K-Meson Conspiracy and the Reactions $p\bar{p} \rightarrow \Lambda\bar{\Lambda}$.

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1. Introduction.

The angular distributions and total cross-sections of the reactions $p\bar{p} \rightarrow \Lambda\bar{\Lambda}$ have been reasonably explained assuming the exchange of a Reggeized $K^*$ (1). In calculating those $K^*$-exchange amplitudes one needs of course the $p\Lambda K^*$ vector and tensor coupling constants, which are more or less unknown. Their values have been theoretically estimated, in the framework of $SU_6$, from the $p\Lambda N'$ vector and tensor coupling constants and a certain mixture of $F/D$ ratio for vector and tensor coupling. Roy (1) used $SU_6$ to fix the $F/D$ ratios as well as the vector to tensor ratio. The only parameter left free is then the $p\Lambda K^*$ vector coupling constant, which is adjusted to the value $g_{p\Lambda K^*}^v \approx 7$, for the best fit to the data.

In all previous calculations, including Roy's, the contribution of the $K$-exchange amplitude has been neglected (1-3) on two accounts.

a) The small value of the coupling constant of strange pseudoscalar mesons to nucleons ($g_s^v$), which was in use at that time, and

b) because of the pseudoscalar nature of the $K$-meson, which makes the $K$-exchange amplitude noncontributing in the forward direction, i.e. in the main region of experimental production.

The just-mentioned arguments for neglecting the $K$-exchange amplitude are reconsidered here for the following two reasons:

1) Kim (7), in a recent analysis, made a new determination of the $p\Lambda K$ coupling constant, and found $g_{p\Lambda K}^v = 16 \pm 2.5$ which is at least twice as big as any previous value and besides is favourable to $SU_3$ symmetry.

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(4) See H. P. C. Rood: Forward dispersion relations and low-energy $K\Lambda N'$ scattering.
2) There is the possibility of a K-conspiracy, in analogy to pion conspiracy (*). The system K-K\(\sigma\) conspirator (K-K\(\sigma\) system) could then give a substantial contribution for small angles, whereas in previous models the contribution was very small. The pion conspiracy has been tried in recent years to explain the sharp forward peaks in \(\pi^+\) photoproduction (\(\dagger\)). If we accept pion conspiracy then by \(SU_3\) symmetry we are led naturally to the kaon conspiracy.

Motivated by this, we have used Kim's large coupling constant to calculate the contribution to the cross-section of the K-K\(\sigma\) conspirator exchange system. We find that reasonable conspiracy models could account for 20 up to 80% of experimental cross-sections.

2. Calculation and results.

Let \(p_1, p_2, p'_1, p'_2\) be the 4-momenta of \(p, \bar{p}, \Lambda\) and \(\bar{\Lambda}\), respectively. In terms of these, we define the Mandelstam invariants

\[ s = (p_1 + p_2)^2, \quad t = (p'_1 - p_1)^2. \]

The differential cross-section for \(p\bar{p} \rightarrow \Lambda\bar{\Lambda}\) is expressed in terms of helicity amplitudes as follows:

\[
\frac{d\sigma}{d\Omega} = \frac{1}{2} \left| \Phi_1^2 + \Phi_2^2 + \Phi_3^2 + 5\Phi_4^2 \right|^2,
\]

where \(\Phi_i(s, t)\) are the helicity amplitudes as defined for example by Sharp and Wagner (\(\dagger\)).

Consider the contribution to the \(\Phi_i\)'s of the K-meson and the K\(\sigma\)-meson exchange amplitude,

\[
\Phi_i(s, t) = \Phi_i^K(s, t) + \Phi_i^\sigma(s, t).
\]

The K-meson pole, due to its pseudoscalar character, contributes only to the \(\Phi_2\) and \(\Phi_4\) amplitudes (\(\Phi_2\) is the nonflip, and \(\Phi_4\) the net helicity-flip amplitude). The K\(\sigma\) pole of course can contribute to all the amplitudes. We shall consider however \(\Phi_2^\sigma\) and \(\Phi_4^\sigma\) only since, in the conspiracy model, they dominate all the others for small \(t\).

The conspiracy requires the following relations among the trajectories \(\alpha_K(t), \alpha_\sigma(t)\) and the residue functions \(b_K(t), b_\sigma(t)\) of the K-K\(\sigma\) system (\(\ddagger\)), at \(t = 0\):

\[
\alpha_K(0) = \alpha_\sigma(0), \quad b_K^\sigma(0) = -\alpha_\sigma(0)b_\sigma^\sigma(0).
\]

(*) The fact that we have here unequal masses has the only effect of shifting the conspiracy point \(t = 0\) from the forward direction \(\theta = 0\) in \(N\bar{N} \rightarrow N\bar{\Lambda}\) to a very small unphysical angle in the present reactions, with no practical effect (see for example S, FRAUTSCHI and L. JONES: Phys. Rev., 167, 1335 (1968)).

