Eu^{154} nucleus ($I = 3$, $\mu = 2.0$ nuclear magnetons), which is known to be ellipsoidal.[5,11] The spin of the Eu^{152} isomer, namely 1—, is in agreement with the hypothesis that the nucleus is spherical.

Thus Eu^{152} is a rare (if not the only) example of a nucleus located intermediately between states with known spherical and ellipsoidal equilibrium shapes, and must thus have several unique properties (other than those considered above). Therefore further experimental study of this nucleus and the establishment of its complete decay scheme is very important for the development of concepts on its structure.

I offer my deep gratitude to L. A. Sliv for detailed discussion of the work.

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SMALL-ANGLE SCATTERING OF FAST NEUTRONS BY HEAVY NUCLEI

IU. A. ALEKSANDROV

Atomic Energy Institute

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We have studied the angular distribution of fast neutrons elastically scattered from Pu, U, Pb, Bi, Sn, and Cu nuclei in the interval of angles* from 4 to 25°. This work may be considered an attempt at the experimental investigation of the possible "polarizability" of the neutron in the strong Coulomb field of the nucleus, which is of interest from the point of view of studying the internal structure of the neutron. As has previously been noted,[1,2] the "polarizability" of the neutron would be observed in the anomalous behavior of the differential elastic scattering cross section at small angles.

A fast neutron beam is extracted from the reactor with the aid of a collimator previously described.[1] The detector was a cylindrical chamber filled with He^4 to a pressure of 15 atmos. In order to improve the characteristics of the chamber, as well as to determine the energy scale, 5% of N_2 was added to the

*The angular distribution of fast neutrons in the interval of angles from 0.7 to 5° will be published later.

chamber. The chamber diameter was 4 cm, and the operating length was approximately 45 cm. The counting efficiency was several percent for neutrons of energy on the order of 1.3 Mev.

The operation of the chamber was tested by the N^{14} (n, p) C^{14} reaction with thermal neutrons, which gives 600 kev protons. The differential pulse amplitude distribution is shown in Fig. 1.

In measuring the angular distribution, the analyzer separated the band from 680 to 890 kev. The energy spectrum of neutrons counted by the chamber was found by calculation, and is shown in Fig. 2. The spectrum was calculated using the data of Adair[3] and Seagrave.[4]

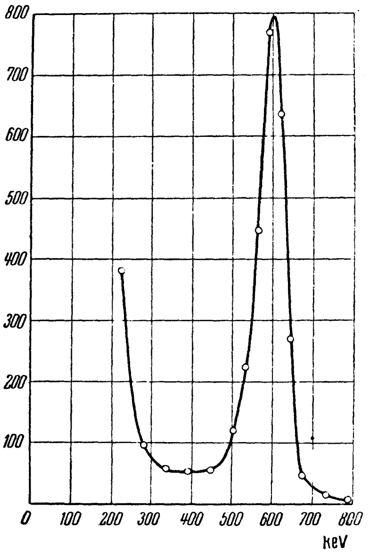

FIG. 1

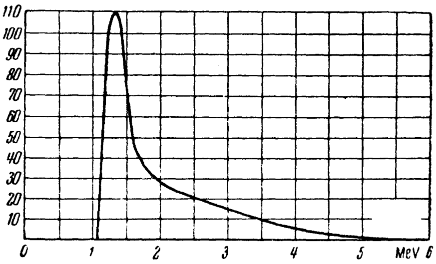

FIG. 2

The scatterers were 1 cm thick plates of the substance being investigated. The absolute magnitudes of the cross sections were found by comparison with the paraffin cross section, as well as by the method previously described.[1] The mean effective energy, as found from the paraffin cross section, was about 2 Mev.

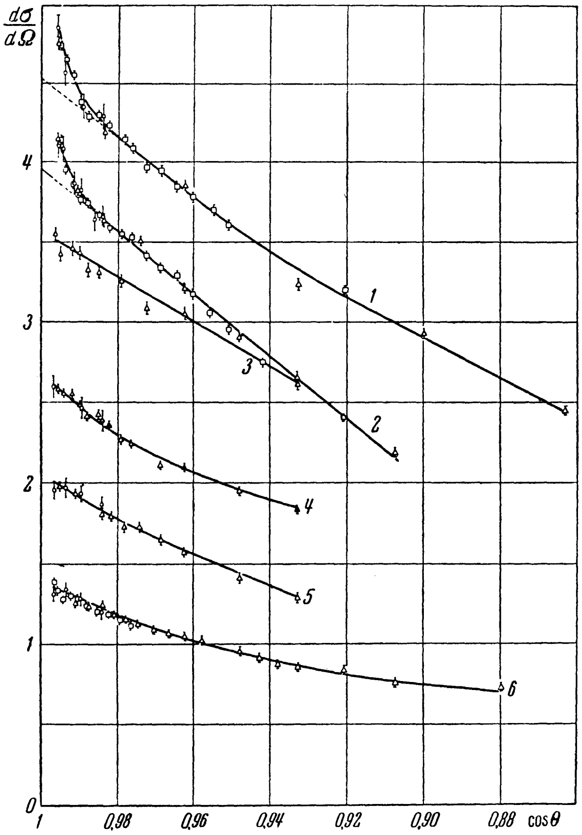

FIG. 3. Experimental results. All experimental points are corrected for the Schwinger scattering cross section. Curves 1, 2, 3, 4, 5, and 6 refer to Pu, U, Sn, Pb, Bi, and Cu, respectively. The vertical scales for curves 4 and 5 are decreased by factors of 1.5 and 2.

