HYPERFRAGMENTS FROM σ_K STARS

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IN the systematic scanning of a photoemulsion stack irradiated by K^- mesons (see reference 1) we found four cases of mesonic decay of hyperfragments in 619 σ_K stars, of which three could be identified. The necessary data on the tracks of the hyperfragments and particles emitted in their decay are given in the table.

Event 1. The hyperfragment comes from a star of the 2+ K^- type and decays "in flight" into two charged particles. The tracks of the hyperfragment and the secondary particles are coplanar. The decay kinematics and the measurements are in agreement with either of the decay schemes:

$$_\Lambda H^4 \rightarrow He^4 + \pi^- \quad (a), \quad _\Lambda H^3 \rightarrow He^3 + \pi^- \quad (b).$$

For either scheme we calculated the angle θ between tracks (F) and (2) from the angle between tracks (F) and (1) and from the range of (1), and compared it with the measured angle $\theta_{meas.} = 41.4° \pm 1.6°$. For scheme (a), $\theta = 38.4° \pm 4.8°$; for scheme (b), $\theta = 35.7° \pm 5.8°$. The time of flight of the hyperfragment, calculated from tables,[2] equals 2.1×10^{-11} sec for scheme (a) and 2.0×10^{-11} sec for scheme (b).

Event 2. The hyperfragment comes from a star of the 4+ 1K^- type and decays into a secondary three-pronged star with coplanar prongs. The analysis shows that the decay is according to the scheme $_\Lambda He^5 \rightarrow He^4 + p + \pi^-$. The binding energy of the Λ^0 particle is $B_\Lambda = (1.8 \pm 0.7)$ Mev.

Event 3. The hyperfragment comes from a star of the 5+ 0K^- type and decays into a two-pronged star. The presence of scattering at the end of the track indicates that the decay occurred after stopping. Detailed analysis allows determination of the decay scheme as $_\Lambda He^4 \rightarrow He^3 + \pi^- + n$. The binding energy is $B_\Lambda = (0.6 \pm 0.6)$ Mev.

In calculating the range of the particles we used the shrinkage factors determined according to reference 3: $K = 2.73 \pm 0.11$, 2.68 ± 0.11 and 2.31 ± 0.07 for events 1, 2 and 3 respectively. We used 7 protons from the decay $\Sigma^+ \rightarrow p + \pi^0$ for events 1 and 2 and 6 protons for event 3.

In calculating the particle energy and binding energy we used the range-energy relations of Barkas,[4] the decay energy of the Λ^0-particle from the work of Friedlander et al.,[5] and nuclear masses from reference 6.

Additional criteria exist for the identification of events corresponding to the nonmesonic decay of hyperfragments as follows: (1) In the formation of a Σ according to the reaction $K^- + N \rightarrow \Sigma + \pi + Q$ the energy release is $Q \simeq 100$ Mev. Hence if the energy release in a σ_K star is known to be larger than Q, the emission of a Σ is excluded (if one ignores the possibility of two-nucleon capture of the K^- meson). (2) The presence of a π meson in a σ_K star excludes the possibility of emission of another π meson, since reactions with emission of two π mesons have small probability. Taking into account these additional considerations, we found two hyperfragments undergoing nonmesonic decay among 427 σ_K stars.

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Event	Track	Range R, μ	ΔR	Range straggling, μ	β	$\Delta\beta$	φ	$\Delta\varphi$	Z	Final identification of the particle	Particle energy, in Mev (at the point of production)
1	F	757			+11.4		0			$_\Lambda H^4$ or $_\Lambda H^3$	30.1 or 27.6
	1	61			−0.9		194.7		$\leqslant 2$	He^4 or He^3	10.4 or 9.3
	2	>105			+36.6		143.4		1	π^-	62.6 or 49.4
2	F	26			−66.1		0			$_\Lambda He^5$	
	1	29	3.3	0.7	+55.8	4.5	145.1	1.2	$\leqslant 2$	He^4	6.45 ± 0.45
	2	3787	37	118	−24.5	1.2	275.2	0.7	−1	π^-	13.24 ± 0.24
	3	1184	26	16.7	−61.7	1.3	343.9	0.7		p	15.42 ± 0.23
3	F	181	1.8	7	+14	1	0			$_\Lambda H^4$	8.9 ± 0.4
	1	19	1.3	0.5	+14	7	270	2		He^3	4.36 ± 0.30
	2	14635	73	166	−23	1	90	0.7	−1	π^-	29.0 ± 0.2

β) Inclination angle of the track to the emulsion plane in degrees. The angle is taken as positive for particles going towards the emulsion surface and as negative for particles going towards the glass. φ) Azimuth angle in degrees measured counterclockwise from the hyperfragment track. ΔR, $\Delta\beta$, $\Delta\varphi$) errors in the measurement of R, β, φ.

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INVESTIGATION OF CONVERSION ELECTRON SPECTRA OF NEUTRON-DEFICIENT ISOTOPES OF LUTECIUM

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THE study of the radiations from highly deformed nuclei provides material for further development of the collective model of the nucleus. The isotopes of lutecium are very interesting from this point of view. Recently a series of papers have appeared[1-4] concerning the neutron-deficient isotopes of Lu, but these data do not give a clear picture of the decay of these isotopes. Further investigations are necessary for this purpose.

We have studied the conversion spectrum of the isotopes of the lutecium fraction separated from a tantalum target irradiated with fast protons (660 Mev). The separation method was described earlier.[5] The measurements were made with a prism β spectrometer having an instrumental halfwidth of $\sim 0.1\%$ and with a double-focusing spectrometer with an instrumental halfwidth ~ 0.25 to 0.30%. The spectrum of conversion electrons contains a large number of lines belonging to Lu^{169} (half-life ~ 1.5 days), Lu^{170} (~ 2 days), Lu^{171} (~ 8 days), Lu^{172} (~ 6.7 days), and Lu^{173} (~ 200 days).[1,4,6] The assignment of the lines to the various isotopes was made on the basis of the half-life. Because of the small difference in lifetime, the separation of the lines of Lu^{169} and Lu^{170} is very difficult and was not completely achieved. It could be established from the measurements that the lines associated with Lu^{170} (84.19 kev, 193.3 kev) decay with a period of ~ 2 days. Lines having a lifetime less than that of the Lu^{170} lines were assigned to Lu^{169}. The comparatively small difference in the half-lives of Lu^{171} and Lu^{172} also prevented a unique assignment of transitions to one or the other of these two isotopes.

Table I gives the energies of γ transitions whose conversion lines decay with a period of $\sim$ 1.5 or 2 days. Table II gives the energies of the γ transitions with period 6.7 to 8 days. The energy of the transitions was determined from the energy of the K and L conversion lines. The accuracy of the energy determination if $\sim 0.1\%$. In those cases where only the K line or the L line was observed, the energy of the transition is given in parentheses.

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TABLE I. Energies of γ transitions in the spectra of Lu^{169}, Lu^{170}

No.	Energy of γ transition in kev	No.	Energy of γ transition in kev	No.	Energy of γ transition in kev	No.	Energy of γ transition in kev
1	24.23	7	110.9	13	(286.5)	19	(543.8)
2	62.65	8	156.8	14	(290.9)	20	(755.1)
3	70.54	9	165.0	15	(369.2)	21	(937.7)
4	84.19	10	191.2	16	378.4	22	(1453)
5	87.30	11	193.3	17	(419.8)	23	(1481)
6	(91.83)	12	283.0	18	(457.2)		

Half-life for Nos. 1, 2, 5, 7, 8, 9, 10: < 2 days; for Nos. 4, 11: ~ 2 days.