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$\text{H}^*$  (1530-MeV) SPIN AND PARITY

**Berkeley, California**

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Lawrence Radiation Laboratory  
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$\Xi^*$  (1530-MeV) SPIN AND PARITY

Janice Button-Shafer, James S. Lindsey, and Gerald A. Smith

July 3, 1964



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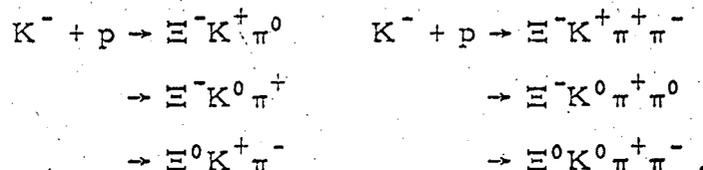
Janice Button-Shafer, James S. Lindsey, and Gerald A. Smith

(Presented by Ronald R. Ross)

Lawrence Radiation Laboratory  
 University of California  
 Berkeley, California

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The  $T=1/2$   $\Xi-\pi$  resonance at 1530 MeV has been analyzed in the following reactions:



The events were obtained with beams of 2.45-, 2.6-, and 2.7-GeV/c  $K^-$  mesons incident on the 72-inch bubble chamber at the Bevatron. Approximately 175 three-body events were obtained at the lowest momentum (2.41 GeV in the center of mass); at 2.6 to 2.7 GeV/c (about 2.49 GeV in the c.m.), 500 three-body events and 85 four-body events were found. The low- and high-momentum samples of  $\Xi K\pi$  yielded 60 and 155  $\Xi^* K$  events, respectively; the  $\Xi K\pi\pi$  sample at high momentum included about 80 events of the type  $\Xi^* K\pi$ .

The three-body events were found to suffer from interference of the  $K^*$  resonance with the  $\Xi^*$  band. In some four-body events, the  $\Xi^*$  (1530) was a decay product of a primary resonance, the  $\Xi^*$  (1820).<sup>1</sup>

The  $\Xi^*$  (1530) decay was analyzed by using the method proposed by Byers and Fenster;<sup>2</sup> this technique was applied in the first study of the  $\Xi^*$  (1530)<sup>3</sup> and was also used for extension of the  $Y_1^*$  (1385) spin-parity analysis.<sup>4</sup> The complexity of the moments, e.g.,  $\langle Y_{LM} \rangle$  or  $\langle PY_{LM} \rangle$  in the

distributions describing the direction and polarization of the decay  $\Xi$ , yields information on the highest spin assignment required; comparison of each moment of the  $\Xi$  transverse polarization with the corresponding moment of its longitudinal polarization gives the parity of the decay.

The  $\Xi^*$  decay was investigated with and without restrictions on the production angle of the  $\Xi^*$ . The coordinate system used for three- and four-body analyses included the normal to the production plane and the incident-beam direction. The value of  $a_{\Xi}$  utilized was -0.43, an approximate best value from  $\Xi$  studies at Berkeley. The moments evaluated from decay distributions are proportional to the expectation values of spin operators,  $t_{LM} = \langle T_{LM} \rangle$ , which describe the  $\Xi^*$  initial spin state. Some of these are presented in Table I.

Table II contains results of spin-parity tests comparing  $t_{LM}$  values from experimental moments in the three-body analysis. Table III presents similar results from the study of the four-body final states. In certain samples the odds in favor of spin 3/2 or those in favor of + parity for spin 3/2 are somewhat improved over the odds stated in reference 3, while in other samples discrimination between hypotheses is poor. Adding the  $\chi^2$  values for all samples except (c) and (f) gives confidence levels for spin 1/2 and spin 3/2 of  $\ll 10^{-7}$  and 0.0004, respectively; adding all  $\chi^2$  values except those for sample (c) gives confidence levels for parity 3/2+ and parity 3/2- of 0.83 and 0.00035, respectively. Combining  $\chi^2$  values for those samples that do not suffer from interference--(d), (e), and (f)--yields confidence levels of  $2 \times 10^{-6}$  and 0.025 for spin 1/2 and 3/2, respectively [sample (f) omitted] and confidence levels of 0.57 and 0.00048 for parity 3/2+ and 3/2-, respectively.

