bottom of the band. $Z(\zeta)$ is the number of states per unit volume having an energy lower than ϵ_F and, as is well known, oscillates as a function of H^{-1}. Thus, photocurrent oscillations take place in a magnetic field.

In conclusion, I am grateful to V. M. Fain and E. I. Rashba for a discussion of the note, and to V. N. Genkin and E. G. Yashchin for valuable remarks.

[1] V. N. Genkin and P. M. Mednis, Fiz. Tverd. Tela 10, No. 3 (1968) [Sov. Phys.-Solid State 10, in press]; Zh. Eksp. Teor. Fiz. 54, 1137 (1968) [Sov. Phys.-JETP 27, in press].

* The matrix elements $\Omega_{cv}(\vec{k})$ are defined, for example, in [1]. We are considering crystals with $\Omega_{cc}(\vec{k}) = 0$.

METHOD FOR DIRECT OBSERVATION OF THE GIANT MAGNETIC FIELDS PRODUCED AT A NUCLEUS BY A HOLE IN THE K SHELL

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The probability that a nucleus will emit a particle or a quantum in a certain direction depends, in the general case, as is well known, on the angle between this direction and the nuclear spin I ($I \geq 1$). For this reason, in the case of a nuclear decay sequence $A^a \to B^b \to C$ the spins I_B of the intermediate nuclei B are not isotropically distributed in space relative to the preferred direction of the registration of particle a. The anisotropy of the orientation of the spins I_B causes in turn the probability W of coincidence of the registration of two particles a and b by two counters C_a and C_b to depend on the angle θ_{ab} between the emission directions:

$$W(\theta_{ab}) = \sum_{l=0}^{l_{max}} a_l \cos^{2l}\theta_{ab},$$

where I_{max} is double the value of the smallest of the three quantities I_a, I_b (the angular momenta carried by the particles a and b), and I_B.

This correlation between the directions of a and b is upset (perturbation of the angular correlations) when a noticeable precession of the magnetic (or quadrupole) moment of the intermediate nucleus B can be produced during its lifetime τ_B in the magnetic (or inhomogeneous electric) fields by the molecular or crystalline environment of the nucleus. In the presence of such a precession, the nucleus B will "forget", by the instant of the emission of b, the direction of I_B at the instant of emission of a and formation of B. The sensitivity of experiments aimed at the observation of the perturbed angular correlations ensures the possibility of investigating on their basis local magnetic (H_N) and electric (q_N) fields at the nuclei if $\omega_B\tau_B \gtrsim 0.01$ (ω_B - precession frequency of I_B), corresponding to $\tau_B \gtrsim 10^{-11}$ sec for the customary values $H_N \approx 10^5$ Oe and $q_N \approx 10^{18}$ V/cm^2 (see [1], Part II, Sec. 8).

The cited values of the local magnetic fields at the nuclei are much lower than the maximum possible ones that are realizable in the presence of a hole in the K shell.

In fact, the energy of interaction of the magnetic moment μ of a nucleus with spin I and a hole in the K shell with the magnetic moment μ_0 is

$$\Delta_K = E_{I+1/2} - E_{I-1/2} = \frac{8\pi}{3I}\mu\mu_0(2I+1)|\Psi_K(0)|^2 \approx \frac{8\pi}{3I}\kappa\frac{e\hbar}{2Mc}\frac{e\hbar}{2mc}(2I+1)\frac{Z^3}{\pi a_0^3}, \tag{1}$$

where $|\Psi_K(0)|^2$ is the density of the K electron in the location of the nucleus, Z the nuclear charge, κ its magnetic moment in nuclear magnetons, M the proton mass, m the electron mass, and $a_0 = 0.53 \times 10^{-8}$ cm the radius of the first Bohr orbit.

For hydrogen $\Delta_K = 5.9 \times 10^{-6}$ eV (the hfs line has a wavelength $\lambda = 2\pi\hbar c/\Delta_K = 21$ cm) and in the general case

$$\Delta_K = 5{,}3 \cdot 10^{-7}\frac{2I+1}{I}\kappa Z^3 eN,$$

meaning that the hole in the K shell produces at the nucleus an effective field equal to $(H_N)_K = 1.7 \times 10^5 Z^3$ Oe. For heavy elements these fields amount to hundreds of billions of Oersteds.

