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ELECTROMAGNETIC SPLITTING OF THE MASSES OF THE 70-PLET IN THE SU(6) SYMMETRY SCHEME

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The classification of new baryon resonances in the 70-plet of the SU(6) symmetry group, and also their mass ratios, were discussed in several papers [1-3]. The relations between the magnetic moments for this multiplet were found in [4,5]. In this paper we consider the electromagnetic mass splitting for this multiplet.

Following Kuo and Yao [6], we assume that the electromagnetic mass splitting is a second-order effect in the electromagnetic interaction, and that the corresponding Hamiltonian is of the form

$$H_{em} = aQQ + b\vec{M}\vec{M} \tag{1}$$

where Q and $\vec{M}$ transform like the charge and magnetic-moment operators, respectively:

$$Q = A_1^1 + A_4^4$$
$$\vec{M} = Q\vec{\sigma}$$

We assume at the same time that the magnetic moments of all the possible quarks of which the 70-plet can be made up are the same.

The states of the 70-plet are described by a mixed-symmetry tensor $\Psi_{[AB]C}$ [7]

$$\Psi_{[AB]C} = \frac{\Lambda}{\sqrt{6}}\epsilon_{\alpha\beta\gamma}X_{(ij)k} + \frac{\sqrt{2}}{3}\left[2\Psi_{[\alpha\beta]\gamma}X_{(ij)k} - \Psi_{[\beta\gamma]\alpha}X_{(jk)i} - \Psi_{[\gamma\alpha]\beta}X_{(ki)j}\right] + \Phi_{(\alpha\beta\gamma)}X_{[ij]k} + \xi_{[\alpha\beta]\gamma}X_{(ijk)} \tag{2}$$

where $A \equiv (\alpha i)$, $B \equiv (\beta j)$, and $C \equiv (\gamma k)$; α, β, and γ are unitary indices; i, j, and k are spin indices. Expression (2) corresponds to the expansion of the irreducible representation of the SU(6) 70 group into the following irreducible representations of the subgroup SU(3) ⊗ SU(2):

$$\underline{70} = (1,2) + (8,2) + (10,2) + (8,4)$$

where [1])

$$(1,2) : \Lambda'$$
$$(8,2) : \tilde{N}, \tilde{\Sigma}, \tilde{\Lambda}, \tilde{\Xi}$$
$$(10,2) : \tilde{N}^*, \tilde{Y}_1^*, \tilde{\Xi}^*, \tilde{\Omega}$$
$$(8,4) : N_\gamma, \Sigma_\gamma, \Lambda_\gamma, \Xi_\gamma$$

The Hamiltonian (1) leads to the following general expression for the matrix element

$$\langle 70|H_{em}|70\rangle = \Sigma_{Tr} a_i \bar{\Psi}QQ\Psi + \Sigma_{Tr} b_i \overline{\Psi\vec{M}\vec{M}\Psi} \tag{3}$$

Where Σ_{Tr} denotes summation over all possible methods of contracting the indices. Expression (3) can be reduced to

$$\langle 70|H_{em}|70\rangle = a_0\overline{\Psi}^{[AB]C}\Psi_{[AB]C} + b_1\overline{\Psi}^{[AB]C}Q_A^{A'}\Psi_{[A'B]C} + b_2\overline{\Psi}^{[AB]C}Q_A^{A'}\Psi_{[A'C]B}$$

$$+ c_1\overline{\Psi}^{[CA]B}Q_A^{A'}Q_B^{B'}\Psi_{[CA']B} + c_2\overline{\Psi}^{[CA]B}Q_A^{A'}Q_B^{B'}\Psi_{[CB']A'} \tag{4}$$

$$+ d_1\overline{\Psi}^{[CA]B}\vec{M}_A^{A'}\vec{M}_B^{B'}\Psi_{[CA']B'} + d_2\overline{\Psi}^{[CA]B}\vec{M}_A^{A'}\vec{M}_B^{B'}\Psi_{[CB']A'}$$

Other contraction methods can be reduced to the foregoing ones with the aid of the relation

$$\Psi_{[AB]C} + \Psi_{[BC]A} + \Psi_{[CA]B} = 0$$

Expression (4) actually contains six parameters, since the first term in its right side gives the total mass shift and therefore makes no contribution to the splitting.

Substituting (2) in (4), we obtain the following eight independent relations (the particle symbols are used in place of their masses):

$$\tilde{N}^{*-} - \tilde{N}^{*0} = \tilde{Y}_1^{*-} - \tilde{Y}_1^{*0} = \tilde{\Xi}^{*-} - \tilde{\Xi}^{*0} = (\tilde{N}^{*++} - \tilde{N}^{*0}) - 3(\tilde{N}^{*+} - \tilde{N}^{*0})$$

$$\tilde{N}^{*+} - \tilde{N}^{*0} = \tilde{Y}_1^{*+} - \tilde{Y}_1^{*0} = \tilde{p} - \tilde{n} = (\tilde{\Sigma}^{+} - \tilde{\Sigma}^{-}) + (\tilde{\Xi}^{-} - \tilde{\Xi}^{0})$$

$$(\Sigma_\gamma^+ - \Sigma_\gamma^-) + (\Xi_\gamma^- - \Xi_\gamma^0) = p_\gamma - n_\gamma$$

$$8(\Sigma_\gamma^- - \Sigma_\gamma^0) + 4(\Xi_\gamma^- - \Xi_\gamma^0) = 35(\tilde{N}^{*-} - \tilde{N}^{*0}) + 31(\tilde{\Xi}^{-} - \tilde{\Xi}^{0}) - 54(\tilde{\Sigma}^{-} - \tilde{\Sigma}^{0})$$

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1) The symbols for the particles are taken here from [2].