Table I. Typical  $t_{LM}$  values for  $J = 3/2$ .

Sample*	$t_{10}$	$t_{20}$	$t_{30}$	Re $t_{32}$
(a)	$0.72 \pm 1.19$	$-0.25 \pm 0.13$	$0.09 \pm 0.39$	$0.15 \pm 0.26$
(b)	$-0.78 \pm 0.86$	$-0.22 \pm 0.09$	$0.04 \pm 0.27$	$-0.24 \pm 0.17$
(c)	$-1.44 \pm 1.05$	$-0.24 \pm 0.10$	$0.04 \pm 0.32$	$-0.15 \pm 0.21$
(d)	$-0.42 \pm 1.10$	$-0.18 \pm 0.11$	$-0.02 \pm 0.40$	$-0.42 \pm 0.19^\dagger$
(e)	$-0.33 \pm 1.28$	$0.009 \pm 0.14$	$0.51 \pm 0.50$	$-0.09 \pm 0.32$
(f)	$-1.14 \pm 1.70$	$0.17 \pm 0.15$	$0.10 \pm 0.60$	$1.32 \pm 0.50$

\* See Tables II and III for a description of the samples.

† UCLA data (see reference 3). Published values for  $at_{LM}$  were divided by  $a = -0.43$ .

Table II.  $\Xi^*$  spin-parity results (from  $\Xi^*K^-$ ). 3 bags

Sample	Beam momentum (GeV/c)	$\hat{M}^* \cdot \hat{K}^-$ limits	Events	$\chi^2$ ( $J = 1/2$ )	$\chi^2$ ( $J = 3/2$ )	$\chi^2$ ( $3/2+$ )	$\chi^2$ ( $3/2-$ )
a	2.45	-1.0, +1.0	61	72 [ $10^{-6}$ ] <sup>†</sup>	32 [0.006]	1.7 [0.80]	8.2 [0.08]
b	2.6, 2.7	-1.0, +1.0	158	55 [0.0003]	25 [0.05]	1.9 [0.75]	4.8 [0.30]
c	2.6, 2.7	-0.8, +0.8	114	74 [ $<10^{-6}$ ]	30 [0.04]	1.9 [0.75]	2.9 [0.57]
d	1.8, 1.95 (UCLA) <sup>‡</sup>	-1.0, +1.0	91	47 [0.003]	18 [0.27]	1.5 [0.83]	10.3 [0.035]

† Values in brackets are the confidence levels for the  $\chi^2$  values.

‡ See reference 3. Confidence levels are not the same as those in reference 3, but are those the authors believe correct for the stated  $\chi^2$  values.



Table III.  $\Xi^*$  spin-parity results (from  $\Xi^* K \pi$ ).

4 body

Sample	Beam momentum (GeV/c)	$\hat{\Xi}^* \cdot \hat{K}^-$ limits	Events	$\chi^2$ (J = 1/2)	$\chi^2$ (J = 3/2)	$\chi^2$ (3/2+)	$\chi^2$ (3/2-)
e	2.6, 2.7	0, +1.0	49	60 [ $6 \times 10^{-5}$ ] <sup>†</sup>	29 [0.016]	3.1 [0.54]	3.1 [0.54]
f	2.6, 2.7	-1.0, 0	32	719 [ $\ll 10^{-7}$ ]	97 [ $\ll 10^{-7}$ ]	5.8 [0.21]	22.2 [0.0002]

<sup>†</sup> Values in brackets are the confidence levels for the  $\chi^2$  values.

<sup>‡</sup> The high-order moments causing the poor  $\chi^2$  (J = 1/2) and  $\chi^2$  (J = 3/2) values for sample f are not involved in the parity  $\chi^2$  evaluations.



FOOTNOTES AND REFERENCES

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