and the specification of a "minimal" solution of the analyticity and factorization requirements. The model of Bitar and Tindle[46] has a correlation between the small-t dependence and the asymptotic s dependence of the t-channel amplitudes. For the terms in the amplitude with the normal $s^{\alpha-m}$ behavior (in $F^{\pm}$), one finds $p=M-m$ and $p=0$ for $M\geqq m$ and $m>M$, respectively, while $q=M-m$, 0, and $n-M$ for $M\geqq m$, $m>M\geqq n$, and $n>M$, respectively. This corresponds to the equality of trajectories and residues in (64) for $j=0,\cdots,(n-1)$ or $(M-1)$, whichever is smaller. In Bitar and Tindle's model there are, however, terms with $p=q=0$ and less than the leading power of s.

[46] K. M. Bitar and G. L. Tindle, Phys. Rev. 175, 1835 (1968).

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Decays of Odd-Parity Baryon Resonances*

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Baryon members of the three-quark $SU(6)$ **70** and **56** are coupled with a vector spurion assigned to the 1^3 of an $SU(6)$ **35** to form odd-parity baryon resonances. Branching ratios for decays are calculated using the relativistic techniques of $SU(6)_W$ and are compared with experiment. The $N_{3/2}^*(1518)$ and $Y_1^*(1660)$ are assigned to an $8^4\subset 1^3\otimes 8^2$ of **35**$\otimes$**70**. Observed branching ratios indicate that the decays proceed through the **70** channel as Capps has predicted. The $Y_1^*(1765)$, $Y_0^*(1830)$, and $\Xi_{3/2}^*(1935)$ are assigned to an $8^6\subset 1^3\otimes 8^4$ of **35**$\otimes$**70**. Missing members of these multiplets are discussed and branching ratios given. Decay amplitudes for other possible multiplets are stated.

INTRODUCTION

THERE are two possible ways of looking at the observed negative-parity baryon resonances if one assumes a quark model.[1] They can be thought of either as four-quark–one-antiquark systems with zero orbital angular momentum or as three-quark systems with one unit of orbital angular momentum. A detailed study of the consequences of both models is required in order to determine which model, if either, is correct.

The first model places a negative-parity baryon resonance in a multiplet of extremely high dimensionality. Coyne, Meshkov, and Yodh have assumed such a model for $Y_1^*(1765)$, which they put in the 1134-dimensional representation of $SU(6)$.[2] Using the (relativistic) techniques of $SU(6)_W$,[3] they have calculated ratios of decay widths which are in reasonable agreement with experiment.

The second model places a negative-parity baryon resonance in a smaller representation of $SU(6)$ and, since the highest possible total intrinsic spin of a three-quark system is $\frac{3}{2}$, adds a unit of orbital angular momentum. Mitra and Ross have calculated decay widths for the **70**$\otimes$**3** representation of $SU(6)\otimes O(3)$ assuming a static $SU(6)$ invariant model and have obtained good results for some states, notably the $Y_1^*(1765)$.[4] Their calculation, which assumes a quark-quark interaction, produces the same ratio of decay widths for the $Y_1^*(1765)$ as Coyne, Meshkov, and Yodh. Capps, who assumes an attractive interaction which transforms like a member of the **70** of $SU(6)$, has noticed that a W-spin calculation produces a result which looks like the inclusion of some P state in the interaction in a quark model.[5] He also gets a ratio of decay widths in agreement with the calculation of Ref. 2.

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[1] S. Meshkov, in *Proceedings of the Third Coral Gables Conference on Symmetry Principles at High Energy* (W. H. Freeman and Co., San Francisco, 1966), p. 150; C. D. Nwachuku, Nuovo Cimento **51**, 1158 (1967).

[2] J. J. Coyne, S. Meshkov, and G. B. Yodh, Phys. Rev. Letters **17**, 666 (1966).

[3] H. Harari, D. Horn, M. Kugler, H. J. Lipkin, and S. Meshkov, Phys. Rev. **146**, 1052 (1966); **140**, B1003 (1965).

