DECAY PROPERTIES OF K_2^0 MESONS*

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In this note we present preliminary data obtained by exposing the magnet cloud chamber to the beam of K_2^0 particles from the internal target of the Joint Institute for Nuclear Research synchrophasotron. Neutral particles emitted from the target at an angle of 97° to the direction of the circulating proton beam are used in the experiment. The cloud chamber is placed at a distance of 8 m from the target.

We have recorded so far more than 500 V^0 events interpreted as decays of K_2^0 mesons. Based on the selective analysis of experimental data, an estimation was made of the relative probability of a K_{e3} decay and quantitative data on the charge ratio in three-body decays were obtained. Only 225 V^0 events are measured completely. There is not a single 2π decay among them. We have found one four-prong event and four electron-positron pairs (with comparatively large opening angles) emitted at a large angle to the direction of K_2^0 flight.

(1) The passage of the charged decay products through a lead plate 5.8 g/cm^2 thick located in the operating volume of the chamber was studied in order to estimate the relative probability of K_{e3} decay. Out of 112 events we have found 24 events in which a particle either stops in the plate or undergoes a momentum loss of more than 30%. Making use of the Bethe-Heitler equation[1] (improved by Eyges[2]) which provides the probability of the given energy loss by an electron for radiation in traversing the definite lead thickness, we have found that the fraction of K_{e3}^0 decay with respect to all the decays with charged products constitutes 38%.[3] Taking into consideration the corrections for K_2^0-particle motion which leads to a relative increase in the number of pions and μ mesons traversing the plate, we determined the fraction of K_{e3}^0 to be equal to 42 $\pm$ 12%.

If one considers that the relative probability of $3\pi^0$ decay of K^0 mesons is not more than 20% for K_2^0 mesons,[4] then the probability of K_{e3} decay for these particles turns out to be equal to the twofold probability of K_{e3} decay for positive K mesons[5] within experimental error. Such a ratio between the two probabilities should occur if the isotopic spin selection rule[6] $\Delta T = \frac{1}{2}$ is valid. Therefore, the experimental data obtained point out, within statistical deviations, the extension of the above-stated selection rule to the decay processes involving leptons.

(2) Quantitative data on the charge ratio (i.e., the ratio of the number of decay events with the emission of π^- mesons to the number of events accompanied by the emission of π^+ mesons) are obtained both by identifying the charged decay products having momentum not larger than 120 Mev/c and by studying the passage of decay particles through the lead plate. In measuring the ionization, the electrons can be reliably selected when the momentum of decay particles does not exceed 100 Mev/c. When the momentum is between 100 and 120 Mev/c, it is only possible to determine whether a particle under study is a π meson or not.

The number of decays obtained which were accompanied by the emission of π^- mesons and π^+ mesons is equal to 46 and 51, respectively. They provide the value 0.90 ± 0.18 for the charge ratio. Within experimental errors this ratio does not differ from unity and is in disagreement with the analogous ratio 0.42 ± 0.27, estimated from the data of Bardon et al.[7]

Neither the authors of the quoted paper nor we have found any event of K_2^0-meson decay into two charged π mesons.

Combining our data with those obtained in reference 7, we set an upper limit of 0.3% for the relative probability of the decay $K_2^0 \to \pi^- + \pi^+$. Our results on the charge ratio and the degree of the 2π-decay forbiddenness are in agreement with each other and provide no indications that time-reversal invariance fails in K^0 decay.

(3) Up to now only three V^0 events[7-9] which might be interpreted as the decay of K_2^0 mesons according to the mode $K_2^0 \to \pi^- + \pi^+ + \pi^0$ have been recorded. We have found one four-prong event[10] which can be considered as the decay of a long-lived K^0 meson into two charged and one neutral π meson. In view of the presence of the Dalitz pair, in our experiment the nature of the neutral product of the decay is determined more directly than in the case of two-prong events; the observed four-prong decay is a direct proof for the existence of K_2^0-meson decay according to

Table I. Characteristics of observed electron-positron pairs.

	Momentum (Mev/c) (+)	(-)	Opening angle
1	55	42	7°– 9°
2	10	43	99°
3	111	103	18°–20°
4	26	79	25°

the above-mentioned mode.

(4) Among all the recorded V^0 events there were found 4 electron-positron pairs with comparatively large opening angles; the directions of three of these pairs make angles greater than 40° with that of the K_2^0-meson beam. The characteristics of these pairs are summarized in Table I.

There is not a single star with an electron-positron pair from the stars found in cloud-chamber gas. On the other hand, the probability of large opening angles for electron-positron pairs arising in the external conversion of γ rays is very small. These are the reasons to consider the pairs obtained to be Dalitz pairs resulting from K_2^0-meson decay into neutral π^0 mesons. Therefore, the fact of their observation can be treated as experimental evidence for the existence of the long-lived K^0-meson decay into three π^0 mesons. The observed quantitative ratio (1:4) of four-prong decay and single Dalitz pairs can also be considered as a support of this treatment.

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*We feel it necessary to publish our communication exactly as it was submitted to the Rochester Conference, since in the Proceedings it appeared to be considerably distorted. See D. Neagu et al., Proceedings of the 1960 Annual International Conference on High-Energy Physics at Rochester (Interscience Publishers, Inc., New York, 1960), p. 603.

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[3]Here the correction for π-meson nuclear absorption is already taken into account.

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[5]This can be easily shown if one compares the known mean lifetimes for K^+ and K_2^0 mesons [$\tau(K_2^0) = (6.1^{+1.6}_{-1.1}) \times 10^{-8}$ sec; F. S. Crawford, Jr., M. Cresti, R. L. Douglass, M. L. Good, G. R. Kalbfleisch, and M. L. Stevenson, Phys. Rev. Letters 2, 361 (1959)] with the relative probabilities of K_{e3} decays for the same particles.

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