NON-MESONIC DECAYS OF HYPERFRAGMENTS

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Non-mesonic decays of 18 hyperfragments were studied in the part of an emulsion stack irradiated with 4.5 Bev π mesons. The ratio of the number of decays due to the interaction between the Λ^0 particle and neutron to the number of decays due to interaction with a proton was determined. It turned out to be 1.25.

THERE have been a number of papers published recently on experimental investigations of non-mesonic decays of hyperfragments.[1,2] In these papers the quantity of interest is the ratio of the number of hypernucleus decays due to interaction of a Λ^0 particle with a neutron to the number of decays due to interaction with a proton:

$$R = N / P.$$

According to the theoretical considerations of Ferrari and Fonda,[3] the value of R gives information about the mechanism through which the Λ^0 particle interacts with the nucleons in the nucleus. The Λ^0 particle can interact directly with a nucleon, or through a virtual Σ state.

According to reference 3, in a direct interaction, no matter what the relative parities of the Λ^0 particle and the nucleon are, the value of R is

Kinematics of the particles

Serial Number	Primary Star	Tracks	Presumed Charge	Range μ	Angles $\theta_{F,\pi}$ $\theta_{F,i}$ deg	Presumed Decay Scheme
1	2	3	4	5	6	7
			A. Decays induced by neutrons			
1	$14+1\pi$	F	3	140.2	97	—
		1		745.6	16	
		2		75.5	68.5	
2	$8+0\pi$	F	3	145.5	90	—
		1		147.0	43.5	
		2		136.0	36.5	
3	$9+2\pi$	F	2	105.0	64.0	—
		1		378.0	74.5	
		2		82.0	81	
4	$10+0\pi$	F	2	46.0	74	—
		1		68.0	84.5	
		2		240.0	50	
5	$18+0\pi$	F	3	43.7	34	—
		1		17.6	89.5	
		2		66.3	18.5	
		3		16.3	105	
6	$10+0\pi$	F	2	97.2	123	—
		1		302.6	102.5	
7	$9+1\pi$	F	2	80.8	60.5	—
		1		20.2	23.6	—
8	$12+2\pi$	F	2	59.2	139	
		1		40.0	98.6	
9	$13+0\pi$	F	6	55.0	114	
		1		34.0	57	
		2		821.0	118	${}_{\Lambda^0}C^{12} \to Be^9 + 2H' + n^0$
		3		609.0	90.5	
10	$16+0\pi$	F	4	47.4	47	
		1		2630	172.5	
		2		72.4	115.3	
		3		32.0	89	
		4		104.5	88	

1	2	3	4	5	6	7
			B. Decays induced by protons			
11	15+0π	F	2	153.0	20	
		1		92.0	52	
		2		>12000	36.5	
12	11+3π	F	2	50.0	29	
		1		5900	38	$_{\Lambda^0}He^5 \to 2H^2 + n^{\upsilon}$
		2		3.5	54	
13	15+0π	F	2	77.7	30	
		1		<15000	136.5	$_{\Lambda^0}He^5 \to H' + H^3 + n^{\upsilon}$
		2		16	83.5	
14	17+0π	F	3	181.0	88	
		1		>23000	59	$_{\Lambda^0}Li^6 \to H' + He^4 + n^0$
		2		43	83	
15	18+3π	F	3	87.0	62	
		1		9900	46	
		2		88	32	$_{\Lambda^0}Li^8 \to H' + 2H^3 + n^0$
		3		22	98	
16	7+0π	F	4	28.5	17	
		1		3746	139	$_{\Lambda^0}Be^9 \to H' + H^2 + He^4 + 2n^0$
		2		2983	24	
		3		16.0	90	
17	15+0π	F	5	16.0	115	
		1		10.0	88.8	$_{\Lambda^0}B^{10} \to He^4 + H' + 2H^2 + n^0$
		2		16500	61	
		3		26	91	
		4		47.5	124	
18	13+2π	F	6	94.5	79	
		1		47.0	72	
		2		48.5	132	$_{\Lambda^0}C^{12} \to 2He^4 + H' + H^2 + n^0$
		3		135	154	
		4		<25000	48	

less than or equal to one ($R \leq 1$). Hence, if $R > 1$, the interaction must proceed through a virtual Σ state. At the present time, there is little experimental data on this problem. In the following we present some results obtained in part of a G-5 emulsion stack irradiated by 4.5 Bev π mesons.

After analyzing all the double stars found in a systematic search of 47 cm^3 of emulsion, 18 cases were selected which satisfied the following criteria: 1) the length of the connecting F-track was greater than 20 μ; 2) the connecting F-track was thinner toward the end of its range, as determined from measurements of the track width. The hyperfragments so found were separated into two classes. In the first class were all decays which had a singly charged particle with range greater than 3 mm, while in the second class were all decays in which the secondary particles were slow ones. The ratio of the number of decays in the second class, N, to the number in the first, P, was 10/8 = 1.25. This ratio is definitely greater than one, since the error can only be positive (the value of N is too small if anything). Taking into account the results of reference 1, we conclude that the interaction of the Λ^0 particle with the nucleons is very likely through a virtual Σ state. We propose to improve the statistics, not only to solve this problem but also to find the parity of the Λ^0N system.

We also examined the angular distribution of the hyperfragments relative to the direction of the incident π-meson beam. Silverstein[2] found the forward/backward ratio to be 2.2 ± 0.5. According to our data, this ratio is 2.6. The forward/backward ratio for lithium fragments ("hammers") was also measured in the same emulsion. For Li fragments with energies comparable to the energies of the hyperfragments, the ratio turned out to be one.

All the experimental results discussed in the text are summarized in the table.

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[1] Baldo-Ceolin, Dilworth, Fry, Greening, Huzita, Limentani, and Sichirollo, Nuovo cimento **7**, 328 (1958).

[2] E. M. Silverstein, Nuovo cimento **10**, Suppl. No. 1, 41 (1958).

[3] F. Ferrari and L. Fonda, Nuovo cimento **7**, 320 (1958).

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