The experimental results are shown in Fig. 3. The ordinate gives $d\sigma/d\Omega$ in barn/sterad. The points indicated by circles were obtained from the angular distribution in the vicinity of 0.5°. To obtain these points, an additional paraffin collimator with an opening 0.5 cm by 2 cm was placed between the chamber and the scatterer. The length of this collimator was 1.5 m. The other points were obtained without this additional collimator. The angular resolution was then about 2.5°.

In obtaining the experimental points of Fig. 3, we have subtracted the quantity $\gamma^2 \cot^2(\theta/2)$, which is the Schwinger scattering cross section [Eq. (10) of Ref. 5]. Nevertheless, Pu (with Z = 94) and U (with Z = 92) have sharp rises in the cross section for angles less than 11° (or for cos $\theta > 0.982$). In the other elements, the increase of the cross section is within the limits of experimental error.

The increase of the cross section mentioned above may be due to the "polarizability" of the neutron. Calculations performed on the assumption that the nucleus can be approximated as a solid sphere for the scattering problem give a coefficient of polarizability $\alpha = (8.0 \pm 3.5) \times 10^{-41}$ cm^3. In this calculation the amplitude of pure nuclear scattering was found by extrapolating the curves from the high-angle regions (dotted curves of Fig. 3). It is also possible that the increase in the cross section at angles less than 11° for Pu and U is due to some other reasons. In any case, no final conclusion as to the "polarizability" of the neutron can be made until a careful theoretical analysis has been performed on the experimental data. It is also desirable to perform investigations with monoenergetic neutrons.

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DECAY PROBABILITIES OF THE Σ-HYPERON WITH PARITY NONCONSERVATION

I. IU. KOBZAREV and L. B. OKUN'

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SEVERAL works[1-3] have investigated the relation between the Σ-hyperons

$$\Sigma^+ \rightarrow p + \pi^0 \; (w^0), \quad \Sigma^+ \rightarrow n + \pi^+ \; (w^+), \quad \Sigma^- \rightarrow n + \pi^- \; (w^-)$$

and it was shown that the quantities

$$X = w^0 / w^+ \text{ and } Y = w^- / (w^+ + w^0) = \tau^+ / \tau^-$$

(where $\tau^{\pm}$ is the lifetime of the $\Sigma^{\pm}$-hyperon) should lie on a curve depending on the spin and parity of the Σ-hyperon. This conclusion is based on the assumptions that in the decay of the Σ-hyperon (1) the selection rule $\Delta T = 1/2$ (where T is the isotopic spin) is valid, (2) invariance under time inversion is maintained, and (3) parity is conserved.

It has been shown[1] that data of the Sixth Rochester Conference (X = 1, Y lies between 0.1 and 0.2) are in agreement with the theoretical curves. Later, however, Alvarez and co-workers obtained $w^0/w^+ = 1.0 \pm 0.2$, $\tau^- = (1.86 \pm 0.26) \times 10^{-10}$ sec, $\tau^+ = (0.86 \pm 0.17) \times 10^{-10}$ sec, and $\tau^-/\tau^+ = 2.2 \pm 0.5$. The corresponding X, Y point ($X = 1 \pm 0.2$, $Y = 0.45 \pm 0.10$) does not lie on the theoretical curves, whence Alvarez[4] concludes that assumption (1) is not valid.

We should like to indicate that this conclusion is not inevitable if assumption (3) is dropped. Parity nonconservation in the case of hyperon decay follows from parity nonconservation in $K_{\pi 2}$ and $K_{\pi 3}$ decays, since the hyperon decay can always go through a virtual decay chain with $K \rightarrow \pi$ decays.

We shall assume as before that assumption (2) is valid in the sense of Wigner,[5] i.e., with respect to the combined inversion CI.[6] This assumption, from which one can derive the fact that the S matrix is symmetric, makes it possible[1] to express the phases of the matrix elements for decay in terms of the scattering phases in the final state,

$$a_+ = i\,{}^1\!/_3 \, (\rho_3 e^{i\alpha_3} + \sigma_3 e^{i\alpha_3'}) + i\,{}^2\!/_3 \, (\rho_1 e^{i\alpha_1} + \sigma_1 e^{i\alpha_1'}), \quad a_0 = i\,(\sqrt{2}\,/\,3\,(\rho_3 e^{i\alpha_3} + \sigma_3 e^{i\alpha_3'}) - i\,(\sqrt{2}/3)\,(\rho_1 e^{i\alpha_1} + \sigma_1 e^{i\alpha_1'}),$$

$$a_- = i\,(\rho_3 e^{i\alpha_3} + \sigma_3 e^{i\alpha_3'})$$

(ρ_3 and ρ_1 here correspond to $\sqrt{3}\rho_3$ and $\sqrt{3/2}\rho_1$ of the previous work referred to[1]). Here the parameters ρ and σ are real, and α and α' are the phases of π-meson—nucleon scattering. For a Σ-hyperon spin of 1/2, the values of (ρ, α) and (σ, α') correspond to transitions in the π-meson—nucleon system to the $S_{1/2}$ and $P_{1/2}$ states, and for Σ spin of 3/2, they correspond to the $P_{3/2}$ and $D_{3/2}$ states, respectively. The indices 3 and 1 refer to isotopic spin states with $T = 3/2$ and $T = 1/2$. The scattering phases α and α' are known and such that $\alpha' \approx 0$.