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U(6,6) SYMMETRY AND HIGHER BARYON RESONANCES

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It has been proposed recently by Dothan, Gell-Mann and Ne'eman¹⁾ that infinite dimensional unitary representations of $U(6,6)$ might be useful for the description of higher meson and baryon resonances. The two simplest ladder representations of the $U(6,6)$ algebra were considered, in reference 1, as possible candidates for the mesons and for the baryons, and correspond to the following infinite series of $SU(6) \times SU(6)$ representations: $(1,1)^+$, $(6,\bar{6})^-$, $(21,\bar{21})^+$, $(56,\bar{56})^-$, etc., (for the mesons), and $(56,1)^+$, $(126,\bar{6})^-$, $(252,\bar{21})^+$, etc., (for the baryons).

Here we consider the consequences which follow from the assignment of the ladder representation to the higher baryonic resonances for the interaction of these resonances with the $(56,1)$ baryonic and the $(6,\bar{6})$ mesonic $SU(6) \times SU(6)$ multiplets.

We shall label each $SU(6) \times SU(6)$ multiplet of the ladder representation by an integer n ($n = 0, 1, \dots$), which corresponds to the number of upper indices in the usual tensor notation for the multiplets:

$$B_{ABC}, B_{ABCD}^{\dot{D}}, B_{ABCDE}^{\dot{D}\dot{E}}, \dots$$

For every value of n we shall consider the states with the maximum possible value of spin $j = \frac{3}{2} + n$, and the next possible one $j = \frac{1}{2} + n$, with the parity in both cases equal to $(-1)^n$. It can be shown that the decays of the states with $j = \frac{3}{2} + n$ into the octet of pseudoscalar mesons and the baryons of the $(56,1)$ $SU(6) \times SU(6)$ representation, and also the decays of the states with $j = \frac{1}{2} + n$ into the octet of pseudoscalar mesons and the octet of baryons, are determined by a single $[SU(6)]_W$ -invariant amplitude of the form $(56)_W(35)_W \leftarrow (56)_W$, where index W denotes the moving $SU(6)$ subgroup of $SU(6) \times SU(6)$.

Because in the initial $(56)_W$ representation the only $SU(3)$ representations present are an octet and a decuplet, no mixture with other $SU(3)$ representations appearing in an $SU(6) \times SU(6)$ multiplet can affect

the resulting branching ratios. The only mixture which should be considered is the mixture of octet and decuplet states for the states with $j = \frac{1}{2} + n$. In the case of the states with $j = \frac{3}{2} + n$ there is no octet in $SU(6) \times SU(6)$ representations and no mixing occurs.

The resulting branching ratios are as follows:

for the decay of $N_{3/2}^*$ ($j = \frac{3}{2} + n$)

$$\begin{aligned} (N_{3/2}^* \pi) : (N_{3/2}^* \eta) : (Y_1^* K) &= 5 : 1 : 2 \\ (N\pi) : (\Sigma K) &= 1 : 1 \\ (N_{3/2}^* \pi) : (N\pi) &= 5(2n+5) : 8(n+1); \end{aligned}$$

for the decay of Y_1^* ($j = \frac{3}{2} + n$)

$$\begin{aligned} (Y_1^* \pi) : (Y_1^* \eta) : (E^* K) : (N_{3/2}^* \bar{K}) &= 1 : 0 : 1 : 1 \\ (\Sigma \pi) : (\Sigma \eta) : (\Lambda \pi) : (E K) : (N \bar{K}) &= 2 : 3 : 3 : 2 : 2 \\ (Y_1^* \pi) : (\Sigma \pi) &= (2n+5) : (n+1); \end{aligned}$$

for the decay of E^* ($j = \frac{3}{2} + n$)

$$\begin{aligned} (E^* \pi) : (E^* \eta) : (\Omega K) : (Y_1^* \bar{K}) &= 1 : 1 : 2 : 4 \\ (E \pi) : (E \eta) : (\Sigma \bar{K}) : (\Lambda \bar{K}) &= 1 : 1 : 1 : 1 \\ (E^* \pi) : (E \pi) &= (2n+1) : 4(n+1); \end{aligned}$$

for the decay of $N_{1/2}^*$ ($j = \frac{1}{2} + n$) ^{*})

$$(N\pi) : (N\eta) : (\Sigma K) : (\Lambda K) = 25 : 1 : 1 : 9 ;$$

for the decay of Y_0^* ($j = \frac{1}{2} + n$)

$$(\Sigma \pi) : (\Lambda \eta) : (E K) : (N \bar{K}) = 6 : 2 : 1 : 9 ;$$

for the decay of $N_{3/2}^*$ ($j = \frac{1}{2} + n$)

$$(N\pi) : (\Sigma K) = 1 : 1 ;$$

^{*}) In the cases of $N_{1/2}^*$ and Y_0^* , when the decaying resonance is an octet, the listed ratios are the consequence of the relation $F/D = \frac{2}{3}$ which holds for all n.

for the decay of Y_1^* ($j = \frac{1}{2} + n$)

$$(\Sigma\pi) : (\Sigma\eta) : (\Lambda\pi) : (\Xi K) : (N\bar{K}) \\ = 2(4+a)^2 : 3(2+a)^2 : 3(2-a)^2 : 2(5-a)^2 : 2(1+a)^2 ;$$

for the decay of Ξ^* ($j = \frac{1}{2} + n$)

$$(\Xi\pi) : (\Xi\eta) : (\Sigma\bar{K}) : (\Lambda\bar{K}) = (1-b)^2 : (3-b)^2 : (5+b)^2 : (1-b)^2 .$$

In the last two cases the parameters a and b correspond to the octet-decuplet mixing parameters for the states with $j = n + \frac{1}{2}$. The listed branching ratios should be corrected for the phase space and the q^{n+1} dependence of the decay amplitudes. The total correction factor is q^{2n+3} .

Comparison of the corrected branching ratios with the corresponding experimental values for the decays of $Y_0^*(1520)$, $Y_0^*(1815)$ and $Y_1^*(1660)$ (with $a \simeq 2$ *) gives rather reasonable agreement.

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REFERENCE

- 1) Y. Dothan, M. Gell-Mann and Y. Ne'eman, Physics Letters 17, 148 (1965).

) We consider the $Y_0^(1660)$ resonance to have $j = \frac{3}{2}$ and negative parity. If the parity of this resonance is positive then it does not belong to the considered series of resonance states.