resentation of a 10-dimensional vector space.[1] The basis vectors of this space are related to ten 32-row matrices Γ^a, where

$$\Gamma^a\Gamma^b + \Gamma^b\Gamma^a = 2\delta_{ab}, \quad a, b = 1, 2, \ldots, 10.$$

There corresponds to a reflection of the basis vectors e^b in the vector space the following transformation of the matrix Γ^a:

$$\Gamma^{a'} = -\Gamma^b\Gamma^a\Gamma^b, \quad a = 1, 2, \ldots, 10,$$

(no summation over b).

We divide the 10-dimensional vector space into a 4-dimensional Minkowski space (the matrices corresponding to the basis vectors are Γ^ν, $\nu = 1, 2, 3, 4$) and a 6-dimensional isotopic space (the matrices here are Γ^a, $a = 5, 6, \ldots, 10$). With the aid of the isotopic space transformations we can determine the following 3-component isotopic vectors, whose components satisfy the same relations as the components of ordinary spin:

$$2\mathbf{J}^1 = (\Gamma^6, \Gamma^5, i\Gamma^5\Gamma^6), \quad 2\mathbf{J}^2 = (\Gamma^8, \Gamma^7, i\Gamma^7\Gamma^8),$$
$$2\mathbf{J}^3 = (\Gamma^{10}, \Gamma^9, i\Gamma^9\Gamma^{10}), \quad 2\mathbf{J}^4 = (i\Gamma^6\Gamma^7, i\Gamma^7\Gamma^5, i\Gamma^5\Gamma^6).$$
$$2\mathbf{J}^5 = (i\Gamma^{10}\Gamma^8, i\Gamma^8\Gamma^9, i\Gamma^9\Gamma^{10}).$$

We assume that the general equation for all baryons is of the type[2]

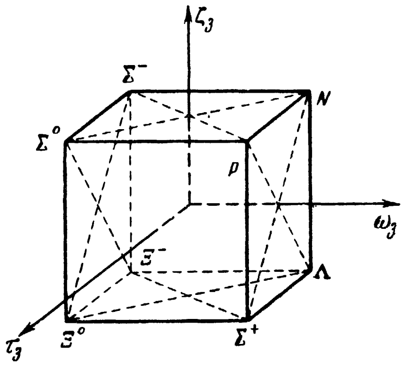
$$\left\{\Gamma^\nu \partial / \partial x_\nu - k_0 I \exp\left[\Gamma^0 \sum_{k=1}^{5} a_k \mathbf{J}^k\right]\right\}\psi = 0, \qquad (1)$$

where $\Gamma^0 = \Gamma^1\Gamma^2\Gamma^3\Gamma^4$, $I = i\Gamma^0\Gamma^6\Gamma^7\Gamma^{10}$, and $\mathbf{a}_k$ are some small isotopic vectors whose components depend on the potentials of the meson and lepton fields.

Equation (1) is solved by perturbation theory, where we express the Hamiltonian of the unperturbed problem as

$$H = \hbar c \left\{\Gamma^4\Gamma^k \partial / \partial x_k - k_0 \Gamma^4 I \exp\left[\Gamma^0 \sum_{k=1}^{5} a_k^3 J_3^k\right]\right\}. \qquad (2)$$

The form of the baryon is characterized here by three quantum numbers τ_3, ω_3, and ζ_3, which appear as eigenvalues of the operators $(i/2)\Gamma^0\Gamma^7\Gamma^8$, $(i/2)\Gamma^0\Gamma^9\Gamma^{10}$, and $(i/2)\Gamma^0\Gamma^5\Gamma^6$ (see references 3 and 4). The baryon scheme can be described by a unit cube whose center lies at the origin of the coordinates τ_3, ω_3, and ζ_3 (see diagram).



From (1) and (2) we can determine the perturbation Hamiltonian which describes the weak interaction transitions between baryons. Every baryon can be displaced along the edges of the cube and along the diagonals marked in the diagram by dotted lines. All the indicated processes are possible in principle, although by the energy conservation law some of these, for example $\Xi^- \to \Sigma^- + \pi^0$, cannot be realized. Other processes, for example, $\Sigma^+ \to \Lambda^0 + \beta^+ + \nu$, are obviously realizable but are seldom found, since competing processes are more probable. The scheme described gives all known baryon transformations and does not give any forbidden transitions. All the weak interaction transitions noted can also proceed from positive energy states to negative energy states and vice versa. This means there can exist processes of the type $N + \overline{P} \to \beta^- + \nu$, whose probability is small compared with that of the strong interaction processes.

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ON THE DECAY SCHEME OF THE Bi^{210} *ISOMER*

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LEVY and Perlman[1] assumed that the α decay of the Bi^{210} isomer with $T_{1/2} = 2.6 \times 10^6$ yr and $E_\alpha = (4935 \pm 20)$ kev goes to the ground state of Tl^{206}. From the energy balance of the α and β transitions $Bi^{210} \to Pb^{206}$ the authors concluded that the long-lived state of Bi^{210} is the ground state and that RaE ($T_{1/2} = 5.01$ days) is metastable with an excitation energy of about 25 kev. We detected[2] the fine structure of the α spectrum of the long-lived bismuth with the most intensive group of α particles with $E_\alpha = (4930 \pm 10)$ kev. These data did not contradict the assumption of Levy and Perlman about the subsequent levels in the Bi^{210} nucleus. In the present paper we give a further study of the radiation from the long-lived bismuth isotope which led to the necessity to change the decay scheme of Bi^{210}.

