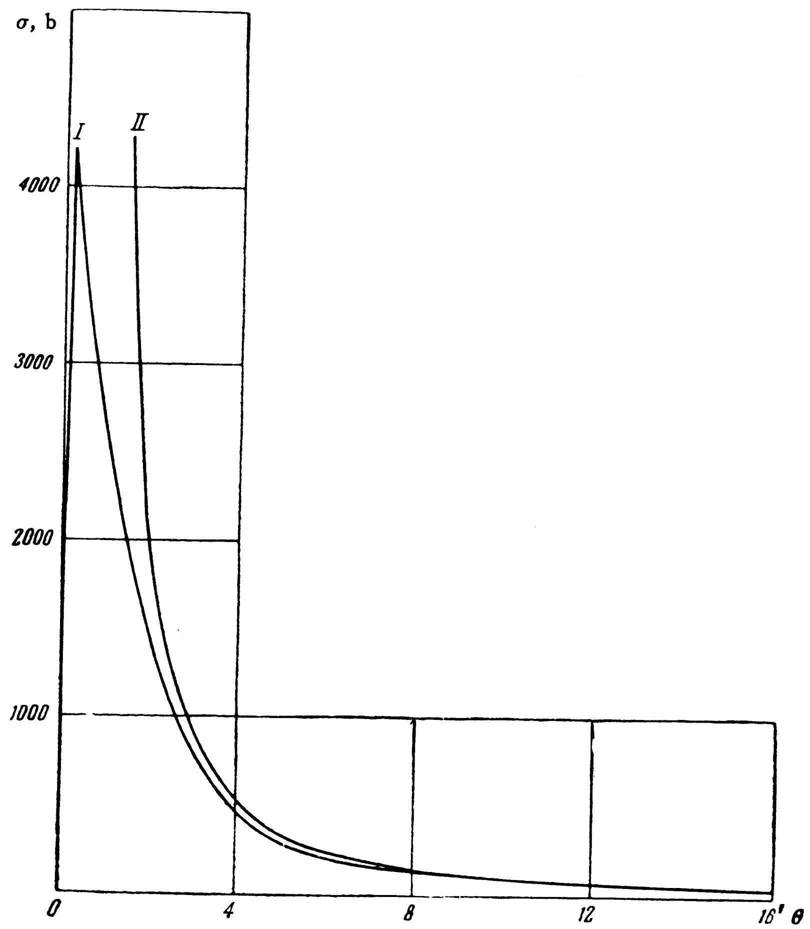

Curve I: cross section of Schwinger scattering with screening; curve II: the same cross section without screening.

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INVESTIGATION OF BETA RADIATION OF Nb^{95} *AND* Ce^{144} *BY THE METHOD OF ABSORPTION IN AIR*

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1. Beta radiation of Nb^{95}. A spectroscopic investigation of this radiation has been the subject of many papers. The values of the β radiation energy of Nb^{95}, obtained by different authors, range over sufficiently wide limits, 0.140 – 0.171 Mev, i.e., the outermost values differ by 20%.[1-4] These investigations were performed with spectrometers of different constructions.

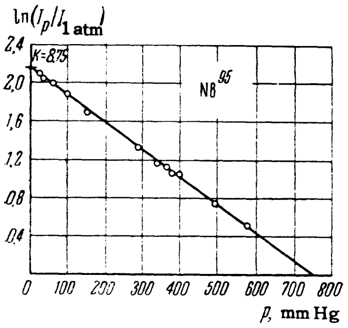

FIG. 1

We have investigated the β radiation of Nb^{95} by the previously described method of absorption in air.[5] The absorption curve of β radiation from Nb^{95} in air (Fig. 1) was obtained by varying the air pressure p between the BFL T-25 counter and a compound located 8 cm from the counter window. Using the empirical relation for $K(E_0)$, where $K = I(p = 0)/I(p = 1 \text{ atmos})$ (Fig. 2), we have determined from the value of $K_{Nb^{95}} = 8.75$ (Fig. 1) the energy of β radiation from Nb^{95}, found to be $E_0 = (0.166 \pm 0.004)$ Mev. The error $\Delta E_0 = 0.004$ Mev was determined from the statistical measurement error, $\delta = 2\%$.

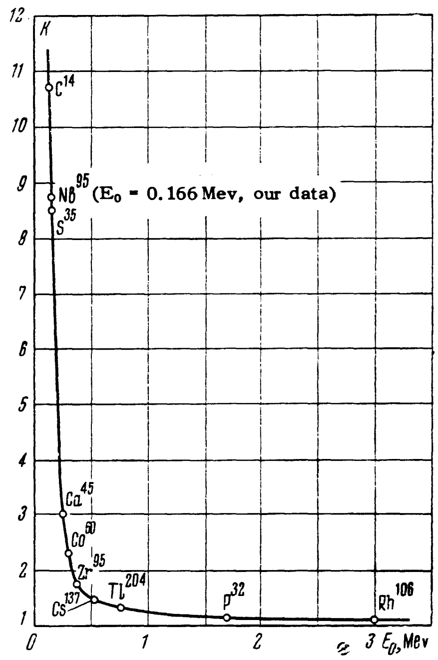

FIG. 2

In determining the empirical relation for $K(E_0)$ at small energies, we used isotopes with simple β spectra, such as C^{14} ($E_0 = 0.155$ Mev) and S^{35} ($E_0 = 0.167$ Mev). The results of the measurements of these β emitters, obtained by different authors, agree well with each other.[6]