Such gigantic magnetic fields, however, act on the nucleus only for a very short time, equal to [2]

$$(\tau_N)_K = 4 \times 10^{-10}/Z^4 \text{ sec.} \tag{2}$$

It is nonetheless easy to verify that the condition $\Delta_K(\tau_N)_K/\hbar \gtrsim 0.01$ is almost always satisfied:

$$\frac{\Delta_K(\tau_N)_K}{\hbar} = 0{,}32\,\frac{2I+1}{I}\,\frac{\kappa}{Z}\,. \tag{3}$$

It is therefore possible to observe experimentally and to investigate quantitatively the perturbation produced in the angular correlations by the brief action of the giant magnetic K-field $(H_N)_K$ on the nucleus, by comparing the character of the $\gamma\gamma$ and $e_K\gamma$ (e_K - internal conversion electron from the K-shell) in the transition

$$A \xrightarrow{\gamma(e_K)} B \xrightarrow{\gamma} C.$$

The general formulas describing the connection between the coefficients of the angular correlations for the $\gamma\gamma$ and $e_K\gamma$ cascades can be found in the literature (e.g., [1], Sec. 5); in the limit of high energies, both types of correlations simply coincide. Thus, if correct account is taken of the role of the apparatus factors, such as scattering of conversion electrons, the comparison of the $\gamma\gamma$ and $e_K\gamma$ correlations should yield direct information on the giant magnetic K-fields $(H_N)_K$ at the nuclei and on the exact values of $|\Psi(0)|^2$.

In conclusion, a few words concerning the intermediate-nucleus (B) lifetimes satisfying the requirements for investigating $(H_N)_K$. The simplest variant corresponds to the condition $\tau_B \gtrsim (\tau_N)_K$. The role of holes in L, M, and other intermediate states arising during the course of stabilization of the electron shells after internal conversion is as a rule negligible, owing to the relatively large width of the Auger transitions for such states. On the other hand, in order that the measurements be also free of a noticeable influence of trivial perturbations of the angular correlations by the long-duration fields H_N and q_N, which are characteristic of stable states of the molecular and crystalline surroundings, it is necessary to satisfy the inequalities $10^{-11} > \tau_B > 4 \times 10^{-10}/Z^4$ sec.* This requirement is satisfied (even if account is taken of the desirability of having not too small and not too large conversion coefficients α in the A → B transition) by a sufficiently large number of levels, so that there is no sense in presenting here concrete examples.

The case $_B < (\tau_N)_K$ is also possible. If in this case $(H_N)_K$ and $(\tau_N)_K$ are known, then comparison of the $\gamma\gamma$ and $e_K\gamma$ correlations yields information on the lifetimes τ_B in the range 10^{-14} - 10^{-18} sec.

[1] H. Frauenfelder and R. M. Steffen, Angular Distribution of Nuclear Radiation. (A) Angular Correlations. (Chapter XIX of "Alpha-, Beta-, and Gamma-ray Spectroscopy," K. Siegbahn, ed., North-Holland Publishing Company, Amsterdam, 1965, vol. 2, pp 997-1198).

[2] W. Heitler, The Quantum Theory of Radiation, Clarendon Press, Oxford, 1954, Chapter 5, Sec. 18.

* Comparison of the $\gamma\gamma$ and $e_K\gamma$ correlations at $\tau_B \gg 10^{-11}$ sec has already been made a number of times for the study of the long-period aftereffects due not to direct formation of a hole in the K shell (see [1], Part II, Sec. 12), but to the subsequent electron transitions.

ERRATA

Vol. 6, No. 4. The following photographs were left out of the earlier edition of the Russian original and were not included in the translated version:

Article by T. L. Asatiani et al, (p. 83):

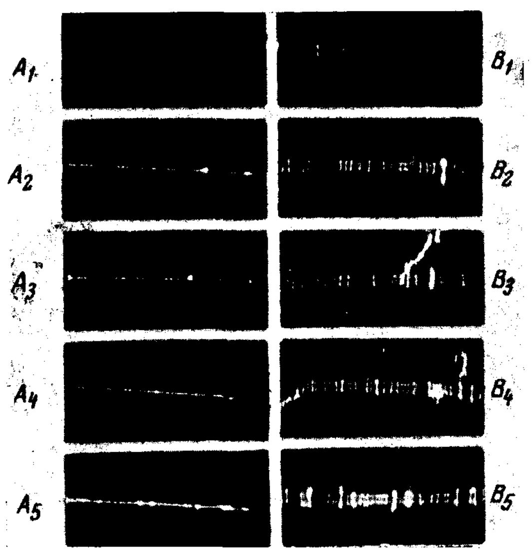

Fig. 1. Photographs of proton tracks in two projections at different energies in the case of a high-voltage pulse duration τ_{III}: A_1, B_1 - I/I_{min} = 1.2; A_2, B_2 - I/I_{min} = 3.4; A_3, B_3 - I/I_{min} = 5.4; A_4, B_4 - I/I_{min} = 6.3; A_5, B_5 - I/I_{min} = 8.5.