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In cosmic ray investigations[1,2] there have been observed some events which are treated by the authors as the decay of a neutral particle according to the scheme

$$D^{\circ} \rightarrow K^{+} + \pi^{-} + Q$$

where the Q -value is equal to 10–50 MeV. In this connection it seems interesting to attempt a search for particles with analogous decay modes which can be obtained from the beams of the high energy accelerators.

We have scanned 20.000 photographs taken during the exposure of the 2-liter xenone bubble chamber (constructed at the Institute of Theoretical and Experimental Physics of the USSR Academy of Sciences[3]) to the beam of π^{-} mesons with the momentum 3 BeV/c. An event has been found, the photograph of which is given in Fig. 1. Its geometry is shown in Fig. 2. The direction of the beam of primary particles is indicated by a dash-dot arrow. The points 'a', 'b', 'c' lie in the xenone, the track 'cd' passes into the glass.

The chamber was operated without a magnetic field, the particles were identified by ionization and multiple scattering. The results of measurements are listed in Table 1. The errors indicated in the Table are only statistical ones.

The mean values of $p\beta$ (Column 4) were calculated from the multiple scattering measurements. The momentum 'bc' (Column 5) was determined from the range measurements, the other momenta were calculated from $p\beta$ (Column 4).

The mass of the particle 'bc' presented in Column 6, is calculated from the multiple scattering-residual range ratio, the mass of the particle 'ba' is calculated with the aid of the ionization-multiple scattering ratio.

In Column 7 are given the values of the ionization calculated by the method of the total length of the gaps[4]. The 'cd' was used as a calibration track (the ionization 'cd' was taken to be 1.46, i.e., equal to the ionization of a π^{+} meson from $K_{\pi 2}$ decay). In Column 8 are listed the values for the ionization, calculated from the magnitudes of the momenta from Column 5.

The measurements of ionization and multiple scattering show that the particles are travelling in the directions indicated in Fig. 2 by the arrows. The mass of the particle 'bc' coming to rest in the chamber was found to be 490 ± 190 MeV, i.e. coinciding with the mass of a K-meson within statistical errors. The measurement of $p\beta$ of the particle 'cd' by the multiple scattering method yielded the value 180 ± 54 MeV/c which is in good agreement with $K_{\pi 2}$ or with $K_{\mu 2}$ decay. Let us remind, that for μ^{+} from $K_{\mu 2}$ decay the $p\beta$ value is 216 MeV/c, for π^{+} from $K_{\pi 2}$ decay the $p\beta$ value – 170 MeV/c, whereas the maximum $p\beta$ value for an electron from $\mu - e$ decay is equal to 53 MeV/c (the mean value of $p\beta$ from $\mu - e$ decay is 38 MeV/c[5]). So, both the measurement of the mass on the track 'bc' and that of $p\beta$ for the track 'cd' point out that the sequence 'bc'–'cd' is the decay of a K^{+} meson rather than $\pi - \mu - e$ decay. The results of the measurements of the ionization 'bc' and 'cd' do not contradict this conclusion.

After the particle 'ba' suffered a nuclear interaction, it stops in the chamber giving rise to a small star. The value of $p\beta$ for this particle measured by the multiple scattering method is found to be 113 ± 22 MeV/c. The mass of the particle 'ba' determined by the ionization–multiple scattering ratio turned out to be 195 ± 55 MeV, i.e., close to the mass of a π or μ meson. Since at the end of its track it undergoes a nuclear interaction, one may say that the particle 'ba' is a π meson. The measurements and the results of the calculations show that the event in question can be treated neither as the production of a π^+ meson in the neutron star 'a' with a subsequent scattering at the point 'b' and π-μ-e decay at the point 'c', nor as the production of a K^+ meson in the neutron star 'a' with the scattering at 'b' and $K_{\mu 2}$ decay at 'c'.

Nor can the event described be interpreted as a neutron star at the point 'b' where two strange particles and a π meson are created(the reaction $n+n \rightarrow \Lambda^0 + K^+ + \pi^- + n$). The calculations show that the threshold for such a reaction is approximately 0.9 BeV higher than the maximum energy of neutrons which would be created in the chamber under the given conditions, because K^+ and π^- mesons are flying in the backward direction relative to that of the primary beam in the lab. system and they must have a very large kinetic energy in the center-of-mass-system of the colliding particles. It seems rather unlikely that this event may be also interpreted as a reaction

$$K^0 + n \rightarrow n + K^+ + \pi^- \qquad (1)$$

since the K^0 - and K - interactions with the Xe- nuclei leading to the generation of π^- mesons are always accompanied by many-prong stars. The same is known from the experiments on K^0 - meson interaction with emulsion nuclei. /8/

The mass of this particle calculate by the momenta of K^+ and π^- -mesons and by the angle between them was found to be

$$m_{D^0} = 660 \pm 50 \text{ MeV}.$$

An attempt has also been made to calculate the mass of D^0 by the kinematics of production, assuming that D^0 is generated in the reaction

$$\pi^- + p \rightarrow n + D^0. \qquad (2)$$

If the calculation is made under the assumption that D^0 meson is produced in the collision of a π^- meson with the proton at rest, then the magnitude of the D^0 mass turns out to be 440 MeV. If one takes into account the Fermi motion of nucleons in a nucleus and assumes, e.g., that a π^- meson collides with a proton flying in the opposite direction (the kinetic energy of a proton is 10 MeV, the momentum 170 MeV/c), then the mass of D^0 is found to be 660 MeV. One can see that due to the nucleon motion in a nucleus there are very large errors in the mass determination by the production kinematics in reaction (2). However,

the same can be said about the the reaction

$$\pi^- + p \rightarrow \Xi^0 + D^0. \qquad (3)$$

In connection with the possibility we are discussing here and in view of the communication on a D^+ meson[6] having the mass

$$m_{D^+} = 742 \pm 25 \text{ MeV}$$

one may, very likely, speak about the existence of three particles D^+, D^o, and D^- mesons with the close values of masses and identical decay modes

$$D \to K + \pi.$$

The problem concerning the place of a D^0 meson in the systematics of elementary particles as well as the consequences resulting from its existence are discussed in[7].

