10^7 ($\lambda = 2\pi c/\omega \sim 180$ m), $\xi \sim 1$ for a field $E_0 \sim 1/300$ v/m.

It is important to note that the usual effect (1) is a quadratic effect and leads to the appearance of combination frequencies $\omega' \pm 2\omega$ (ω' is the frequency of the field of a weak radiowave which propagates in a medium which is perturbed by a strong wave at frequency ω). On the other hand, the effects in (2) and (3) are linear* with respect to field 1 and the combination frequencies are $\omega' \pm \omega$.

It should be noted that effects (2) and (3) are, by their nature, the same as occur in the scattering of transverse (radio) waves on plasma waves in an isotropic medium (cf. references 4 and 5).†

The concrete role played by the effect described in (2) and (3) on the propagation of radio waves in the ionosphere of the earth and the solar corona require special investigation.

*Obviously we are considering here the nonlinear dependence of the tensor ε'_{ik} on the field. In this case the field equations are clearly nonlinear.

†We note that the existence, of plasma oscillations excited by various perturbations in the ionosphere can be verified experimentally by observing on earth radio waves in which combination frequencies are produced as a result of scattering in the ionosphere.

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ELECTRON-POSITRON PAIRS FROM THE DECAY $\pi^0 \rightarrow e^- + e^+ + \gamma$

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FOURTEEN events of charge-exchange scattering of π^- mesons on hydrogen with the subsequent decay of the π^0 meson into a photon and a Dalitz electron-positron pair[2] were observed in a diffusion chamber filled with hydrogen at 25 atmos and placed in the 150 Mev π^--meson beam of the synchrocyclotron of the Joint Institute for Nuclear Research.[1] The sensitive volume of the chamber measured 380 mm in diameter. A constant magnetic field of 9000 Oe intensity was used. The 14 events mentioned were found in the scanning of 45,000 stereophotographs and were identified by π^--meson track endings in hydrogen accompanied by electron-positron pairs. Photographs of two such events are shown in Fig. 1. It is estimated that other processes giving rise to similar pairs (internal conversion of photons in the reaction $\pi + p \rightarrow n + \gamma$, pair creation by a photon near the decay point of $\pi^0 \rightarrow 2\gamma$, etc) are negligible under our experimental conditions.

The number of conventional π^0-meson decays (into two photons) must be known in order to determine the relative probability for the decay process $\pi^0 \rightarrow e^- + e^+ + \gamma$. Direct counting of the number of charge exchange events is extremely difficult in a diffusion chamber, owing to the existence of local insensitive regions and to edge effects. However the number of π^0 mesons can be determined from data on the cross sections for charge-exchange and elastic π^--p scattering,[3] whose ratio is 1.8 at energies ~150 Mev. Since we observed 600 events of elastic π^--p scattering it follows that the number of π^0 mesons was 1080. Consequently the ratio of the probabilities for the

Pair No.	E^- (Mev)	E^+ (Mev)	$E=E^-+E^+$ (Mev)	α° (lab. frame)	θ° (lab. frame)
1	—	—	—	2.5	118
2	>134	70	>204	16	50
3	19	41	60	36	95
4	106	>24	>130	7	91
5	20	111	131	8	145
6	27	6	33	22	117
7	89	67	156	6	50
8	>14	>96	>110	>5	100
9	—	—	—	2	110
10	>58	103	>161	53	140
11	36	>134	>170	3	99
12	10	24	34	38	86
13	166	20	186	28	65
14	22	27	49	46	118.5

