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A POSSIBLE EXAMPLE OF THE CHARMED PARTICLE DECAY INTO THE CHANNEL $B_c \to e^+e^- +$ HADRONS

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Abstract

In the course of the analysis of the 600 stars, produced in nuclear emulsion by π^- -mesons with the momentum 200Gev/c, a secondary star 0+0+5p originated at the distance 42 μ from the primary star has been found, which contains an electron pair and possibly presents an example of the charmed baryon decay into the channel $B_c \rightarrow e^+e^-$ + hadrons.

1. Observed [1] untill now charmed particle decay modes, including several cases of such decays, detected in nuclear emulsions [2-5] agree with the predictions of GIM - model [6] and the idea that these decays are caused by charged weak currents. At the same time hypothesis of the existence of the charm changing neutral weak current has received some attention in the literature [7-10]. Existence of the charm changing neutral current would lead to the specific decay modes of the charmed particles not including strange particles and in case of semileptonic decays containing e^+e^- pairs along with hadrons.

Intensity of such decay modes depends on the value of mixing angle for u and c - quarks and judging on the available data for charmed particles [11] is much lower than the intensity of the decay modes, caused by the charged weak currents. Further experiments will hopefully make more clear the status of the charm changing neutral current hypothesis.

Belon we give description of the event, detected in nuclear emulsion which due to its peculiarities might present an example of the charmed particle decay, caused by the charm changing neutral weak current.

2. A stack of nuclear emulsions of the type BR-2 with sizes 10x20 cm^2 and pellicle thickness 600μ was irradiated at FNAL by π^- - beam with the momentum 200 Gev/c. 350 cases of π^-N-interaction and 250 cases of π^-A-interaction have been found.

With the purpose of searching for the cases of the short-lived particle decays with the number of the decay products $n_s \geq 3$ star tracks from the forward cone ($\theta_L < 0,1$) have been traced up to the distance 1 mm from the interaction point. Total length of the scanned tracks for all found stars was 240 cm.

6 secondary interactions have been found in the course of this scanning, five out of which had typical features of the interaction with the emulsion nuclei*) and one presented very narrow jet of the relativistic particles of the type 0+0+5p. Jet originated at the distance 42 μ from the primary star 21+6+23p. Schematic picture of this event is given at Fig 1.

Results of an le and momentum measurement for the jet particles are shown in Table 1. For all jet tracks ioniza- tion relative ionization of the primary pions has been also measured. Jet particles N 19 and 21 have been identified as electrons on the basis of their characteristic energy losses and non changing ionization close to 1. It has been established also that the particle N 18 (with minimal ionization) is a slow pion, whereas particles N 20 and 22 are hadrons. Total momentum of all five particles is about 9 Gev/c.

*) This number is in good agreement with the expected one, as interaction length of the pions in the nuclear emulsion is 45 cm and estimated number of the stars 240/45 ~ 5.

The pecularity of this event is its narrowness and presence of two electrons among five charged particles. The probability to observe on all scanned track length (240 cm) such a narrow jet, produced by ordinary streng interaction of pions (at energies 10-20 Gev) with emulsion nucleons or by coherent generation on emulsion nuclei under assumption that e^+e^- pair is a Dalitz-pair from π^0 -decay is less than 4.10^{-7}. The same probability related to 42 μ gives value $< 10^{-11}$. Extremely small values of these probabilities were the reasons for considering alternative explanations of this event, in particular its possible treatment as a charmed particle decay. Estimates of the mass of the decaying particle made at various assumptions about the nature of the particles N 20 and 22 show (see Table 2) that the mass close to the mass of the charmed particle arises if particle N 22 is a proton. Life time in this case is evaluated to be 3.10^{-14} sec. Assumed decay scheme is:

$$B_c \text{ -- } e^+ + e^- + p + 2\pi$$

i.e.decay is caused by the charm changing neutral weak current.

3. As charmed particles should be produced in hadronic interactions in pairs, we have made an attempt to look for manifestation of the decay of another charmed particle among charged secondaries of the discussed star. With this aim particles of the forward cone ($\theta_L < 0,1$) were carefully analyzed.

On one of the tracks (N 15) a kink has been found at the distance l_{15}= 20 mm. The angle of the kink was 2°, particle momentum changed from (10,4±2,5) Gev/c to (3,5±0,5) Gev/c, that is a kink could be caused either by inelastic interaction or by the decay of some particle. Path length for inelastic interaction of the type 0+0+1p at the momentum p = 10 Gev/c is equal 10 m. If one takes into account that share of this kind of inelastic interactions with an angle < 3° does not exceed 10%, one gets an estimate that the probability to observe a kink at l = 2 cm with the angle 2° is less than 2.10^{-4}. If the kink is not caused by the scattering but due to the decay of some particle, then most probable candidate is $\Sigma^{\pm}$ - hyperon. Assuming realisation of the decay channel $\Sigma^{\pm} \to \pi^{\pm} + n$, one really obtains $M_{15} \simeq M_{\Sigma}$. Probability to observe $\Sigma^{\pm}$-decay at length l=2 cm and momentum equal 10 Gev/c is 7.10^{-2}, that is not too small.