[4] A. N. Mitra and M. Ross, Phys. Rev. **158**, 1630 (1967); O. W. Greenberg, *ibid.* **163**, 1844 (1967); K. T. Mahantappa and E. C. G. Sudarshan, Phys. Rev. Letters **14**, 163 (1965); D. L. Katyal, V. S. Bhasin, and A. N. Mitra, Phys. Rev. **161**, 1546 (1967); H. J. Lipkin, *ibid.* **159**, 1303 (1967); P. N. Dobson, Jr., *ibid.* **160**, 1501 (1967); A. Kernan and W. M. Smart, Phys. Rev. Letters **17**, 832 (1966); S. Fenster *et al.*, *ibid.* **17**, 841 (1966); D. L. Katyal and A. N. Mitra, Phys. Rev. **169**, 1322 (1968); G. C. Joshi, V. S. Bhasin, and A. N. Mitra, *ibid.* **156**, 1572 (1967); Sutapa Das Gupta and A. N. Mitra, *ibid.* **156**, 1581 (1967); P. G. O. Freund, A. N. Maheshwari, and E. Schonberg, *ibid.* **159**, 1232 (1967).

[5] R. H. Capps, Phys. Rev. **158**, 1433 (1967); **153**, 1503 (1967).

The rarity of states with high Y (hypercharge) and I (isotopic spin) casts doubt upon the existence of the **1134** of $SU(6)$.[6] In the present calculation we retain the four-quark–one-antiquark model, but we form the $Y_1^*(1765)$ in a different manner from the calculation of Ref. 2. We couple a vector angular momentum spurion [the 1^3 of the **35** of $SU(6)$] with a baryon of the **70** or **56** of $SU(6)$.[7] Decay-width calculations are then possible using generalized Clebsch-Gordan coefficients for the product $\mathbf{35}\otimes\mathbf{70}$.[8] Particles are classified according to $SU(6)_S$ and decay widths are calculated after transforming to $SU(6)_W$.[3] We have used the $SU(3)$ coupling coefficients of Chilton and McNamee.[9] Experimental data are taken from the compilation of Rosenfeld *et al.*[10] A more recent analysis by Merrill and Button-Shafer[11] substantiates the assignment of $J^P=\frac{3}{2}^-$ to the $\Xi^*(1815)$.

CALCULATION

The details of the calculation are as follows: The state from which the decay takes place is written in $SU(6)_S$ as arising from $1^3\otimes 8^4$ using the ordinary angular momentum Clebsch-Gordan coefficients (our notation is $[SU(3)\text{ multiplicity}]^{SU(2)\text{multiplicity}}$). For example:

$$8_{\frac{3}{2}}{}^6=(\sqrt{\tfrac{2}{5}})(1_0{}^3\otimes 8_{\frac{3}{2}}{}^4)+(\sqrt{\tfrac{3}{5}})(1_1{}^3\otimes 8_{\frac{1}{2}}{}^4)\,, \quad (1)$$

where superscripts refer to SU_2 multiplicity and subscripts to helicity. The state is next subjected to a W-spin transformation.[12] Thus

$$8_{\frac{3}{2}}{}^6\xrightarrow{W}(\sqrt{\tfrac{2}{5}})(1_0{}^1\otimes 8_{\frac{3}{2}}{}^4)+(\sqrt{\tfrac{3}{5}})(1_1{}^3\otimes 8_{\frac{1}{2}}{}^4)\,. \quad (2)$$

The W-spin transformation has taken us partially out of $\mathbf{35}\otimes\mathbf{70}$ into $\mathbf{1}\otimes\mathbf{70}$, since the $1_0{}^1$ is not a member of the **35**. Thus

$$8_{\frac{3}{2}}{}^6\xrightarrow{W}\tfrac{3}{5}8_{\frac{3}{2}}{}^6(1^3\otimes 8^4)+\tfrac{1}{5}(\sqrt{6})8_{\frac{3}{2}}{}^4(1^3\otimes 8^4)+(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^4(\mathbf{1}\otimes\mathbf{70})\,. \quad (3)$$

[Our notation means, for example, that the 8^6 under W spin transforms into an 8^4 which belongs to the $1^3\otimes 8^4$ of the $SU(6)$ $\mathbf{35}\otimes\mathbf{70}$ and an 8^4 of the $SU(6)$ $\mathbf{1}\otimes\mathbf{70}$.]