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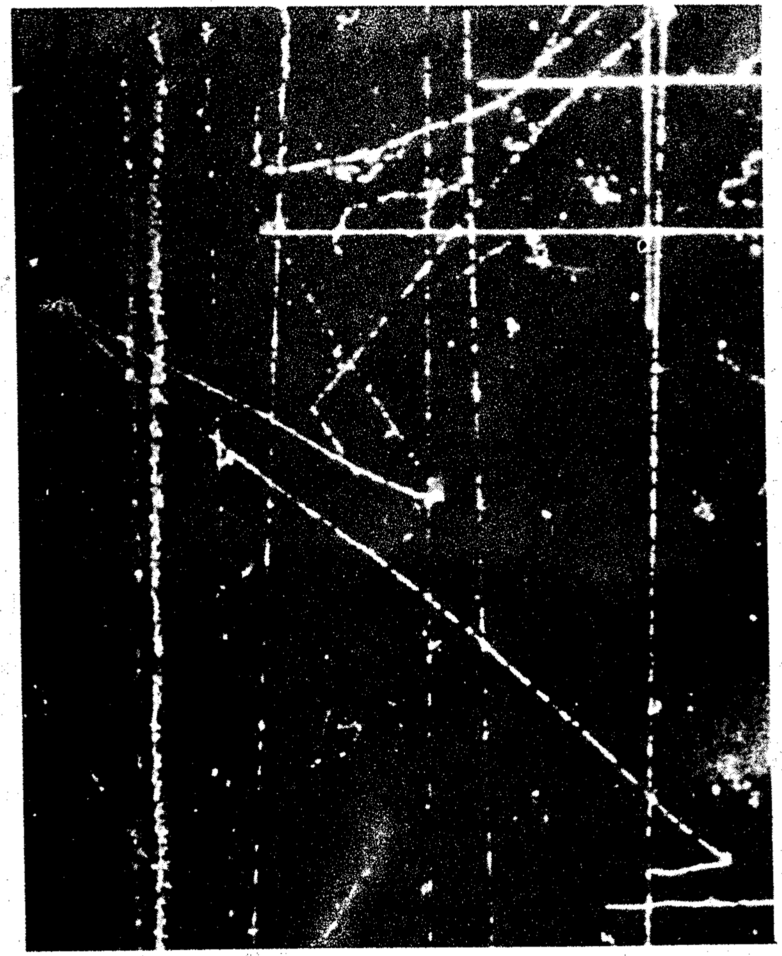

Fig. 1. *A possible decay of a heavy meson by the scheme* $D^0 \rightarrow K^+ + \pi^-$.
The point at which the decay takes place is denoted by 'b'.

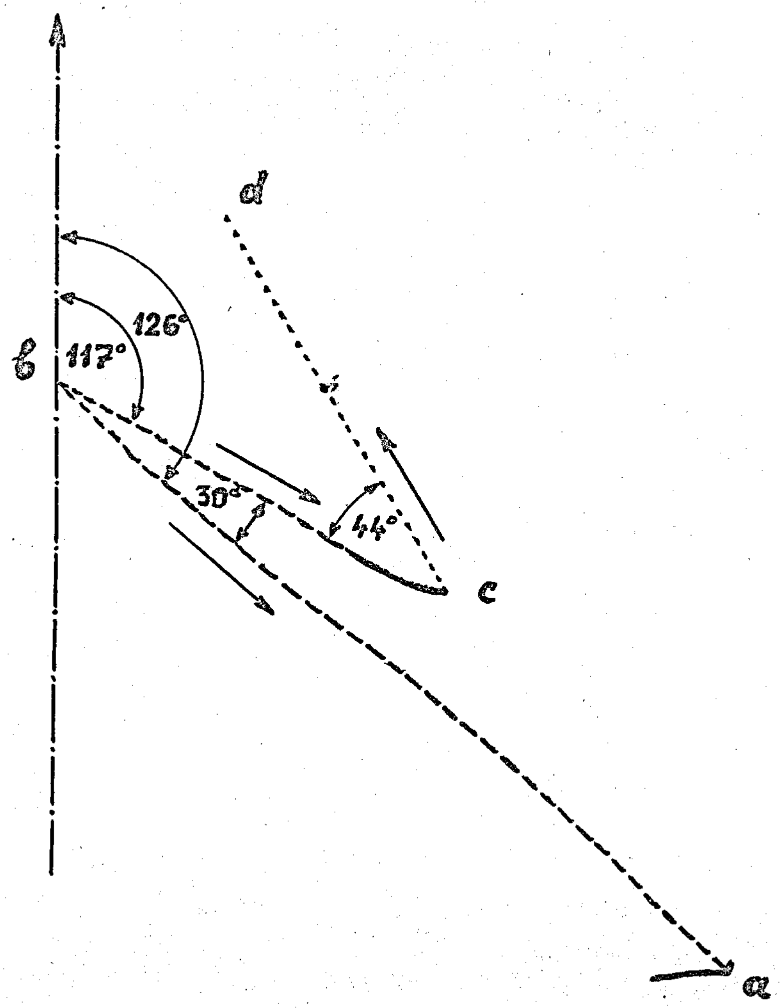

Fig. 2. *The decay geometry.* 'bc' – the track of K^+
'cd' – the track of π^+ (μ^+)
'ba' – the track of π^-.