CONCERNING ONE POSSIBLE METHOD OF DETERMINING ISOBAR PARITY

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It is well known that a phase-shift analysis is needed to determine the isobar parity in investigations of elastic PB interactions (P = pseudoscalar meson, B = baryon) when the c.m.s. particle energy is equal to the isobar mass (see [1]). It is necessary here to measure the angular distribution and the polarization of the recoil baryon.

In investigations of heavy isobars it may turn out that the inelastic isobar decay channels play a rather noticeable role. This makes the phase-shift analysis exceedingly difficult. In this case the parity of the isobar in elastic PB interaction could be determined from the contribution made to the recoil baryon polarization of only the resonant term of the amplitude (outside the diffraction region the contribution of the resonant term dominates over the interference between the resonant and nonresonant terms). To this end, however, it would be necessary to have also a polarized target [2]. If it turns out that the isobar decays into a baryon and vector meson, then to determine its parity in the process $P + B \to V + B$ (V = vector meson) at resonant energy, it is possible to dispense with the polarized target [2]. If we use an unpolarized target and measure the polarization of the recoil baryon in all the cases when the vector-meson decay vector $\vec{\tau}$ is located in the region

$$(\vec{\tau}\cdot\vec{n}_2)(\vec{\tau}\cdot\vec{n}_3) \geq 0, \qquad (1)$$

then

$$\frac{\xi_2^{\vec{n}_3}}{\xi_2^{\vec{n}_1}} = \pm \frac{\pi \sin\vartheta \, P'_{j+\frac{1}{2}}(z) \, P'_{j-\frac{1}{2}}(z)}{(j+\frac{1}{2})[(j+\frac{3}{2}) P'_{j-\frac{1}{2}}(z) P_{j+\frac{1}{2}}(z) - (j-\frac{1}{2}) P'_{j+\frac{1}{2}}(z) P_{j-\frac{1}{2}}(z)]} \qquad (2)$$

(We define the vector-meson decay vector either as the normal to the vector-meson decay plane, if the latter decays into three pseudoscalar mesons, or as a unit vector in the direction of the vector-meson decay in the rest frame, if it decays into two pseudoscalar mesons; as shown in [3], the roles of these vectors are perfectly identical.)

The upper sign holds if the parity of the isobar is $(-1)^{j+1/2}$, and the lower if it is $(-1)^{j-1/2}$. The notation in (1) and (2) is: $\vec{n}_1$ - unit vector in the vector-meson momentum direction, $\vec{n}_3$ - unit vector in the direction of $\vec{p}_1 \times \vec{p}_2$ ($\vec{p}_1$ and $\vec{p}_2$ are the momenta of B_1 and B_2), $\vec{n}_2 = \vec{n}_3 \times \vec{n}_1$, $\xi_2^{n_1}$ and $\xi_2^{n_3}$ - projections of the recoil-baryon polarization vector $\vec{\xi}_2$ on the corresponding axes (all vectors are in the c.m.s.), j - spin of the isobar through which the process $P + B \to V + B$ proceeds.

Formula (2) was obtained with account of only the resonant term of the amplitude, and is therefore valid outside the diffraction region.

To measure $\xi_2^{n_1}$ and $\xi_2^{n_3}$, which enter in (2), we can use all cases of vector-meson decay. To this end it is necessary, in cases when $\vec{\tau}$ is in the domain

$$(\vec{\tau}\cdot\vec{n}_2)(\vec{\tau}\cdot\vec{n}_3) \leq 0 \ , \tag{1}$$

to take $\xi_2^{n_1}$ with a sign opposite to that actually measured. We note that if B_2 is a strange baryon, then there is no loss of statistics in the measurement of its polarization.

The foregoing situation is similar to the case when the isobar decays into a lighter isobar with spin 3/2 and a pseudoscalar meson [4].

If it turns out that the polarizations entering into (2) are small, then to determine the parity of the isobar it is necessary to measure the recoil-baryon polarization in those cases when $\vec{\tau}$ is in the domain

$$(\vec{\tau}\cdot\vec{n}_1) > 0, \qquad (\vec{\tau}\cdot\vec{n}_2) > 0, \qquad (\vec{\tau}\cdot\vec{n}_3) > 0, \tag{3}$$

and also

$$(\vec{\tau}\cdot\vec{n}_1) < 0, \qquad (\vec{\tau}\cdot\vec{n}_2) < 0, \qquad (\vec{\tau}\cdot\vec{n}_3) < 0. \tag{3'}$$

In this case

$$\frac{\xi_2^{n_1}}{\xi_2^{n_4}} = \mp \frac{\sqrt{2}\,\sin\vartheta\, P'_{j+\frac{1}{2}}(z)\; P'_{j-\frac{1}{2}}(z)}{(j+\frac{1}{2})[(j+\frac{3}{2})\,P'_{j-\frac{1}{2}}(z)\,P_{j+\frac{1}{2}}(z) - (j-\frac{1}{2})\,P'_{j+\frac{1}{2}}(z)\,P_{j-\frac{1}{2}}(z)]} \tag{4}$$

where $\xi_2^{n_4}$ is the projection $\vec{\xi}_2$ on an axis making an angle $\pi/4$ with $\vec{n}_2$ and $\vec{n}_3$.

We note that the foregoing formulas are valid also if the investigated isobar N^* is produced in the reaction $P_1 + B \rightarrow P_2 + N^*$ and is at the same time emitted forward (Adair's situation), and then decays int V and B_2.

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[1] V. M. Shekhter, Rezonansnoe sostoyanie elementarnykh chastits (Resonant State of Elementary Particles), M., 1965.

[2] M. S. Dubovikov, Dissertation, Moscow Physico-technical Institute, 1965.

[3] M. S. Dubovikov, JETP 47, 1933 (1964), Soviet Phys. JETP 20, 1299 (1965).