Symmetries in K-Interaction.

Y. Eisenberg (*) and W. Koch

Physikalisches Institut der Universität - Bern

(ricevuto il 7 Gennaio 1959)

Recently it has been pointed out (1) that the interaction of negative K-mesons with nuclear matter could be used for checking the validity of global symmetry in strong interactions (2). The reaction rates (~cross-section) for the absorption of s-wave K- mesons by single nucleons, calculated by Amati and Vitale (3) under the assumption of global symmetry, are given in Table I (4). For a comparison,

Table I. Reaction rates assuming

<table>
<thead>
<tr>
<th>Reactions</th>
<th>Charge independence only</th>
<th>Charge independence and global symmetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) $K^- p \rightarrow \Sigma^+ + \pi^+$</td>
<td>$\frac{3}{2}r^2 + 1 + \sqrt{6} r \cos \varphi$</td>
<td>$1 + b^2 - 2b + (e^2/2) - \sqrt{2}(1 - bc) \cos (a_1 - a_3)$</td>
</tr>
<tr>
<td>(2) $\Sigma^- p \rightarrow \Sigma^+ + \pi^-$</td>
<td>$\frac{3}{2}r^2 + 1 - \sqrt{6} r \cos \varphi$</td>
<td>$1 + b^2 + 2b + (e^2/2) + \sqrt{2}(1 - bc) \cos (a_1 - a_3)$</td>
</tr>
<tr>
<td>(3) $\Sigma^0 + \pi^0$</td>
<td>$3r^2\Lambda$</td>
<td>$b^2 + 2c^2 - 2\sqrt{2}bc \cos (a_2 - a_4)$</td>
</tr>
<tr>
<td>(4) $\Lambda^0 + \pi^0$</td>
<td>$3r^2\Lambda$</td>
<td>$b^2 + 2c^2 - 2\sqrt{2}bc \cos (a_2 - a_4)$</td>
</tr>
<tr>
<td>(5) $K^- n \rightarrow \Sigma^+ + \pi^0$</td>
<td>$3r^2$</td>
<td>$2b^2 + 2c^2 + \sqrt{2}bc \cos (a_2 - a_4)$</td>
</tr>
<tr>
<td>(6) $\Sigma^0 + \pi^-$</td>
<td>$3r^2$</td>
<td>$2b^2 + 4c^2 - \sqrt{2}bc \cos (a_2 - a_4)$</td>
</tr>
<tr>
<td>(7) $\Lambda^0 + \pi^-$</td>
<td>$6r^2\Lambda$</td>
<td>$2b^2 + 4c^2 - 4\sqrt{2}bc \cos (a_2 - a_4)$</td>
</tr>
</tbody>
</table>

(*) On leave of absence from the Weizmann Institute, Rehovoth.

(1) D. Amati and B. Vitale: Nuovo Cimento, 9, 895 (1958). The single nucleon reaction rates notations used in the present work will be those of Amati and Vitale.


(3) Note that in ref. (1) a factor 6 is missing in all the neutron reaction rates when normalized in the same way as the proton reaction rates.
in the same table the reaction rates obtained (1) by assuming charge independence only, are also given.

The notations used in Table I are:

\[ r \exp [i\varphi] = \frac{\langle T = 1 \mid S^2 \mid T = 1 \rangle}{\langle T = 0 \mid S^2 \mid T = 0 \rangle} \]
\[ r_A = \frac{\langle T = 1 \mid S^A \mid T = 1 \rangle}{\langle T = 0 \mid S^2 \mid T = 0 \rangle} \]

\[ A = i |A| \exp [iz_1], B = i |B| \exp [iz_2], C = i |C| \exp [iz_3] \quad \text{and} \quad b = |B||A|, c = |C||A| \]

The \( a_i \)'s are the pion-hyperon phase shifts for the \( I = \frac{1}{2} \) and \( I = \frac{3}{2} \) states respectively (1).

From Table I we see that from the requirement of charge independence some very simple relations among the various reaction rates follow (*):

\[(1) + (2) + (5) = 2((1) + (2)) \]

In addition to the above equalities, the following inequalities should be satisfied if charge independence holds:

\[(1) + (2) > 2(3) \]

and also the stronger relation:

\[(11) 8 \times (3)[(1) + (2) - 2(3)] - [(1) - (2)]^2 > 0 . \]

This could also be expressed in the form of a triangular inequality (**):

\[ |\sqrt{(1)} - \sqrt{(2)}| < \sqrt{2(5)} < \sqrt{(1)} + \sqrt{(2)}. \]

The requirement of global symmetry (second column of Table I) leads to new inequalities, the simplest of which is (1):

\[(111) [(1) + (2) - 4(3)]^2 + 4[(3) \times (4) - 1(1) \times (2)] > 0. \]

It should be noted that while relations (1) and (11) do not require any special assumptions about the initial state (1) (i.e., unique angular momentum state and unique K^-energy), relation (111) does require such an assumption (1).


(**) Bracketed numbers will denote here reaction rates.

(*) We are grateful to Dr. Vittale for pointing out this to us.