The 8^6 and 8^4 in $\mathbf{35}\otimes\mathbf{70}$ which arise from $1^3\otimes 8^4$ contain contributions from the various representations formed by $\mathbf{35}\otimes\mathbf{70}$.

$$8^6(1^3\otimes 8^4)=\tfrac{1}{4}(\sqrt{10})8^6\{1134\}-\tfrac{1}{2}8^6\{560\}+\tfrac{1}{2}(\sqrt{\tfrac{1}{2}})8^6\{540\}\,, \quad (4)$$

$$\begin{aligned}8^4(1^3\otimes 8^4)=&\tfrac{1}{4}(5/3)^{1/2}8_B{}^4\{560\}-\tfrac{5}{8}(\sqrt{\tfrac{2}{3}})8_C{}^4\{1134\}\\&+(\sqrt{\tfrac{1}{6}})8_A{}^4\{1134\}+\tfrac{1}{2}(\sqrt{\tfrac{1}{3}})8_B{}^4\{560\}\\&-\tfrac{1}{4}8_A{}^4\{540\}+\tfrac{1}{4}(5/3)^{1/2}8_B{}^4\{540\}\\&-\tfrac{1}{4}8_C{}^4\{540\}-\tfrac{1}{4}(5/3)^{1/2}8^4\{70_{\mathrm{I}}\}\\&-\tfrac{1}{8}(10/3)^{1/2}8^4\{70_{\mathrm{II}}\}\,, \end{aligned}\quad (5)$$

where the numbers in curly brackets on the right refer to $SU(6)$ multiplicities of product states. The letters refer to $8_A{}^4$, $8_B{}^4$, and $8_C{}^4$ of the **1134**, etc. The Roman numerals specify the non-simply-reducible $SU(6)$ representations. The notation used is that of Ref. 8. The terms from Eq. (3) which are contained in the initial state are therefore

$$\begin{aligned}\tfrac{3}{5}8_{\frac{3}{2}}{}^6=&\tfrac{3}{4}(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^6\{1134\}-\tfrac{3}{10}8_{\frac{3}{2}}{}^6\{560\}+\tfrac{3}{20}\sqrt{2}8_{\frac{3}{2}}{}^6\{540\}\,,\\ \tfrac{1}{5}(\sqrt{6})8_{\frac{3}{2}}{}^4=&\tfrac{1}{2}(\sqrt{\tfrac{1}{10}})8_{B\frac{3}{2}}{}^4\{1134\}-\tfrac{1}{4}8_{C\frac{3}{2}}{}^4\{1134\}\\&+\tfrac{1}{5}8_{A\frac{3}{2}}{}^4\{560\}+\tfrac{1}{5}(\sqrt{\tfrac{1}{2}})8_{B\frac{3}{2}}{}^4\{560\}\\&-(1/20)(\sqrt{6})8_{A\frac{3}{2}}{}^4\{540\}+\tfrac{1}{2}(\sqrt{\tfrac{1}{10}})8_{B\frac{3}{2}}{}^4\{540\}\\&-(1/20)(\sqrt{6})8_{C\frac{3}{2}}{}^4\{540\}-\tfrac{1}{2}8_{\frac{3}{2}}{}^4(\sqrt{\tfrac{1}{10}})\{70_{\mathrm{I}}\}\\&-(1/20)(\sqrt{5})8_{\frac{3}{2}}{}^4\{70_{\mathrm{II}}\}\,,\end{aligned}\quad (6)$$

$$(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^4\{\mathbf{1}\otimes\mathbf{70}\}\,.$$

The $SU(6)$ **70**-plet structure of the initial state requires special consideration. It is

$$-\tfrac{1}{2}(\sqrt{\tfrac{1}{10}})8_{\frac{3}{2}}{}^4\{70_{\mathrm{I}}\}-\tfrac{1}{4}(\sqrt{\tfrac{1}{5}})8_{\frac{3}{2}}{}^4\{70_{\mathrm{II}}\}+(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^4\{\mathbf{1}\otimes\mathbf{70}\}\,. \quad (7)$$

