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E * (1530-MeV) SPIN AMD PARITY

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$^{3}(1530\text{-MeV})$ SPIN AND PARITY

Berkeley, California
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$E^*$ (1530-MeV) SPIN AND PARITY

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July 3, 1964
The $T = \frac{1}{2} \Xi - \pi$ resonance at 1530 MeV has been analyzed in the following reactions:

$$K^- + p \rightarrow \Xi^+ K^0 \pi^- \quad K^- + p \rightarrow \Xi^- K^+ \pi^- \pi^-$$

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 $\Xi^* K \pi \pi$.

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 $\Xi^* (1820)$.

The $\Xi^* (1530)$ decay was analyzed by using the method proposed by Byers and Fenster; this technique was applied in the first study of the $\Xi^* (1530)$ and was also used for extension of the $Y^* (1385)$ spin-parity analysis. The complexity of the moments, e.g., $\langle Y_{LM} \rangle$ or $\langle P Y_{LM} \rangle$ 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 \( < 10^{-7} \) 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 $J = 3/2$. 

<table>
<thead>
<tr>
<th>Sample</th>
<th>$t_{10}$</th>
<th>$t_{20}$</th>
<th>$t_{30}$</th>
<th>Re $t_{32}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>0.72 ± 1.19</td>
<td>-0.25 ± 0.13</td>
<td>0.09 ± 0.39</td>
<td>0.15 ± 0.26</td>
</tr>
<tr>
<td>(b)</td>
<td>-0.78 ± 0.86</td>
<td>-0.22 ± 0.09</td>
<td>0.04 ± 0.27</td>
<td>-0.24 ± 0.17</td>
</tr>
<tr>
<td>(c)</td>
<td>-1.44 ± 1.05</td>
<td>-0.24 ± 0.10</td>
<td>0.04 ± 0.32</td>
<td>-0.15 ± 0.21</td>
</tr>
<tr>
<td>(d)</td>
<td>-0.42 ± 1.10</td>
<td>-0.18 ± 0.11</td>
<td>-0.02 ± 0.40</td>
<td>-0.42 ± 0.19†</td>
</tr>
<tr>
<td>(e)</td>
<td>-0.33 ± 1.28</td>
<td>0.009 ± 0.14</td>
<td>0.51 ± 0.50</td>
<td>-0.09 ± 0.32</td>
</tr>
<tr>
<td>(f)</td>
<td>-1.14 ± 1.70</td>
<td>0.17 ± 0.15</td>
<td>0.10 ± 0.60</td>
<td>1.32 ± 0.50</td>
</tr>
</tbody>
</table>

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

† UCLA data (see reference 3). Published values for $t_{LM}^*$ were divided by $c = -0.43$.

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Table II. $E^*$ spin-parity results (from $E^*K$).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Beam momentum (GeV/c)</th>
<th>$E^*\cdot K$ limits</th>
<th>Events</th>
<th>$\chi^2_{J=1/2}$</th>
<th>$\chi^2_{J=3/2}$</th>
<th>$\chi^2_{3/2+}$</th>
<th>$\chi^2_{3/2-}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>2.45</td>
<td>-1.0, +1.0</td>
<td>64</td>
<td>72</td>
<td>32</td>
<td>1.7</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[40^{-6}]†</td>
<td>[0.006]</td>
<td>[0.80]</td>
</tr>
<tr>
<td>b</td>
<td>2.6, 2.7</td>
<td>-1.0, +1.0</td>
<td>158</td>
<td>55</td>
<td>25</td>
<td>1.9</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.0003]</td>
<td>[0.05]</td>
<td>[0.75]</td>
</tr>
<tr>
<td>c</td>
<td>2.6, 2.7</td>
<td>-0.8, +0.8</td>
<td>114</td>
<td>74</td>
<td>30</td>
<td>1.9</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[&lt;10^{-6}]</td>
<td>[0.01]</td>
<td>[0.75]</td>
</tr>
<tr>
<td>d</td>
<td>1.8, 1.95</td>
<td>-1.0, +1.0</td>
<td>94</td>
<td>47</td>
<td>18</td>
<td>1.5</td>
<td>10.3</td>
</tr>
<tr>
<td>(UCLA†)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0.003]</td>
<td>[0.27]</td>
<td>[0.83]</td>
</tr>
</tbody>
</table>

† 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 $\Xi^*K\pi$).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Beam momentum (GeV/c)</th>
<th>$\Xi^* \cdot K^-$ limits</th>
<th>Events</th>
<th>$\chi^2_{(J = 1/2)}$</th>
<th>$\chi^2_{(J = 3/2)}$</th>
<th>$\chi^2_{(3/2+)}$</th>
<th>$\chi^2_{(3/2-)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>2.6, 2.7</td>
<td>0, +1.0</td>
<td>49</td>
<td>60</td>
<td>29</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>2.6, 2.7</td>
<td>-1.0, 0</td>
<td>32</td>
<td>749</td>
<td>97</td>
<td>5.8</td>
<td>22.2</td>
</tr>
</tbody>
</table>

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

‡ 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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