The measurements were performed by means of a burst ionization chamber with a grid and with a scintillation γ-spectrometer. The resolving power of the chamber was 28 kev for the α line of U^{233} with an energy of 4816 kev. In Tables I and II we give the results of measurements of the energy and of the relative intensities of α particles and γ transitions which accompany the α decay of the long-lived Bi^{210} isomer.

TABLE I. α-particle energies

	Energy, kev	Relative intensity, %
α_0	not detected	<0.03
α_1	5130±15	~0.1
α_2	4930±10	60
α_3	4890±10	34
α_4	4590±10	5±1
α_5	4480±15	~0.5
α_6 (Po^{210})	5300	⩽0.01

TABLE II. γ-transition energies

	Energy, kev	Relative intensity, %
γ_1	260±10	60
γ_2	300±10	30
γ_3	340±10	
γ_4	620±20	

To explain the decay scheme of Bi^{210} we investigated α-γ coincidences. The γ-ray detector was a scintillation counter arranged in a coincidence set-up with the burst ionization chamber.

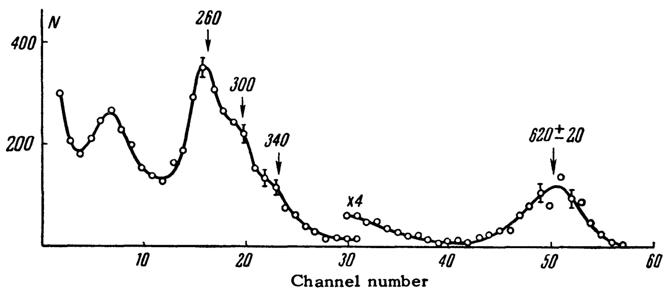

FIG. 2. Coincidences γ spectrum with $E_\alpha = 4590$ kev.

The spectrum of γ lines which were in coincidence with α particles of well-defined energy was measured. The results of the measurement are given in Figs. 1 and 2. We observed coincidences of the most intensive group of α particles with an energy of 4930 kev with γ lines with an energy of 260 kev. These α particles correspond thus to the transition not to the ground state of Tl^{206}, as was assumed earlier, but to an excited one with an energy of 260 kev. Besides, we observed coincidences of γ lines with $E_\gamma = 300$ kev with α particles with an energy of 4890 kev and of γ lines with $E_\gamma = 340$ and 620 kev with α particles with an energy of 4590 kev. The maxima in Fig. 2 corresponding to $E_\gamma = 260$ and 300 kev are caused both by cascade transitions and by coincidences with scattered α particles with $E_\alpha = 4930$ and 4890 kev. A comparison of the γ emission from the bismuth sample studied with a γ-ray reference source shows that the observed number of γ transitions is approximately equal to the total number of α decays.

On the basis of the data obtained we assumed a decay scheme for Bi^{210m} (Fig. 3). The energy of the α decay of RaE to the ground state of Tl^{206} can be evaluated from the energy balance and is

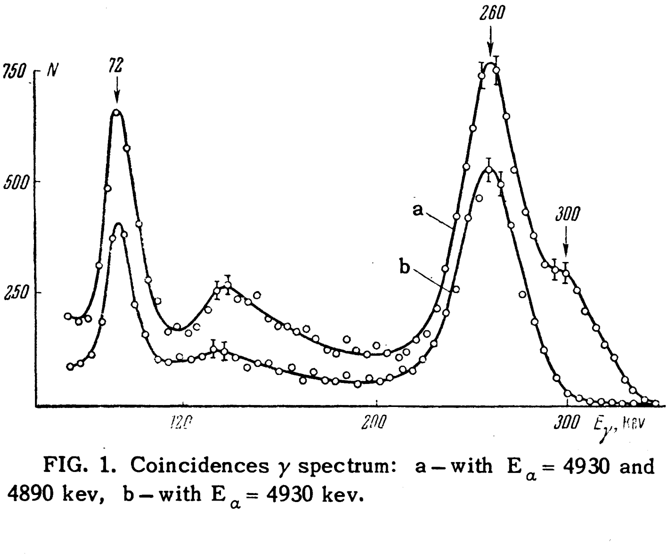

FIG. 1. Coincidences γ spectrum: a – with $E_\alpha = 4930$ and 4890 kev, b – with $E_\alpha = 4930$ kev.

