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Among the 140 decays of long-lived K_2^0-meson in the cloud chamber a four-pronged event has been observed, which is most likely to be the decay $K_2^0 \to \pi^+ + \pi^- + \pi^0$ followed by the decay of a neutral pion via the Dalitz pair.

During the exposure of a cloud chamber* to the beam of neutral particles from the JINR synchrophasotron, 140 V^0 - events have been recorded at a distance of 8 m from the internal target**. Among them there was a four-prong star, the photograph of which is given in the Figure. Tracks A,B, and D have the upward direction with respect to the plane of the picture, whereas track C- the downward direction. For tracks A,B. and D, the radii of the magnetic curvature have been measured; for short track C we succeeded in determining only the sign of the magnetic curvature. The results of the measurements are listed in the Table.

Track	Momentum (in MeV/c)	Sign of charge	Angle of emission	Dip angle (in degrees)	Angle between tracks (in degrees)
A	89 ± 5	+	$43,5 \pm 1,5$	$13,5 \pm 0,5$	3 ± 1
B	$31,5 \pm 2$	–	$43,0 \pm 1,5$	$11,0 \pm 0,5$	
C	?	–	33 ± 5	33 ± 5	66 ± 1
D	160 ± 16	+	$32,0 \pm 1,5$	$16,5 \pm 0,5$	

All the tracks, including those of positive particles A and D have the ionization close to the minimum one.

It follows from the data of measurements that positive particles cannot be protons, while tracks A and B are most likely to be an electron-positron pair. Therefore, it is quite reasonable to treat the star observed as a result of the decay of a neutral unstable particle.

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* The cloud chamber used in the experiment is described in detail in /1/.

** The angle between the direction of the neutral particles beam and that of the protons incident on the target is 97°.

Indeed, when considering possible reactions of the interactions of the neutrons (available in the beam) with the chamber gas nuclei, a similar event may appear only as a result of the simultaneous production of two neutral pions or two charged pions and a neutral one, provided star protons are absent. In both above-mentioned events we can observe a four-prong star, if each π^0-meson decays into a γ- quantum and the Dalitz pair. Under our conditions however, this possibility seems extremely unlikely since the neutrons have small energies. This is proved by the following experimental facts. First, the mean energy of protons knocked out by neutrons from the chamber wall is 75 MeV. Besides, among the 10000 investigated recoil protons not a single one has been found with an energy of more than 400 MeV. Secondly, among the 15000 stars recorded in the gas of the chamber there were found only 15 in which a π^--meson is produced and not a single reliable event of pair π- meson production (of course, there is no question of triple production). The probability of observing a four-prong star due to the simultaneous production of two or three π-mesons was estimated to be $\sim 10^{-7}$ for these possibilities. The estimation was made on the basis of the given experimental data and the data of papers/2,3,4/ in which the process of meson production in nucleon-nucleon interaction has been investigated). The probability of accidental superposition of two V^0- events which could simulate a four-pronged event is also small.

The decay of a neutral pion into two electron-positron pairs is the only type of decay with four charged secondaries known up to now. In our case this extremely rare decay mode is practically excluded if one takes into account the magnitude of the probability of its observation and the kinematic relations. In particular, the angle between tracks C and D is large (66^o); besides, there is no correlation between this angle and the energy of γ-quanta. It would be most reasonable to identify the above event as one of the so far unobserved decays of the long-lived K^0-mesons. There are two possible modes of decay allowed from the standpoint of the CP-invariance.

$$K_2^0 \rightarrow \pi^+ + \pi^- + \gamma \rightarrow e^+ + e^- \quad (1)$$

$$K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0 \begin{array}{l} \nearrow e^+ + e^- \\ \searrow \gamma \end{array} \quad (2)$$

According to a theoretical estimate made by Dalitz/5/, the probability of the decay mode (1) is only 4% of the probability of the decay mode (2). Therefore, the four-prong event we observed is most likely to be treated as the decay of K_2^0 mesons into three π mesons with a subsequent decay of a π^0 meson via one Dalitz pair.

For the decay scheme (1), it is possible to determine the mass of the decaying particle, it was found to be 400 ± 40 MeV. For the event having a more probable decay scheme (2), we have found the magnitude of its kinetic energy which amounts to 80 MeV if the mass of K_2^0 - particle is assumed to be 496 MeV.