It is possible to assume, that $\Sigma^{\pm}$ - origin is connected with the decay of the second charmed particle, produced in the same star. Provided life-time of this second charmed particle is $< 10^{-14}$sec, one would see a $\Sigma^{\pm}$ - hyperon coming out directly from the star centre. These considerations are not quite conclusive and don't fully solve the question of what is the partner associated with B_c.

Thus in π^-A-interaction occured at p = 200 Gev/c we observed a narrow jet 0+0+5p, containing e^+e^--pair. It was assumed that the jet was caused by the decay $B_c \to e^+e^-$+hadron,

though the possibility of accidental realization of very rare event of ordinary nature cannot be exluded.

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Table 1

Angles and moments of the charged particles in the secondary star 0+0+5p

Number of the part.	θ°_{L}	φ°	P, Gev/c	l, mm	Nature of the part.
18	4,89	214	$0,25\pm0,01$	31,9	π
19	4,36	195	$0,68\pm0,06$	21,7	e
			$0,38\pm0,02$	38,8	
			$0,22\pm0,03$	7,0	
			$0,04\pm0,01$	5,0	
20	4,69	206	$4,5\pm0,4$	42,4	hadron
21	4,55	194	$1,70\pm0,25$	9,4	e
			$1,05\pm0,12$	18,4	
			$0,60\pm0,10$	13,1	
			$0,21\pm0,02$	19,2	
			$0,11\pm0,03$	2,4	
22	4,86	205	$2,0\pm0,2$	56,9	hadron.
18^{a}	4,63	200	≥ 9		

Characteristics of the decaying particle at various assumptions on the nature of the decay products

Identification of the particles					M_{inv} Gev/c^2	γ	$\tau \cdot 10^{14}$ sec
N18	N19	N20	N21	N22			
π	e	π	e	p	2,2	4,2	3,3
π	e	p	e	π	1,5	6,1	2,3
π	e	π	e	π	0,9	10	1,4

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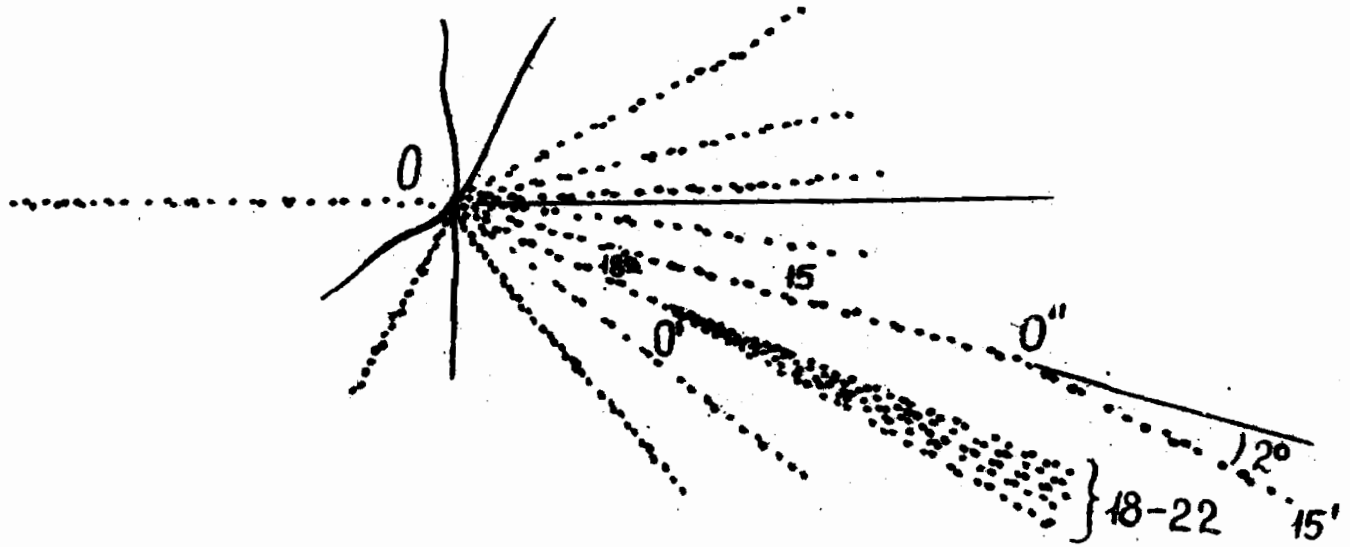

Fig.1. Schematic picture of the event:

0 - primary star (21+6+23p)

$0'$ - centre of the narrow jet of the type 0+0+5p

$0''$ - kink on the track № 15.