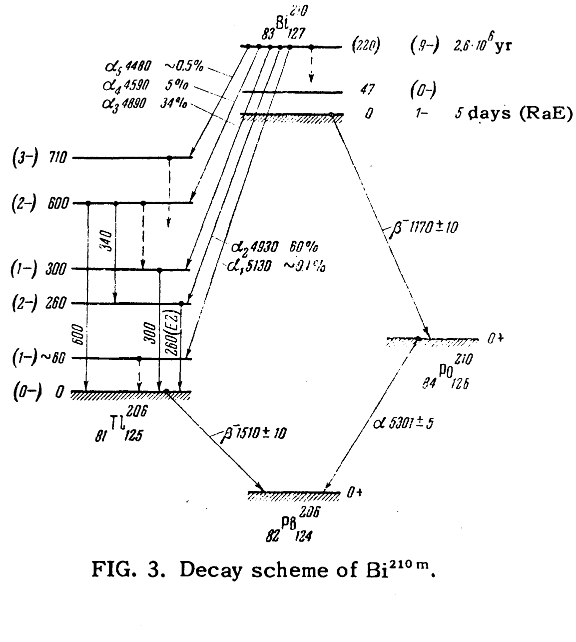

FIG. 3. Decay scheme of Bi^{210m}.

$Q_\alpha = (5064 \pm 15)$ kev, if we take the value $E_{\beta\,max} = (1510 \pm 10)$ kev[3] for Tl^{206}. The total α-decay energy of the long-lived Bi^{210} isomer is $Q_\alpha = (5286 \pm 15)$ kev if we take into account the recoil of the nucleus and the energy of the γ quanta. This value of Q_α is 220 kev larger than the above mentioned energy of the α decay of RaE. One must thus assume that RaE with $T_{1/2} = 5.01$ days is the ground state of Bi^{210} and the state with $T_{1/2} = 2.6 \times 10^6$ yr a metastable one. The partial lifetime of Bi^{210m} relative to an electromagnetic transition T_γ can be estimated from the build up of Po^{210} from the subsequent decay through RaE. It is clear from Table I that the intensity of the α-line of Po^{210} with an energy of 5300 kev is $\leq 0.01\%$, which corresponds to $T_\gamma \geq 10^{10}$ yr.

The energy levels of Bi^{210} were calculated by Yu. I. Kharitonov on the nuclear shell model basis taking pair interaction and the interaction with the nuclear surface into account. It was shown that the lowest levels of Bi^{210} corresponded to the $(h_{9/2})^1_p(g_{9/2})^1_n$ configuration and that one should assign spins and parities 1^- and 0^- to the ground state and first excited state and 9^- to the isomeric state. Similar calculations for Tl^{206} point to a doublet structure of the levels and lead to spin values corresponding to the configurations $(s_{1/2})^{-1}_p(p_{1/2})^{-1}_n$, $(d_{3/2})^{-1}_p(p_{1/2})^{-1}_n$, $(d_{5/2})^{-1}_p(p_{1/2})^{-1}_n$ or $(s_{1/2})^{-1}_p(f_{5/2})^{-1}_n$ (Fig. 3). For the given values of the spins and parities the α decay to the ground state of Tl^{206} must be forbidden, because of parity, which agrees with the experimental data.

In conclusion the authors express their deep gratitude to L. A. Sliv for a discussion of the results obtained, and to E. G. Grachevaya, N. B. Obel'skaya, V. K. Makhnovskaya, and L. Ya. Rudaya for the chemical purification of the specimen from radioactive impurities and for the preparation of the samples.

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*EXPERIMENTAL INVESTIGATION OF THE HARMONIC OSCILLATIONS OF A DISK IN ROTATING HELIUM II**

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THE problem of the oscillations of a system of circular disks suspended from a torsion fiber in helium II, and participating together with the latter in uniform rotational motion, has been investigated by us[1,2] and by Hall.[3,4] It has been shown that the period of oscillation of such a stack of disks depends upon the ratio of the frequencies Ω (the frequency of the oscillations) and ω (the rotational frequency), as well as upon the spacing of the disks and the condition of their surfaces. These investigations, however, failed completely to take into account the possibility of changes in the damping processes in rotating helium II.

With the object of studying this aspect of the problem, we constructed an apparatus in which a transparent beaker of organic glass 44 mm in diameter filled with liquid helium performed uniform rotational motion at angular velocities of from $\omega = 13 \times 10^{-3}$ sec^{-1} to $\omega = 129 \times 10^{-3}$ sec^{-1}. A single circular disk 1 mm thick and 30 mm in diameter, suspended within the beaker of helium, took part simultaneously in two types of motion: rotation, with the same velocity as the beaker; and harmonic oscillation about an axis perpendicular to its own plane and parallel to that of the beaker. The surface of the disk was alternatively covered with granules with linear dimensions $l \approx 50\,\mu$, or polished. The frequency of the oscillations of the disk was 0.581 sec^{-1} in the case of the rough surface and 0.551 sec^{-1} for the smooth surface case.

The logarithmic damping decrement δ of the oscillations of the disk was determined by noting the time required for a light spot associated with it to traverse a fixed path between two photomultipliers rotating, together with a scale, in synchronism with the beaker. A detailed description of this apparatus, as well as of the theory of the method, has been given in reference 5. Calibration of the system was carried out using classical liquids (water, helium I), for the viscosity coefficients of which good agreement was obtained with tabulated data. In both cases the damping remained