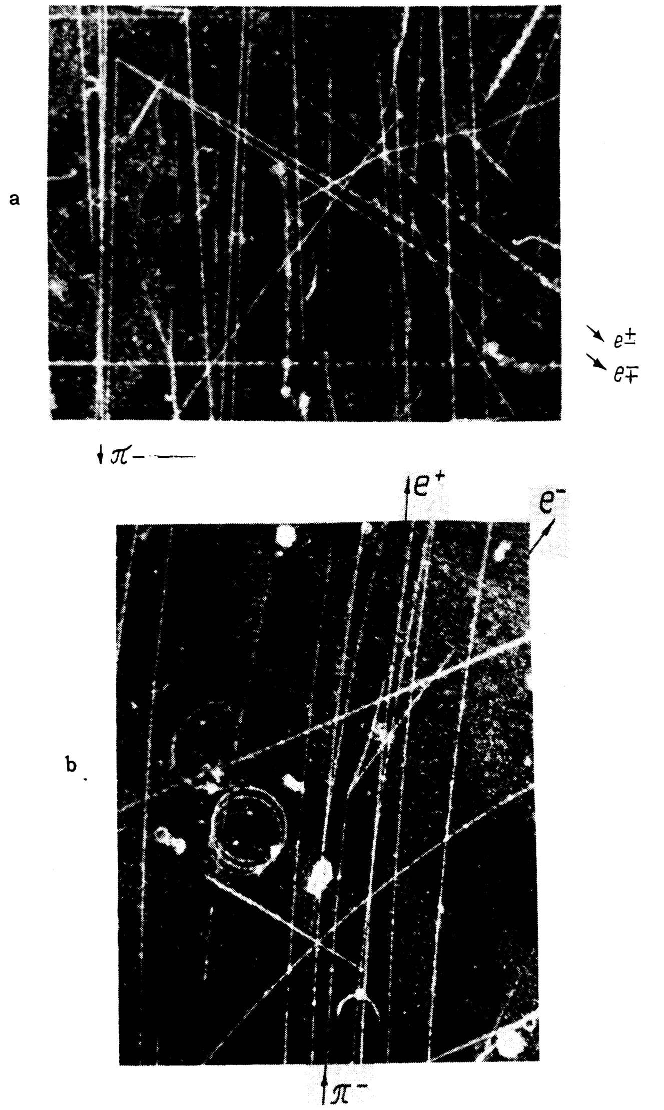

FIG. 1. Photographs of $\pi^- + p \to \pi^0 + n$ followed by the decay $\pi^0 \to e^- + e^+ + \gamma$, as seen in the diffusion chamber: a) pair No. 1, b) pair No. 2.

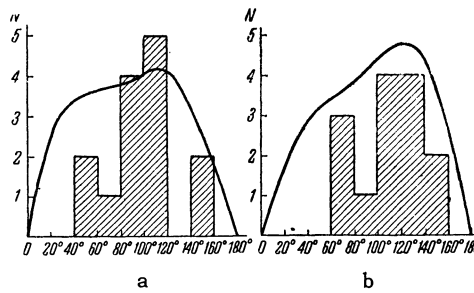

FIG. 2. a) θ(lab. frame), b) $\theta(\pi^- - p$ c.m. frame).

decays $\pi^0 \to e^- + e^+ + \gamma$ and $\pi^0 \to 2\gamma$ is $2\rho_0 = 0.0130 \pm 0.0024$ and the coefficient of internal conversion for this reaction is $\rho_0 = 0.0065 \pm 0.0012$, the indicated error being the probable statistical error. This value for ρ_0 is in good agreement with theoretical calculations[2,4] as well as with experimental data.[5-8*]

The results of the analysis of the electron-positron pairs are given in the table. The electron energy E^- and the positron energy E^+ were determined to an accuracy of 10 to 15% or better from the radii of curvature of the tracks. Only lower limits for these energies are given in the case of very short tracks. The No. 1 and No. 9 pairs were found in film exposed without a magnetic field. A comparison of E^- and E^+ fails to show any tendency for the energy to be divided equally between the members of a pair, which tendency appeared in the experiments of Sargent et al[8] and also especially in those of Anand.[6] The total energy $E = E^- + E^+$ lies in the interval 17 to 270 Mev for all pairs, corresponding to the energy spectrum of γ rays from the decay of π^0 mesons obtained as a product of the charge-exchange process.