2. Beta radiation from Ce^{144}. One of the most interesting objects for spectroscopic investigation is Ce^{144}. For a long time this substance was associated with a β radiation of energy on the order of 0.3 Mev.[7] An investigation in regions of small energies with the aid of the Fermi-Curie graph is difficult in this case, owing to the presence of a large number of conversion electron peaks in the soft part of the spectrum. Porter and Cook[8] were first to propose the existence of a softer component in Ce^{144}, with an energy $E_0 = 0.170$ Mev, at a content of approximately 30%. This assumption was based on the investigation of conversion lines of γ rays from Pr^{144}. These data were later confirmed by other authors.[9,10]

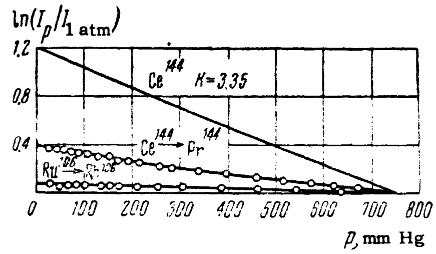

FIG. 3

We have investigated the β radiation of Ce^{144} by the method of absorption in air. Figure 3 shows an absorption curve in air of the summary β radiation of Ce^{144} and Pr^{144}. By means of absorption in an aluminum foil we have eliminated from the total curve the β radiation of Pr^{144} ($E_0 = 3$ Mev). With this, we extrapolated the curve of absorption in aluminum for Pr^{144} to zero thickness of absorber in accordance with the variation of the absorption curve* for $Ru^{106} - Rh^{106}$.

The elimination of Pr^{144} from the total curve of absorption in air at less than atmospheric pressure was also carried out in accordance with the course of the absorption curve in air for $Ru^{106} - Rh^{106}$. As a result we obtain for Ce^{144} the absorption curve in air shown in Fig. 3.

As can be seen from Fig. 2, the value of the air coefficient of Ce^{144}, equal to 3.35, differs greatly from the assumption that only a single β-radiation component with energy ~ 0.3 Mev exists in Ce^{144}, as stated by several authors.[7] The 0.3-Mev β radiation corresponds to a considerably lower value of air coefficient, namely 2.30. Therefore, in addition to the 0.3-Mev component, one must assume that Ce^{144} has at least one other softer component. Investigating the graph of the variation of $K(E_0)$, and also the formulas derived earlier,[5] we obtained a β-radiation component with energy $E_0 = (0.168^{+0.032}_{-0.020})$ Mev, with a content of (40 ± 12)%. These data agree with the results obtained by Porter and Cook, and also by other authors.[8-10]

*The β radiation of Ru^{106} is completely absorbed by the counter window and by the air, and the character of the absorption of β radiation from Pr^{144} and Rh^{106} in aluminum is approximately the same.

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THE REACTION $p + d \rightarrow t + \pi^+$ AT PROTON ENERGY 670 Mev

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A comparison of the cross sections for the reactions

$$p + d \rightarrow t + \pi^+, \quad (1)$$

$$p + d \rightarrow He^3 + \pi^0 \quad (2)$$

allows us to test the principle of the charge independence of nuclear forces, since, for isotopic spin conservation, the angular distributions for the two processes should be the same, and the ratio of their total or differential cross sections in the center-of-mass system should be 2 : 1.[1,2] A study of these two processes is interesting in itself, since they are connected with analogous processes of meson production in the reactions

$$p + p \rightarrow d + \pi^+, \quad (3)$$

$$p + n \rightarrow d + \pi^0 \quad (4)$$

and they admit of a simple theoretical interpretation.[1,3]

A measurement of the cross sections for reactions (1) and (2) was carried out earlier at energies of 340 Mev,[4] 450 Mev,[5] and 600 Mev.[6] In the present work, measurements were carried out to clarify the conditions for comparing processes (1) and (2) for the incident proton energy $E_p = 670$ Mev.

The examination of the reaction $p + d \rightarrow t + \pi^+$ was carried out on a proton beam with an intensity 10^{11} protons/sec. The secondary charged particles formed in the heavy polyethylene or carbon target were identified by momentum, specific ionization, and range. The selection by specific ionization was made simultaneously by five scintillation counters in a telescope,[7] so that rare emissions of particles with high ionization could be detected against a background of irrelevant particles with smaller ionization. The emission of low-energy tritium nuclei in reaction (1) was measured for angles 5.4° and 11° in the laboratory system. The calibration of absolute cross sections was carried out with the aid of a measurement of the path of the deuterons in reaction (3), since the angular distribution there was well known for an energy of 660 Mev.[8] The differential cross sections for reaction (1), calculated in the center-of-mass system and relative to the pion emission angle, are equal to

$$d\sigma(12°)/d\Omega = (9.3 \pm 1.5) \cdot 10^{-30} \text{ cm}^2/\text{sr},$$

$$d\sigma(25°)/d\Omega = (3.1 \pm 0.5) \cdot 10^{-30} \text{ cm}^2/\text{sr}.$$

These results are shown in the figure, together with the data obtained at different proton energies. As the energy of the incident protons is increased, a change is observed in the differential cross section of reaction (1), which tends to peak more in the forward, meson-emission direction. This kind of change in the differential cross section can be got qualitatively from the relation between the π^+ formation processes in reaction (1) and in reaction (3). This relation was obtained by interpreting process (1) on the basis of a hard-core nucleon model and by application of the impulse approximation.[3]