).

An experimental source of pulsed bremsstrahlung x-rays based on such a gun has a pulsed power ~10^9 r/sec with exposure dose ~100 r/pulse and an effective energy 15 - 25 keV.

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REORIENTATION OF MAGNETIC FIELD AT THE NUCLEUS OF A DIAMAGNETIC ATOM IN A RARE-EARTH ORTHOFERRITE

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The spontaneous reorientation of the magnetic moment from one crystal axis to another was observed in a number of rare-earth orthoferrites in a definite temperature interval [1, 2].

We report here a new effect of reorientation of the induced magnetic field at the nucleus of the diamagnetic tin atom in the orthoferrite $Nd_{0.95}Ca_{0.05}Fe_{0.95}Sn_{0.05}O_3$.

Rare-earth orthoferrites are weak ferromagnets. The resultant magnetic moment of the orthoferrite lies in a direction perpendicular to the plane in which the magnetic moments of the iron sublattices lie. In investigations of rare-earth orthoferrites with small admixtures of tin, we have recently observed that strong magnetic fields H_{eff}^{Sn} are induced at the nuclei of the diamagnetic ions Sn^{4+} [3, 4]. It is very important to obtain information on the orientation of the magnetic field H^{Sn}_{eff}. It is also of interest to know the behavior of the field at the tin when the magnetic moments of the iron ions are reoriented from one crystal axis to another.

To investigate these effects, we chose the tin-substituted neodymium orthoferrite $Nd_{0.95}Ca_{0.05}Fe_{0.95}Sn_{0.05}O_3$. In the non-substituted orthoferrite $NdFeO_3$, the spontaneous magnetic moment at room temperature is directed along the c-axis of the crystal and the moments of the two iron sublattices lie along the a-axis. When the temperature is lowered, approximately in the interval 110 - 150°K, the weak magnetic moment turns from the c to the a-axis [5].

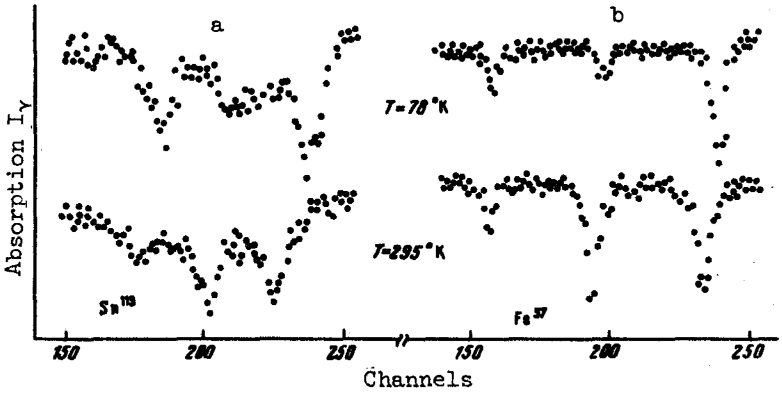
When working with oriented single crystals, a procedure based on the Mossbauer effect makes it possible to determine the direction of the magnetic moment relative to the crystallographic axes in the absence of an external magnetic field. The probabilities of the nuclear transitions between the magnetic sublevels and the intensities of the Mossbauer-spectrum lines corresponding to these transitions depend on the angle θ between the flight direction of the γ quanta and the direction of the effective magnetic field at the nucleus:

$$I_1 : I_2 : I_3 = I_6 : I_5 : I_4 = 3 : \alpha : 1, \qquad (1)$$

where $\alpha = 4\sin^2\theta/(1 + \cos^2\theta)$, and I_1, I_2, ... I_6 are the intensities of the first, second, etc. spectral lines.

Having no single-crystals of orthoferrite with tin admixture, we used a polycrystalline sample oriented beforehand in an external magnetic field in accordance with the following technique: finely ground orthoferrite powder was mixed with epoxy resin in a flat aluminum cuvette. The cuvette was then placed in a uniform 8-kOe magnetic field of a sonenoid and kept there until the resin was fully polymerized. The magnetic field oriented the weak magnetic moment of the orthoferrite as well as the c-axis of each crystallite perpendicular to the plane of the cuvette.

Figure b shows the Mossbauer spectra of the Fe^{57} nuclei in an oriented polycrystalline orthoferrite $Nd_{0.95}Ca_{0.05}Fe_{0.95}Sn_{0.05}O_3$ at 78 and 295°K. The spectra were obtained in a geometry in which the γ quanta traveled in a direction perpendicular to the plane of the cuvette. The ratio of the line intensities of the Fe^{57} spectra at room temperature indicates that the magnetic moments of the iron ions in both sublattices lie in the basal plane, and are apparently oriented in the same way as in the pure orthoferrite $NdFeO_3$, along the a-axis of the crystal [5]. The theoretical ratio of the line intensities should in this case



Mossbauer spectra (fourth, fifth, and sixth lines) of the orthoferrite $Nd_{0.95}Ca_{0.05}Fe_{0.95}Sn_{0.05}O_3$ at 78 and 295°K: a - spectra of Sn^{119} nuclei, b - spectra of Fe^{57} nuclei.

be, according to (1), $I_1:I_2:I_3 = I_6:I_5:I_4 = 3:4:1$.

When the temperature is lowered to 78°K, the intensities of the second and fifth lines of the spectrum decrease strongly. This indicates reorientation of the magnetic moments of the Fe^{3+} ions from the basal plane to the c-axis of the crystal. The theoretical ratio of the line intensities in the case of total rotation of the moments to the c-axis should be $I_1:I_2:I_3 = I_6:I_5:I_4 = 3:0:1$. The incomplete vanishing of the second and fifth lines of the spectrum (see Fig. b) can be attributed to several factors: 1) inaccurate orientation of the crystallites when the sample is treated with the external field; 2) the presence of weak noncollinearity of the iron sublattices in the orthoferrite; 3) deviation of the experimental geometry from ideal; 4) the possibility that the reorientation of the magnetic moments is not completed at 78°K.

The investigation of the Mossbauer spectra of the Sn^{119} nuclei has shown that the effective magnetic field at the nuclei of the diamagnetic tin atoms H_{eff}^{Sn} at 295°K lies in the basal plane (see Fig. a), i.e., it coincides in direction with the magnetic moments of the Fe^{3+} ions. With increasing temperature, the ratio of the line intensities in the Sn^{119} spectrum varies in approximately the same way as in the spectra of the iron nuclei Fe^{57} (see Fig. a). This indicates that the field H_{eff}^{Sn} changes its direction at 78°K. It follows the magnetic moments of the iron ions and becomes oriented in the c-direction.

This phenomenon, which is of extraordinary interest from the methodological point of view, is likewise not trivial from the physical point of view. The field at the nucleus of a diamagnetic atom reflects the magnetic state of the iron ions surrounding this atom [4]. The state of these iron ions, in turn, is different because their nearest surrounding contains at least one diamagnetic atom. Therefore the very fact of the reorientation of the field at the tin means that iron ions with weakened exchange couplings take part in the reorientation. The nature of this phenomenon calls for further research.

On the basis of our results we can draw the following conclusions:

1. When a small number of diamagnetic tin atoms is introduced, the neodymium orthoferrite remains a weak ferromagnet and the effect of spin reorientation does not vanish.

2. The magnetic field at the nucleus of the diamagnetic Sn atom is oriented along the magnetic moments of the iron ions.

3. We have found a new method for investigating spin orientation by measuring the Mossbauer effect on an impurity diamagnetic atom. The Mossbauer-effect procedure makes it possible to perform this research on polycrystalline samples and in the absence of an external magnetic field.

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