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YEREVAN PHYSICS INSTITUTE

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OBSERVATION OF NEW SHORT-LIVED PARTICLES IN EMULSIONS IRRADIATED BY 400 GEV/C PROTONS

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OBSERVATION OF NEW SHORT-LIVED PARTICLES IN EMULSIONS IRRADIATED BY 400 GEV/C PROTONS

The results of searching for short-lived particles in ~ 1800 events of interaction of protons with emulsion nuclei are given. The characteristics of both generation and decay of new charged particles are analyzed.

Yerevan Physics Institute
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НАБЛЮДЕНИЕ НОВЫХ КОРОТКОЖИВУЩИХ ЧАСТИЦ В ЭМУЛЬСИЯХ, ОБЛУЧЕННЫХ 400 ГЭВ/С ПРОТОНАМИ

Приведены результаты поиска короткоживущих частиц в ~ 1800 событиях взаимодействия протонов с ядрами эмульсии. Анализируются характеристики генерации и распада заряженных новых частиц

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The existance of charmed particles group is beyond any doubt at present. Some specimens of this group, both mesons and baryons, were discovered mainly in experiments on crossing positron-electron beams in the last 3-4 years, their masses and probabilities of some decay modes defined with a good accuracy /1/. However, the definition of life-time of one of the main characteristics of these particles is possible only applying the photoemulsion technique at availability of significant statistics. Therefore, the most important problem is accumulation of experimental data on anomalous events that can be ascribed to both production and decay of charmed particles. The observation of such events in photoemulsions irradiated by of hundreds GeV protons is given in Refs./2-7/. In Ref./7/ were observed 9 events interpreted as the decay of charmed baryons and their mean life-time is approximately estimated.

In this work are given the data on both searching and characteristics of events which can be interpreted as the decay of charged charmed particles into three charged ones.

The searching of short-lived particles was carried out in emulsion layers irradiated on FNAL accelerator with a 400 GeV/c proton beam. The conditions of photonuclear emulsion exposition are given in detail in Ref./7/. The searching for primary interactions of protons with the emulsion nuclei

was performed by track-following on МБИ -9 microscope at 900-multiplied total magnification. At the same magnification the forward neighbourhood of 1812 interactions (of stars) is examined up to 1000 mkm distance. A continuous area-prospecting method is applied and since the events searched are difficult to be noticed by their vertex, all traces crossing with a minimum density the scanning area were scanned towards the interaction /5/ side. As for the material, the searching was carried out by track-following of relativistic particles emitted from the primary interaction. As a result, 32 secondary stars were found, connected with the primary interaction of a one-charged relativistic particle. In addition, 11 stars were found at 1000 up to 3000 mkm distance from the primary ones at measuring the angular distributions of the secondary particles of the primary interactions. Thus, among 43 secondary stars there were found 10 "white" stars (without any sign of a nucleus-target in them), with 4 events of (0+0+3)p type among them. The 5 events found, here called "false" triads, imitating interactions of (0+0+3)p type representing a sort of superimposing of the (e^+e^-) pair on the track of the emitted particle, are not included in the number of above given stars. Most likely, these events are identical to the events 7, 13, 18 from Ref./7/. Note, that we did not observe similar events at the primary proton momentum 200 GeV/c on about 1000 interactions statistics. At present the work on revealing the character of these events is being carried out.

In the figure are shown the polar angle θ of forming particles and the distance ℓ from primary interactions of all secondary stars found. As one can see, the most effective region is up to 4° , where about 80% of all events found are concentrated. This should be expected according to both the scanning conditions and the angular distribution character of secondary particles in interaction of a 400 GeV/c proton with emulsion nuclei /8/. As is seen, the two events of (0+0+3)p type are found outside this region.

At our statistics volume the expected number of stars of (0+0+3)p type does not exceed one. Such interactions are the main source of background events for decaying of charmed particles into three charged ones, since the probability of observation of the other similar process, i.e. the generation and the subsequent decay of K-mesons into three π -mesons, is two order less than the probability of interaction of the same type. Thus, it is necessary to analyze each of the four events found, which are probably due to formation and decay of charmed particles.

Both angular and momentum characteristics of the decay products are given in Table 1. The polar and azimuthal angles are given relative to a flight direction of a decayed particle. The small values of a rest transverse momentum, which are obtained at examining of the momentum balance, allow one to assume that in the first three cases the decay of particles occurs without the neutral secondary one.

The invariant masses of decayed particles for the above cases are calculated under different assumptions on the nature of the decay products. The results are given in Table 2. In all the cases the errors of the mass definition make no more than 20%. As one can see, at some acceptable decay schemes the obtained values come close to the charmed baryon mass. The flight time before the decay lies in the interval ($9.3 \quad 10^{-14}$ - $1.6 \quad 10^{-12}$) sec.