In the present calculation, the initial state belongs to $\mathbf{35}\otimes\mathbf{70}$ and the final state belongs to $\mathbf{35}\otimes\mathbf{56}$. The interaction which accounts for the decay is invariant under both $[U(6)\otimes U(6)]_\beta$ and $SU(6)_W$. It is important, therefore, to consider the $[U(6)\otimes U(6)]_\beta$ structure of the initial state and the final state. Final states of physical interest belong to $\mathbf{35}\otimes\mathbf{56}$. States of $\mathbf{35}\otimes\mathbf{56}$ belong to either $(210,\bar{6})$ or $(126,\bar{6})$, while states of $\mathbf{35}\otimes\mathbf{70}$ belong to $(210,\bar{6})$, $(105_A,\bar{6})$, or $(105_B,\bar{6})$. The **1134** of both $\mathbf{35}\otimes\mathbf{56}$ and $\mathbf{35}\otimes\mathbf{70}$ is contained in $(210,\bar{6})$, so the **1134** of both the initial state and the final state has the same $U(6)\otimes U(6)$ structure. The **70** of $\mathbf{35}\otimes\mathbf{56}$ belongs to $(210,\bar{6})$ exclusively, while the **70** of $\mathbf{35}\otimes\mathbf{70}$ belongs to $(210,\bar{6})$, $(105_A,\bar{6})$, and $(105_B,\bar{6})$. The overlap

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[6] Y. Ne'eman, in *Proceedings of the Third Coral Gables Conference on Symmetry Principles at High Energy* (W. H. Freeman and Co., San Francisco, 1966), p. 272; D. Horn, H. J. Lipkin, and S. Meshkov, Phys. Rev. Letters **17**, 1200 (1966), have shown that it is possible that the **1134** does exist but that there are selection rules which inhibit its decay by modes most easily accessible to experiment.

[7] M. Gell-Mann, Phys. Rev. Letters **14**, 77 (1965); V. de Alfaro and Y. Tomoyawa, Phys. Rev. **138**, B1193 (1965); A. Pais, Rev. Mod. Phys. **38**, 215 (1966); H. Ruegg and W. Ruhl, Helv. Phys. Acta **40**, 9 (1967); S. N. Gupta, Phys. Rev. **154**, 1456 (1967); **151**, 1235 (1966); R. Ferrari and M. Konuma, Phys. Rev. Letters **14**, 378 (1965).

[8] J. C. Carter and J. J. Coyne (to be published). Classification problems arising from the nonsimple reducibility of certain products in $\mathbf{35}\otimes\mathbf{70}$ have been solved by determining the 210 (four-quark) parentage of each state. This has been done by projecting out the four-quark part of each state, thus guaranteeing that a state which belongs to, e.g., $10_A{}^4$ of the **1134** in $\mathbf{35}\otimes\mathbf{70}$ is the same state as a state of the $10_A{}^4$ of the **1134** of $\mathbf{35}\otimes\mathbf{56}$.

[9] P. McNamee and Frank Chilton, Rev. Mod. Phys. **36**, 1005 (1964).

[10] A. H. Rosenfeld *et al.*, Rev. Mod. Phys. **40**, 77 (1968).

[11] D. W. Merrill and J. Button-Shafer, Phys. Rev. **167**, 1202 (1968).

[12] Our W-spin phase convention is that under a W-spin transformation $\Psi_{\pm1}{}^1$ goes into $\pm\Psi_{\pm1}{}^1$ and $\Psi_0{}^1$ goes into $\Psi_0{}^0$, where the the superscript gives the $q\bar{q}$ total intrinsic spin and the subscript gives the third component of spin.

TABLE I. Branching ratios for decay of initial state: $8^4 \subset 1^3 \otimes 8^4$.

	Observed resonance		Branching ratios Calculated	Experimental
$Y=1, I=\frac{1}{2}$	$N^*(1518)$	$N_{\frac{3}{2}}^*(1236)\pi/N\pi$	0.08	0.35
		$N\eta/N\pi$	0.28	0.006 approximate
$Y=0, I=1$	$Y^*(1660)$	$\bar{K}N/\Lambda\pi$	1	0.4 All are quite uncertain.
		$\Sigma\pi/\Lambda\pi$	5	2
		$Y_1^*(1385)\pi/\Lambda\pi$	0.4	4
$Y=0, I=0$		$\bar{K}N/\Sigma\pi$	7.0	Data are incomplete for $Y^*(1690)$, but do not agree well. $\bar{K}N/\Sigma\pi \approx \frac{1}{3}$; these are the only decay modes observed.
		$\bar{K}N/Y_1^*\pi$	0.33	
		$\bar{K}N/\Lambda\eta$	0.56	
$Y=-1, I=\frac{1}{2}$		$\bar{K}\Sigma/\bar{K}\Lambda$	0.28	$\Xi^*(1815)$ has $\Xi^*\pi/\bar{K}\Lambda \approx 0.2$ and the $\bar{K}\Sigma$ mode is unobserved.
		$\Xi^*\pi/\bar{K}\Lambda$	0.07	
		$\Xi\pi/\bar{K}\Lambda$	0.31	

