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$SU(3) \otimes SU(3)$ AND NON-LEPTONIC
HYPERON DECAYS

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Although $SU(6)$ has been applied with success to the classification of particles at rest ¹⁾, it is not always applicable to interactions with moving particles ²⁾. Volkov ³⁾ has proposed to consider, for collinear processes, its $SU(3) \otimes SU(3)$ subgroup generated by the operators $\lambda_i(1 \pm \sigma_z)$ and this has led ⁴⁾ to many of the results of the $SL(6, C)$ group ⁵⁾. One of these $SU(3)$ groups acts on spin-up quarks [indices 1 to 3 of $SU(6)$] and the other on spin-down quarks (indices 4 to 6) and the decomposition of the $SU(6)$ multiplets under this group follows immediately from the formulae given by Sakita ¹⁾. We will not write down invariants and just state the results below.

We will first discuss hyperon non-leptonic decays when the weak interaction Hamiltonian transforms like the $(8_3^2 + 8_2^3)$ component of the representation 35 of $SU(6)$ ⁶⁾. Imposing $SU(3) \otimes SU(3)$ invariance to the Lagrangian for $\text{baryon}_1 (s_z = +\frac{1}{2}) \rightarrow \text{baryon}_2 (s_z = +\frac{1}{2}) + \text{meson}$ leads to 9 independent amplitudes. Demanding also PC invariance ⁷⁾ reduces these to three amplitudes for the parity violating decays (S and D waves) and six amplitudes for the parity conserving decays (P waves). This leads to the relations :

$$\langle \Sigma^+ \rightarrow n \pi^+ \rangle_S = 0 \quad (1)$$

$$\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_D = 0 \quad (2)$$

$$\langle \Omega^- \rightarrow \Xi^0 \pi^- \rangle_D = -\frac{\sqrt{5}}{\sqrt{2}} \langle \Lambda^0 \rightarrow p \pi^- \rangle_S + \frac{\sqrt{15}}{2} \langle \Sigma^- \rightarrow n \pi^- \rangle_S \quad (3)$$

$$\langle \Lambda^0 \rightarrow p \pi^- \rangle_S + 2 \langle \Xi^- \rightarrow \Lambda^0 \pi^- \rangle_S - \sqrt{3} \langle \Sigma^+ \rightarrow p \pi^0 \rangle_S = 0 \quad (4)$$

$$\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_P = \frac{\sqrt{3}}{2} \left\{ \langle \Lambda^0 \rightarrow p \pi^- \rangle_P + 2 \langle \Xi^- \rightarrow \Lambda^0 \pi^- \rangle_P - \sqrt{3} \langle \Sigma^+ \rightarrow p \pi^0 \rangle_P \right\} \quad (5)$$

When PC is not imposed, relation (5) remains valid, and for the parity violating amplitudes one obtains the similar equation :

$$\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_D = \frac{\sqrt{15}}{2} \left\{ \langle \Lambda^0 \rightarrow p \pi^- \rangle_S + 2 \langle \Xi^- \rightarrow \Lambda^0 \pi^- \rangle_S - \sqrt{3} \langle \Sigma^+ \rightarrow p \pi^0 \rangle_S \right\} \quad (5')$$

Relation (4) follows already from $SU(3)$ and PC invariance ⁷⁾. To obtain it in the framework of $SU(3) \otimes SU(3)$ one needs explicitly the PC condition as opposed to the case of $SU(6)$ invariance where it follows already without PC invariance ⁶⁾. The only relation obtained for P waves, (5), has already been obtained in a different way in Ref. ⁸⁾.

Assuming invariance under $SU(6)$ for the parity violating amplitudes gives, as could have been expected, zero for the D wave amplitudes $\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_D$ and $\langle \Omega^- \rightarrow \Xi^0 \pi^- \rangle_D$ and relations (1), (3) and (4) reduce to the ones of Altarelli et al. and Suzuki ⁶⁾.

It has been seen that in $SU(6)$, relation (1) remains still valid when all current-current $\Delta T = \frac{1}{2}$ spurions contained in the representations 189 and 405 are allowed ^{9),10)} and PC is assumed. This is not the case in $SU(3) \otimes SU(3)$. When one allows for Lagrangians transforming like $(8_2^2 + 8_2^3)$ of 189 and 405 one only obtains the relation :

$$\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_D = \sqrt{10} \langle \Sigma^+ \rightarrow n \pi^+ \rangle_S \quad (6)$$

Equation (6) permits to take into account the threshold behaviour of the $\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_D$ and $\langle \Sigma^+ \rightarrow n \pi^+ \rangle_S$ amplitudes (which has to be the same) and predicts

$$\langle \Omega^- \rightarrow \Lambda^0 K^- \rangle_D = \sqrt{10} \left(\frac{p_{K^-}}{p_{\pi^+}} \right)^2 \langle \Sigma^+ \rightarrow n \pi^+ \rangle_S = 4,3 \langle \Sigma^+ \rightarrow n \pi^+ \rangle_S = \begin{matrix} -0,05 \pm 0,13 & (a) \\ -1,72 \pm 0,06 & (b) \end{matrix} \quad (7)$$

$\times 10^5 \text{ sec}^{-1} m_{\pi}^{-1}$

for solutions (a) and (b) of Ref. ¹¹⁾. On the other hand, Eq. (3) is not sufficient to determine $\langle \Omega^- \rightarrow \Xi^0 \pi^- \rangle_D$ due to the difference in threshold behaviour of the S and D waves.

Let us finally remark that, the fewer $SU(3) \otimes SU(3)$ predictions could be compatible with the experimental situation, whereas the more plentiful predictions of $SU(6)_W$ or $\widetilde{SU}(12)$ models contradict experiment ^{10),12)}.

REFERENCES AND FOOTNOTES

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- 2) As far as we know, excepting the S wave hyperon decays which require the introduction of a spurion, the only test of pure SU(6) could be the ratio

$$\frac{K^- p \rightarrow \Sigma^0 \pi^0}{K^- p \rightarrow \Lambda^0 \pi^0}$$
 for K^- absorption at rest. The initial and final states are in an S wave and pure SU(6) predicts this ratio to be $\frac{1}{3}$, while experimentally it is 4 (phase space corrections lead thus to a discrepancy of a factor 16). Nevertheless, the near lying $Y_0^*(1405)$ might induce a strong SU(6) breaking.
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