In all the three cases there is no direct evidence of pair production, but all of them have something common as to the character of generation. This common character consists in the fact, that the decayed particles fly out of the star, being followed by a particle (and in events 70-78 by even two particles) very close in its angular characteristics to the decayed one. The accompanying particles are traced at sufficiently large distances (≥ 7 cm each), and we can only say they are not electrons. If using the value ν we introduced /9/, then it turns out that $\nu > 200$ for them. An analysis was carried

out of the angular distributions of all secondary particles generated in interactions with the secondary stars found in them. It awas found that for secondary stars of (0+0+3)p type the frequency of generation at such an accompaniment is 5 times larger than the same value for the rest of secondary interactions.

The authors are grateful to the Nuclear Physics Department of Academy of Sciences of the USSR, to the staff and personnel of FNAL for assistance, to the staff of AALMT-collaboration for supplying with a part of irradiated emulsion stack. The authors thank also S.G.Matinyan and M.I.Tret'akova for useful discussions.

Characteristics of secondary events of (0+0+3)p type

Table 1

Number of events	Type of primary interaction	ℓ (mkm)	θ	ψ	Momentum (GeV/c)	ℓ' (mm)	Notes
—			6.0	I23	5,8± I.I	69	(6+2+2)p
78-79	(II+2+I8)p	I65	6.I	325	6.0± I.5	26	secondary interaction
			9.9	220	I.0± 0,2	22	
75-I74	(6+3+I9)p	I50	2.I	I80	5.0± I.2	82	
			II.3	73	2.4± 0,4	30	kink θ = 7°
			I9.5	287	I.2± 0,4	7	
78-70	(0+0+I6)p	2420	4.0	336	5.8± 0,9	9I	
			8.I	I6I	4.3± 0,8	50	(5+2+3)p
			I9.3	29	0.7± 0.2	32	secondary interaction
82-I94	(0+0+II)p	3I2	0,7	91	I4.3 ± 1.9	68	
			0,6	72	91.5± 3.2	49	
			0,4	359	40.1± 7.8	32	

Table 2

Invariant masses of events

Assumed scheme of decay	Mass, GeV/c^2		
	78 -79	75 -I74	73 - 70
$K\pi\pi$	I.7	I.6	I.6
$\pi K\pi$	I.7	I.7	I.6
$\pi\pi K$	2.2	2.5	2.3
$pK\pi$	2.2	2.I	2.I
$Kp\pi$	2.2	2.3	2.2
$p\pi K$	2.6	2.2	2.2
πpK	2.6	2.6	2.4
πKp	3.4	2.9	4.0
$K\pi p$	3.4	3.I	3.9
$\Sigma\pi\pi$	2.3	2.2	2.I
$\pi\Sigma\pi$	2.3	2.7	2.4
$\pi\pi\Sigma$	4.I	3.3	4.I

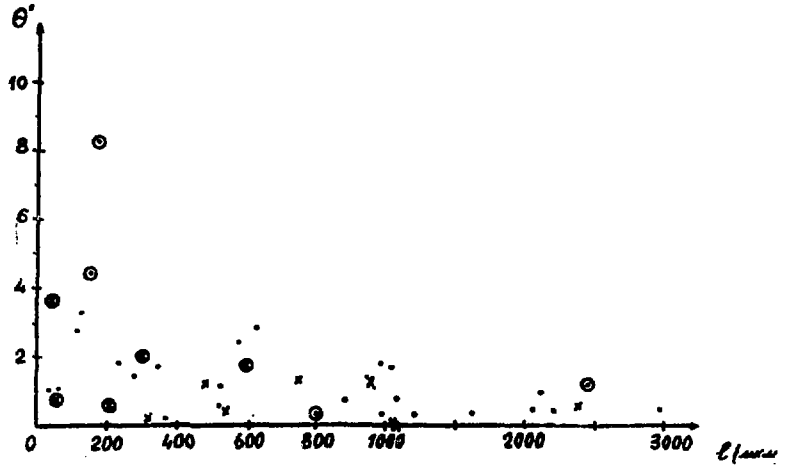
θ'
10
8
6
4
2
0
200
400
600
800
1000
2000
3000
ℓ (mètres)

Figure Caption

Polar angle and the tracks' length of particles forming secondary stars:

• - with N_h ; X - "white"; ⊗ - of (0+0+3)n type;

⊙ - "false" triads.

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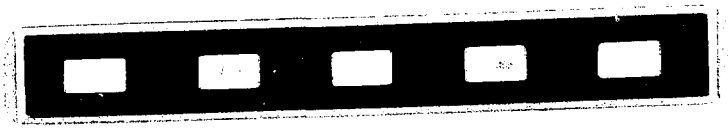

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