Mesonic Decay of a Tritium Hyperfragment

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An analysis is made of the mesonic decay of a hyperfragment according to the scheme ${}^3_{\Lambda^0}H^* \rightarrow p + p + n + \pi^- + Q$, where $Q = 35.9 + 0.7$ Mev.

IN THE SYSTEMATIC scanning of a stack of 30 Ilford G 5 pellicles provided by Professor Powell, which had been exposed in Italy at 25 km for 8 hours during the autumn of 1955, we observed the mesonic decay of a tritium hyperfragment with the π^--meson coming to rest in the emulsion. Since there are few known decays of this type which permit a relatively exact measurement of the Λ^0 particle binding energy[1-4] we wish to add this case to the available data.

A slow singly-charged particle hf is ejected from the primary $10 + 0_n$ star (see the projection drawing), is stopped in the same pellicle, and produces a secondary three-prong star. The range of hf is 360 μ, its mass is greater than a proton mass as estimated either from the gap count and range or from the scattering and range (the second difference $\bar{D}$, as measured on the basis of $\bar{D} = 0.5\,\mu$, is $0.23 \pm 0.10\,\mu$). A single charge is found for hf from the gap count, range, and grain density.

The two short-range particles of the secondary star (tracks 1 and 2) have identical ranges $12 \pm 0.6\,\mu$. The charge which results from comparison of the grain densities of tracks 1 and 2 with the grain densities of α particle tracks from Be^8 and ThC′ decay gives $z = 1$. Track 3 belongs to a π^--meson with 15,700 μ range. This π^--meson passed through 8 pellicles and produced a one-prong σ star at the end of its range. The details of the measurements are given in the tables.

The combined momentum of particles 1, 2 and 3 is 91.2 ± 1.2 Mev/c. If it is assumed that an equal and opposite momentum was borne off by a neutron we obtain the following decay scheme:

$$ {}^3H^* \rightarrow p + p + n + \pi^- + Q, $$

where $Q = 35.9 \pm 0.7$ Mev. Hence we obtain for the Λ^0 binding energy in tritium

$$ B_{\Lambda^0} = -1.2 \pm 1.2 \text{ Mev.} $$

The most accurate values of B_{Λ^0} for similar ${}^3H^* \rightarrow p + p + n + \pi^-$ decays are 1.4 ± 0.6[1]; 0.4 ± 0.7[2]; 5.4 ± 1[3] and -3.0 ± 0.8[4] Mev.

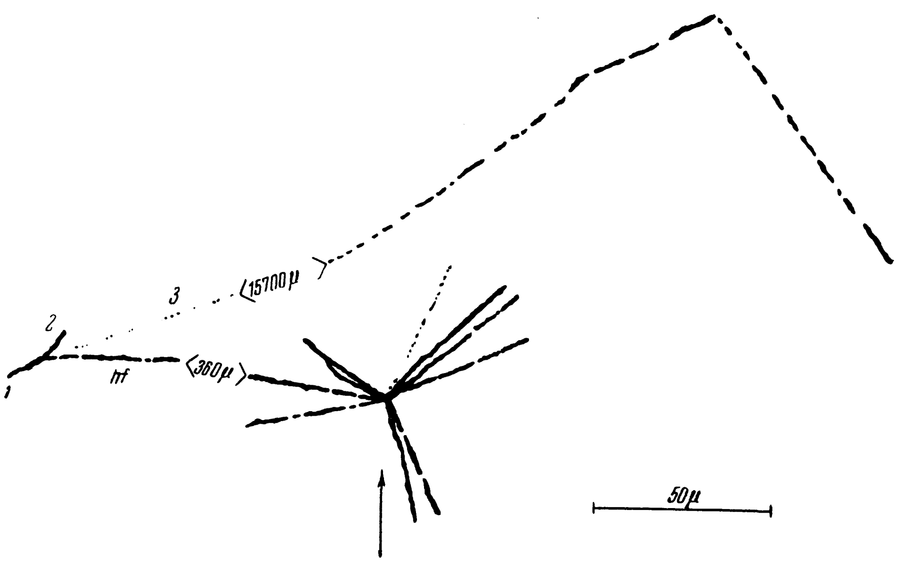

TABLE I. Hyperfragment track

Primary star	Associated phenomena	Range, μ	Dip angle in undeveloped emulsion	Proof of stopping	Z_F	Mass measurement	Energy per nucleon in Mev
$10+0_n$	Unobserved	360 ± 5	10°40′	1) Scattering	1	$>M_p$ (α, R)	≈ 4.2 (if H^3)
				2) Grain density	—	$>M_p$ (g, R)	

TABLE II. Secondary star

Track	Range, μ	Total experimental error	Straggling in %	Dip angle θ	Error $\Delta\theta$	Polar angle φ	Error $\Delta\varphi$	Type of particle	Measured mass	Energy in Mev
1	12	$\pm$ 0.6	$\sim$2.5	−15°20′	±30′	214°30′	± 1°	p	—	0.9
2	12	$\pm$ 0.6	$\sim$2.5	+27°	±40′	55°	± 1°	p	—	0.9
3	15700	$\pm$ 500	$\sim$2.4	+17°40′	±6′	18°40′	±10′	π^-	230^{+90}_{-50} in 1 mm of track	29.8 ± 0.6

The decay scheme ${}^4H^* \rightarrow p + d + n + \pi^-$ cannot be entirely excluded. In this case the large negative values -4.7 ± 1.2 and -4.4 ± 1.2 Mev are obtained for B_{Λ^0} depending upon whether track 1 or 2 is the deuteron. The decay ${}^4H^* \rightarrow p + p + n + n + \pi^-$ into 5 particles also cannot be excluded but possesses small probability.

In our reduction of the data we used values of constants taken from Shapiro's survey article[5].

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