of the **70**'s in our calculation is only in $(210,\bar{6})$. The $(210,\bar{6})$ content of (7) turns out to be[8]

$$\tfrac{3}{4}(\sqrt{\tfrac{1}{5}})8_{\frac{3}{2}}{}^4\{\mathbf{70};\,(210,\bar{6})\}. \tag{8}$$

The decay products of physical interest are the pseudoscalar mesons and the baryon members of the $SU(6)$ **56**. We here calculate a decay into $8_0{}^1 \otimes 10_{\frac{3}{2}}{}^4$, where the pseudoscalar mesons are put in 8^1 and the decuplet baryons in 10^4. The calculation proceeds as above:

$$(8_0{}^1 \otimes 10_{\frac{3}{2}}{}^4) \overset{W}{\longrightarrow} (8_0{}^3 \otimes 10_{\frac{3}{2}}{}^4) = \alpha[(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^6 - (\sqrt{\tfrac{3}{5}})8_{\frac{3}{2}}{}^4] + \cdots,$$

$$(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^6 = (\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^6\{1134\},$$

$$-(\sqrt{\tfrac{3}{5}})8_{\frac{3}{2}}{}^4 = -\tfrac{1}{4}8_{\frac{3}{2}C}{}^4\{1134\} + \tfrac{1}{4}(\sqrt{5})8_{\frac{3}{2}}{}^4\{70\} - (\sqrt{\tfrac{1}{10}})8_{\frac{3}{2}B}{}^4\{1134\} - \tfrac{1}{2}(\sqrt{\tfrac{1}{2}})8_{\frac{3}{2}}{}^4\{700\}, \tag{9}$$

where α is an $SU(3)$ multiplet coupling coefficient for the desired final state in $8 \otimes 10 = 8$.

Now that the initial and final states have been subjected to a W-spin transformation and written out in full, the matrix element for the decay is

$$\begin{aligned}
&\langle 8_{\frac{3}{2}}{}^6(1^3 \otimes 8^4) \,|\, (8_0{}^1 \otimes 10_{\frac{3}{2}}{}^4)\rangle \\
&= \alpha\langle \tfrac{3}{4}(\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^6\{1134\} - \tfrac{3}{10}8_{\frac{3}{2}}{}^6\{560\} \\
&\quad + \tfrac{3}{20}\sqrt{2}8_{\frac{3}{2}}{}^6\{540\} + \tfrac{1}{2}(\sqrt{\tfrac{1}{10}})8_{B\frac{3}{2}}{}^4\{1134\} - \tfrac{1}{4}8_{C\frac{3}{2}}{}^4\{1134\} \\
&\quad + \tfrac{1}{5}8_{A\frac{3}{2}}{}^4\{560\} + \tfrac{1}{10}\sqrt{2}8_{B\frac{3}{2}}{}^4\{560\} \\
&\quad - (1/20)(\sqrt{6})8_{A\frac{3}{2}}{}^4\{540\} + \tfrac{3}{4}(\sqrt{\tfrac{1}{5}})8_{\frac{3}{2}}{}^4\{70;\,(210,\bar{6})\} \\
&\quad + \cdots \,|\, (\sqrt{\tfrac{2}{5}})8_{\frac{3}{2}}{}^6\{1134\} - (\sqrt{\tfrac{1}{10}})8_{B\frac{3}{2}}{}^4\{1134\} \\
&\quad - \tfrac{1}{4}8_{C\frac{3}{2}}{}^4\{1134\} + \tfrac{1}{4}(\sqrt{5})8_{\frac{3}{2}}{}^4\{70;\,(210,\bar{6})\} \\
&\qquad\qquad - \tfrac{1}{2}(\sqrt{\tfrac{1}{2}})8_{\frac{3}{2}}{}^4\{700\} + \cdots\rangle \\
&= \alpha\tfrac{3}{10}\langle 8_{\frac{3}{2}}{}^6\{1134\} \,|\, 8_{\frac{3}{2}}{}^6\{1134\}\rangle \\
&\quad - (1/20)\langle 8_{B\frac{3}{2}}{}^4\{1134\} \,|\, 8_{B\frac{3}{2}}{}^4\{1134\}\rangle \\
&\quad + \tfrac{1}{16}\langle 8_{C\frac{3}{2}}{}^4\{1134\} \,|\, 8_{C\frac{3}{2}}{}^4\{1134\}\rangle + \tfrac{3}{16}\langle 8_{\frac{3}{2}}{}^4\{70\} \,|\, 8_{\frac{3}{2}}{}^4\{70\}\rangle \\
&= \alpha[\tfrac{3}{10}D - (1/20)D + \tfrac{1}{16}D + \tfrac{3}{16}A] = \tfrac{1}{16}(5D + 3A)\alpha.
\end{aligned} \tag{10}$$

