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1) The peaks in backward meson-baryon scattering were considered earlier [4] not only in the quark model but also in the Sakata model (sakaton exchange). In the latter model, however, there should be no peak in backward $\pi^- p$ elastic scattering, and this contradicts the experimental data.

2) The distribution of the cross sections depends on $p_\perp$ and differs from the distribution in u (or in t). Near 180°, however, when $|\sin\theta| \approx |\tan\theta|$, identical slopes in the plots of the cross sections against u (or t) correspond also to identical slopes in the plot against $p_\perp$.

3) This ratio was measured also at 4 GeV/c, but at this energy the backward-scattering cross section is strongly influenced also by isobar production [10,11].

CONSEQUENCES OF THE QUARK MODEL FOR THE ANNIHILATION OF A PROTON-ANTIPROTON PAIR INTO A HYPERON-ANTIHYPERON PAIR

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We analyze in this note the consequences of the quark model for the annihilation of a nucleon-antinucleon pair into a pair of hyperons. We assume with this that the model under consideration is valid at high energies and relatively low momentum transfers, when the final hyperon is emitted in the c.m.s. in the direction of the momentum of the initial nucleon, and the antihyperon is emitted in the direction of the initial antiproton momentum.

Then the amplitudes of the processes $\bar{N} + N \to \bar{Y} + Y$ can, in the quark ideology [1], be additively made up of the $\bar{p}' + p' \to \bar{\Lambda}' + \Lambda'$ and $\bar{n}' + n' \to \bar{\Lambda}' + \Lambda'$ quark amplitudes, which are equal in magnitude (owing to isotopic invariance) and differ only in sign. In such a scheme we can attempt to take into account the moderately strong interaction in the same manner as used by Lipkin [2] for elastic scattering of hadrons, i.e., we can assume that exact SU(3) symmetry does not hold for the quark amplitudes. For the processes considered, the turning on of the moderately strong interaction does not change the results that follow.

In the quark model, the following relations hold between the cross sections for production of baryons and antibaryons belonging to octet representations of the SU(3) group:

$$\sigma(\bar{p}p \to \bar{\Sigma}^-\Sigma^-) = \sigma(\bar{p}p \to \bar{\Xi}^0\Xi^0) = \sigma(\bar{p}p \to \bar{\Xi}^-\Xi^-) = \sigma(\bar{p}n \to \bar{\Xi}^0\Xi^-) = 0 \tag{1}$$

$$\begin{aligned}\frac{1}{9}\sigma(\bar{p}p \to \bar{\Lambda}\Lambda) &= \sigma(\bar{p}p \to \bar{\Sigma}^0\Sigma^0) = \frac{1}{3}\sigma(\bar{p}p \to \bar{\Lambda}\Sigma^0) = \frac{1}{3}\sigma(\bar{p}p \to \bar{\Sigma}^0\Lambda) = \frac{1}{4}\sigma(\bar{p}p \to \bar{\Sigma}^+\Sigma^+) \\ &= \frac{1}{2}\sigma(\bar{p}n \to \bar{\Sigma}^+\Sigma^0) = \frac{1}{6}\sigma(\bar{p}n \to \bar{\Sigma}^+\Lambda) = \frac{1}{2}\sigma(\bar{p}n \to \bar{\Sigma}^0\Sigma^-) = \frac{1}{6}\sigma(\bar{p}n \to \bar{\Lambda}\Sigma^-).\end{aligned} \tag{2}$$

Equations (1) are a natural consequence of the model under consideration, since it corresponds to exchange of octet representations of the SU(3) group in the t-channel.

T a b l e

Reaction	σ, μb					
	2.8 [3]	3.0 [4]	3.6 [4]	4.0 [4]	5.7 [5]	6.94 [6]
$\bar p + p \to \bar\Lambda + \Lambda$	-	117 ± 18	72 ± 20	39 ± 16	40 ± 10	31 ± 13
$\bar p + p \to \bar\Lambda + \Sigma^0 + (\text{c. c})$	-	102 ± 17	67 ± 19	46 ± 13	30 ± 8	-
$\bar p + p \to \bar\Sigma^0 + \Sigma^0$	-	< 18	< 22	< 17	-	-
$\bar p + p \to \Sigma^+ + \Sigma^+$	-	31 ± 5	23 ± 6	$18^{+6}_{-3.5}$	37 ± 10	20
$\bar p + p \to \bar\Sigma^- + \Sigma^-$	-	9.5 ± 4	11 ± 4	$8^{+3}_{-3.5}$	2 ± 6	37
$\bar p + p \to \bar\Xi^- + \Xi^-$	-	2.1 ± 1	< 1	< 1	-	11 ± 4
$\bar p + p \to \left\{\begin{matrix}\bar\Sigma^+ + \Lambda \\ \bar\Lambda + \Sigma^-\end{matrix}\right.$	139 ± 23	-	-	-	-	-

