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Ξ^* (1530-MeV) SPIN AND PARITY

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Ξ^* (1530-MeV) SPIN AND PARITY*

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(Presented by Ronald R. Ross)

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

$$\begin{aligned} K^- + p &\to \Xi^- K^+ \pi^0 \qquad & K^- + p &\to \Xi^- K^+ \pi^+ \pi^- \\ &\to \Xi^- K^0 \pi^+ & &\to \Xi^- K^0 \pi^+ \pi^0 \\ &\to \Xi^0 K^+ \pi^- & &\to \Xi^0 K^0 \pi^+ \pi^- . \end{aligned}$$

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 Ξ^* band. In some four-body events, the Ξ^* (1530) was a decay product of a primary resonance, the Ξ^* (1820).[1]

The Ξ^* (1530) decay was analyzed by using the method proposed by Byers and Fenster;[2] this technique was applied in the first study of the Ξ^* (1530)[3] and was also used for extension of the Y_1^* (1385) spin-parity analysis.[4] 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 Ξ, yields information on the highest spin assignment required; comparison of each moment of the Ξ transverse polarization with the corresponding moment of its longitudinal polarization gives the parity of the decay.

The Ξ^* decay was investigated with and without restrictions on the production angle of the Ξ^*. 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 α_{Ξ} utilized was -0.43, an approximate best value from Ξ 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 Ξ^* 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 χ^2 values for all samples except (c) and (f) gives confidence levels for spin 1/2 and spin 3/2 of $<< 10^{-7}$ and 0.0004, respectively; adding all χ^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 χ^2 values for those samples that do not suffer from interference--(d), (e), and (f)--yields confidence levels of 2×10^{-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 ± 1.19	-0.25 ± 0.13	0.09 ± 0.39	0.15 ± 0.26
(b)	-0.78 ± 0.86	-0.22 ± 0.09	0.04 ± 0.27	-0.24 ± 0.17
(c)	-1.44 ± 1.05	-0.24 ± 0.10	0.04 ± 0.32	-0.15 ± 0.21
(d)	-0.42 ± 1.10	-0.18 ± 0.11	-0.02 ± 0.40	-0.42 ± 0.19†
(e)	-0.33 ± 1.28	0.009 ± 0.14	0.51 ± 0.50	-0.09 ± 0.32
(f)	-1.14 ± 1.70	0.17 ± 0.15	0.10 ± 0.60	1.32 ± 0.50

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

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

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

Sample	Beam momentum (GeV/c)	$\hat{\Xi}^* \cdot \hat{K}^-$ limits	Events	χ^2 (J = 1/2)	χ^2 (J = 3/2)	χ^2 (3/2+)	χ^2 (3/2-)
a	2.45	-1.0, +1.0	61	72	32	1.7	8.2
				[10^{-6}]†	[0.006]	[0.80]	[0.08]
b	2.6 , 2.7	-1.0, +1.0	158	55	25	1.9	4.8
				[0.0003]	[0.05]	[0.75]	[0.30]
c	2.6 , 2.7	-0.8, +0.8	114	74	30	1.9	2.9
				[$<10^{-6}$]	[0.01]	[0.75]	[0.57]
d	1.8 , 1.95	-1.0, +1.0	91	47	18	1.5	10.3
	(UCLA‡)			[0.003]	[0.27]	[0.83]	[0.035]

† Values in brackets are the confidence levels for the χ^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 χ^2 values.

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

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

† Values in brackets are the confidence levels for the χ^2 values.

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

FOOTNOTES AND REFERENCES

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