A is the decay width for the **70** channel and D for the **1134** channel. It is to be noted that the interaction connects only states of the same multiplicity in $[U(6) \otimes U(6)]_\beta$, $SU(6)_W$, and $SU(3) \otimes SU(2)_W$. It is assumed that different $SU(6)_W$ channels correspond to different decay widths. The decay width for each channel is obtained by squaring the contribution for each helicity state and summing over the allowed helicities. To compare with experiment, we use the method described in earlier work.[2,13]

RESULTS

We have calculated branching ratios for the members of the $J^P = \frac{3}{2}^-$ octet of states, which we assign to a $1^3 \otimes 8^2$ of $\mathbf{35} \otimes \mathbf{70}$, the 8^2 being a $J^P = \frac{1}{2}^+$ baryon octet. Comparisons with experimental branching ratios suggest that decays from this octet proceed entirely through the **70** channel, as has been suggested by Capps.[14] The ratios are presented in Table I, with experimental values for those possible members which have been investigated. For the missing members Dalitz[15] has suggested the $\Xi^*(1815)$ and an as yet unobserved $Y_0^*(1670)$. Merrill and Button-Shafer[11] suggest that the $Y_0^*(1690)$ could be this resonance. Comparison of our branching ratios with presently available data discourages this view. Further experimental investigation of these two resonances would be helpful. The $Y_1^*(1660)$ has been discussed by Mitra and Ross[6] and by Capps.[5] Their results differ from ours.

For completeness, branching ratios for members of a $J^P = \frac{5}{2}^-$ octet assigned to a $1^3 \otimes 8^4$ of $\mathbf{35} \otimes \mathbf{70}$ are given in Table II with experimental results for some possible members of the multiplet. It should be noted that our model may not be as good for this particular multiplet as for the $\frac{3}{2}^-$ octet or for the $\frac{5}{2}^-$ decuplet discussed below, since the necessary $\frac{3}{2}^+$ octet is not

[13] J. C. Carter, J. J. Coyne, and S. Meshkov, Phys. Rev. Letters **15**, 373 (1965); **15**, 768(E) (1965); C. L. Cook and G. Murtaza, Nuovo Cimento **39**, 531 (1965).
[14] R. H. Capps, Phys. Rev. Letters **14**, 842 (1965).
[15] R. H. Dalitz, in *Proceedings of the Oxford International Conference on Elementary Particles, 1965* (Rutherford High Energy Laboratory, Chilton, Berkshire, England, 1965).

TABLE II: Branching ratios for decay of initial state: $8^6 \subset 1^3 \otimes 8^4$.

	Observed resonance		Branching ratios Calculated	Experimental
$Y=1,\ I=\frac{1}{2}$		$N\pi/N_{3/2}^*\pi$	$\frac{1}{9}$	$N^*(1680)$ is discussed in the text.
		$N\eta/N_{3/2}^*\pi$	$\frac{1}{9}$	
		$\Lambda K/\Lambda_{3/2}^*\pi$	0	
$Y=0,\ I=1$	$Y^*(1765)$	$\bar{K}N/\Lambda\pi$	2.7	2.7
		$\Sigma\eta/\Lambda\pi$	1.0	0.15
		$\Lambda^*\pi/\Lambda\pi$	2.3	1.1
$Y=0,\ I=0$	$Y^*(1830)$	$\bar{K}N/\Sigma\pi$	0	0.2
		$\Lambda\pi/\Sigma\pi$	0	The $\Lambda\pi$ and $\Lambda\eta$ decay modes are unobserved.
		$\Lambda\pi/\Sigma\pi$	0.33	
$Y=-1,\ I=\frac{1}{2}$	$\Xi^*(1935)$	$\bar{K}N/\pi\Xi$	$\frac{1}{4}$	Little is known about this resonance. The $\pi\Xi$ mode is dominant
		$\bar{K}\Sigma/\pi\Xi$	$\frac{1}{4}$	