The table lists the presently available experimental data (for different antiproton momenta in GeV/c) concerning annihilation into a hyperon-antihyperon pair. A characteristic feature of these data is a clearly pronounced angular dependence of the differential cross sections, viz., the overwhelming number of antihyperons produced in the direction of the antiproton c.m.s. momentum. Therefore (1) and (2) can be regarded as valid for the total cross sections, too.

Comparison of the experimental data with (1) and (2) shows that, first, the exclusion rules (1) are well satisfied and, second, relation (2) also agrees with experiment within the limits of errors.

In terms of the quark amplitudes indicated above, we can express also the amplitudes for the production of an antihyperon (hyperon) and hyperon (antihyperon) resonance belonging to the decuplet. This gives rise to the relations:

$$\begin{aligned}\sigma(\bar pp \to \bar\Sigma^-\Sigma^-_\delta) &= \sigma(\bar pp \to \bar\Sigma^-_\delta\Sigma^-) = \sigma(\bar pp \to \bar\Xi^0\Xi^0_\delta) = \sigma(\bar pp \to \bar\Xi^0_\delta\Xi^0) = \sigma(\bar pp \to \bar\Xi^-\Xi^-_\delta) \\ &= \sigma(\bar pp \to \bar\Xi^-_\delta\Xi^-) = \sigma(\bar pn \to \bar\Xi^0\Xi^-_\delta) = \sigma(\bar pn \to \bar\Xi^0_\delta\Xi^-) = 0,\end{aligned} \tag{3}$$

$$\begin{aligned}\sigma(\bar pp \to \bar\Lambda\Sigma^0_\delta) &= \sigma(\bar pp \to \bar\Sigma^0_\delta\Lambda) = 3\sigma(\bar pp \to \bar\Sigma^0\Sigma^0_\delta) = 3\sigma(\bar pp \to \bar\Sigma^0_\delta\Sigma^0) = 3\sigma(\bar pp \to \bar\Sigma^+\Sigma^+_\delta) \\ &= 3\sigma(\bar pp \to \bar\Sigma^+_\delta\Sigma^+) = 2\sigma(\bar pn \to \bar\Lambda\Sigma^-_\delta)2\sigma(\bar pn \to \bar\Sigma^+_\delta\Lambda) = 6\sigma(\bar pn \to \bar\Sigma^0\Sigma^-_\delta) = 6\sigma(\bar pn \to \bar\Sigma^+_\delta\Sigma^0).\end{aligned} \tag{4}$$

From the data on the annihilation of antiprotons with momentum 5.7 GeV/c [5] we have:

$$\sigma(\bar{p}p \to \bar{\Sigma}^-\Sigma_\delta^-) + \sigma(\bar{p}p \to \bar{\Sigma}_\delta^-\Sigma^-) \simeq 1\ \mu b,$$

$$\sigma(\bar{p}p \to \bar{\Sigma}^+\Sigma_\delta^+) + \sigma(\bar{p}p \to \bar{\Sigma}_\delta^+\Sigma^+) \simeq 12\ \mu b,$$

$$\sigma(\bar{p}p \to \bar{\Lambda}\Sigma_\delta^0) + \sigma(\bar{p}p \to \bar{\Sigma}_\delta^0\Lambda) \simeq 50\ \mu b,$$

which agrees with the predictions (3) - (4).

In conclusion we note that the quark model considered here predicts suppression of the Ω^--hyperon production reaction $\bar{p} + p \to \bar{\Omega}^- + \Omega^-$; this, too, is in good agreement with the experimental data [6].

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E r r a t a

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The abscissas of Fig. 2 represent B_0 in kOe.