The last columns of the table give the correlation angle α (laboratory frame) between the electron and the positron of a pair, and the angle θ (laboratory frame) between the direction of motion of the center-of-mass of the pair and incident π^- meson. The accuracy of measurement of the angles α is $\pm 1°$ or better, of the angles $\theta - \pm 2°$ or better. The overall form of the angular distribution of the pairs in the angle α is in agreement with the dependence $P(\alpha)d\alpha \approx \text{const}\, d\alpha/\alpha$ obtained by Dalitz.[2] The angular distribution of the pairs relative to the direction of the incident π^- mesons is characterized by a preferential emission of pairs into the back hemisphere, analogous to the distribution found by Schein et al.[10] In view of the fact that the electrons and positrons from the decay $\pi^0 \to e^- + e^+ + \gamma$ are well correlated, the angular distribution of the pairs should coincide to a high degree of accuracy with the angular distribution of photons from the $\pi^0 \to 2\gamma$ decay. Figure 2 is a histogram of the angular distribution of pairs relative to the direction of the π^- meson obtained in our experiment: a — in the laboratory frame, and b — in the π^--p center-of-mass frame. There is no contradiction with the solid curves which represent, on an arbitrary scale, the angular distribution $(d\sigma/d\Omega)\sin\theta$ of photons from the decay of π^0 mesons obtained from the reaction $\pi^- + p \to \pi^0 + n$ with 150-Mev π^- mesons.[11]

In conclusion we note that in none of the seven pairs whose total energy was measured accurately do the kinematics satisfy the requirements for the $\pi^0 \to e^- + e^+$ decay; nor have we found any cases of $\pi^0 \to e^- + e^+ + e^- + e^+$ in the scanned photographs.

We are continuing this work and the final results and analysis will be reported later.

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*The internal conversion coefficients of reference 8 were obtained by using the value P = 0.94 ± 0.20 for the Panofsky ratio. If one accepts the value[9] P = 1.15 – 1.9 then the internal conversion coefficients derived from the data of reference 8 are in disagreement with other experiments and with theory.

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*MEASUREMENT OF THE POLARIZATION OF INTERNAL CONVERSION ELECTRONS**

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As a consequence of parity nonconservation in β decay, the daughter nucleus is polarized along the direction of emission of the β electron. Consequently, the conversion electrons resulting from the internal conversion process following β decay will have definite polarization related to the direction of emission of the β electron.

Formulas for this polarization were obtained by Berestetskii and Rudik[2] and by Geshkenbein.[3] It follows from these formulas that the polarization of conversion electrons depends on the same combination of coupling constants and matrix elements as the angular distribution of electrons from β decay of oriented nuclei.

We report here on the results of measurement of the polarization of internal conversion electrons following the β decay of Hg^{203} $\left(? \xrightarrow{\beta} 3/2 + \xrightarrow{e_K} 1/2 +\right)$. The β electrons were registered by counters 1 and 2. The conversion electrons, emitted at an angle of 90° with respect to the β electrons, were registered by counters 3 and 4 after passing through a system of magnetic lenses and undergoing scattering through an angle of 125° from a scatterer. The axis of counters 3 and 4 was at an angle of $\pi/2$ with respect to the axis of counters 1 and 2. Amplitude discrimination and the tuning of the spectrometer to the energy of the conversion electrons were used to distinguish the conversion electrons from the β electrons. Counters 3 and 4 were wired in coincidence with counters 1 and 2. The setup was such that β-e_K coincidences were registered separately in counters 1 and 3, 1 and 4, 2 and 3, and 2 and 4.

If the conversion electrons are transversely polarized parallel (or antiparallel) to the direction of emission of the β electrons, then one should observe, in the single scattering by a heavy element thin scatterer, azimuthal asymmetry in the direction of counters 3 and 4, which, in the absence of asymmetries in the apparatus, equals $N_{13}/N_{14} = N_{24}/N_{23} = \alpha < 1$ (or > 1). Here N_{ik} stands for the number of coincidences in counters i and k after subtraction of the background due to accidental coincidences.

The azimuthal asymmetry of the conversion electrons scattered by gold (0.4 mg/cm^2) was found to be

$$\alpha_{Au} = \sqrt{\frac{N_{13}}{N_{14}}\frac{N_{24}}{N_{23}}} = 1.11 \pm 0.04.$$

The asymmetry inherent in the apparatus was found by using aluminum as a scatterer, which should yield practically no azimuthal asymmetry due to the electron polarization: $\alpha_{Al} = 0.97 \pm 0.03$. Thus, correcting for apparatus asymmetry, we find

$$\alpha = \alpha_{Au} / \alpha_{Al} = 1.15 \pm 0.05.$$