It should be noted that among the decays of long-lived K^0-mesons recorded earlier there are three events[6-8] which are in agreement with the assumption that the unobserved neutral secondary is a π^0 meson. The observation of the four-prong decay of a K_2^0 meson is a direct proof of the validity of this assumption and, hence, an evidence on the existence of the decay of the long-lived K^0-meson by the scheme (2). Some years ago an analogous four-prong event has been observed in cosmic rays[7]*. The authors treated it as a decay of a τ^0 meson with the lifetime 3.10^{-10}sec. Besides, they recorded 43 decays of the short-lived K^0 mesons. The above facts, however, are difficult to be brought into agreement with the recent theoretical and experimental data which point out that the decay of the shortlived K^0 meson into three π mesons is strongly forbidden. At the same time the probability of observing a similar decay of the long-lived K^0 meson under the conditions of their experiment is small ($\sim 10^{-3}$). In our case we are concerned with the decay of the long-lived K^0 meson since the internal target which is the source of neutral particles is placed at a distance of 8 metres from the cloud chamber. Even if an unlikely assumption is made that the production of the decaying particle took place in the wall of the chamber, then its lifetime exceeds the mean lifetime of a K_1^0 meson by an order . As for the expected probability of observing the decay of a K_2^0 meson by mode (2), it is 0.1–0.2 under the conditions of our experiment, (according to the available experimental data). We have observed also 2 electron-positron pairs whose direction of emission makes a large angle ($\sim 90^o$) with the collimator axis, so that they cannot be due to γ- quanta being in the incident beam. There are grounds to consider these electron-positron pairs to be Dalitz pairs created as a result of the decay $K_2^0 \to 3\pi^0$, the probability of which is likely to be not very different from that of the decay $K_2^0 \to \pi^+ + \pi^- + \pi^0$. **

To make final conclusions, however, a further increase of statistics and a more careful study of background conditions is necessary.

In conclusion the authors express their gratitute to the operating staff of the Synchrophasotron Division for providing the performance of the experiment, to B.M. Pontecorvo for his constant interest and attention to this work to M.A. Markov and M.I. Podgoretsky for the discussion and critical remarks. The authors are also grateful to D Neagu for assistance in the calculations and to M.H. Anikina and P.I. Zhabin for making the measurements.

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* For this four-prong event the signs of the charges of the two decaying particles have not been determined.

** If one assumes that the symmetric T = 1 state is dominant (as for $K^+_{3\pi}$ -decay) then in this case the selection rule $|\Delta T| = 1/2$ which is in good agreement with experiment, leads to the relation

$$\frac{W(K_2^0 \to 3\pi^0)}{W\, K_2^0 \to \pi^+ + \pi^- + \pi^0} = 3/2$$

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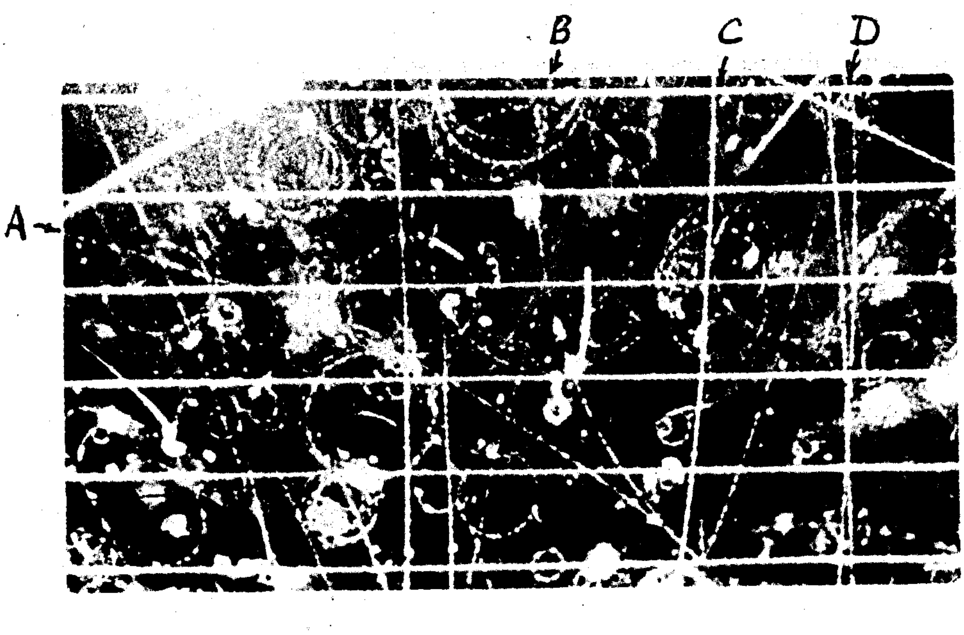

Fig. 1.