observed. This, however, may not be an objection as it can be explained in terms of the hidden-spin quark model of Franklin.[16] Previous investigators, each using a different model, have obtained precisely the same amplitude ratios as ours for this octet.[2,4,5] The $N_{5/2}^*(1680)$ does not appear to have the branching ratios predicted for the $Y=1$, $I=\frac{1}{2}$ member of this multiplet, although the mass relation

$$\tfrac{1}{2}(M_N)+\tfrac{1}{2}(M_\Xi)=\tfrac{1}{4}(M_\Sigma)+\tfrac{3}{4}(M_\Lambda) \tag{11}$$

requires an $N_{5/2}^*$ of mass around 1685 MeV.

The decuplet of $J^P=\frac{3}{2}^+$ baryons is well known and usually assigned to a **56** of $SU(6)$. Thus it is reasonable to expect that there exists a $J^P=\frac{5}{2}^-$ decuplet of baryon resonances assigned to a $1^3\otimes 10^4$ of $\mathbf{35}\otimes\mathbf{56}$, although comparison of branching ratios indicates that its members have not been observed. The decay amplitudes are

$$\begin{aligned}
&\langle 10_{3/2}^6(1^3\otimes 10^4)\,|\,(8_0^1\otimes 10_{3/2}^4)\rangle \\
&\qquad = -\tfrac{2}{5}(\surd\tfrac{1}{10})[D-(5/3)A+\tfrac{2}{3}B]\gamma\,, \\
&\langle 10_{3/2}^6(1^3\otimes 10^4)\,|\,(8_0^1\otimes 10_{1/2}^4)\rangle \\
&\qquad = -\tfrac{1}{5}(1/15)^{1/2}[D-(5/3)A+\tfrac{2}{3}B]\gamma\,, \\
&\langle 10_{3/2}^6(1^3\otimes 10^4)\,|\,(8_0^1\otimes 8_{1/2}^2)\rangle \\
&\qquad = \tfrac{2}{5}(1/15)^{1/2}[D-(5/3)A+\tfrac{2}{3}B]\rangle\delta\,,
\end{aligned} \tag{12}$$

where γ is an $SU(3)$ multiplet coupling coefficient for $8\otimes 10=10$, where δ is an $SU(3)$ multiplet coupling coefficient for $8\otimes 8=10$, and where superscripts refer to $SU(2)$ multiplicity and subscripts to helicity. D, C, A, and B refer to the **1134**, **700**, **70**, and **56** channels, respectively.

A $J^P=\frac{3}{2}^-$ octet can be assigned to a $1^3\otimes 8^2$ of $\mathbf{35}\otimes\mathbf{56}$. Branching ratios for this octet do not agree with experiment as well as those presented in Table I. This is somewhat surprising as the $J^P=\frac{1}{2}^+$ octet of baryons in its ground state is usually assigned to an $SU(6)$ **56**.[17] The decay amplitudes are

$$\begin{aligned}
&\langle 8_{3/2}^4(1^3\otimes 8^2)\,|\,(8_0^1\otimes 10_{3/2}^4)\rangle \\
&\quad = [-(5/3)(1/30)^{1/2}D-\tfrac{5}{8}(1/30)^{1/2}A \\
&\qquad\qquad +(5/4)(1/30)^{1/2}C]\alpha\,, \\
&\langle 8_{1/2}^4(1^3\otimes 8^2)\,|\,(8_0^1\otimes 10_{1/2}^4)\rangle \\
&\quad = [-\tfrac{1}{8}(1/30)^{1/2}D-(25/72)(1/30)^{1/2}A \\
&\qquad +(35/108)(1/30)^{1/2}C+(4/27)(1/30)^{1/2}B]\alpha\,, \\
&\langle 8_{1/2}^4(1^3\otimes 8^2)\,|\,(8_0^1\otimes 8_{1/2}^2)\rangle \\
&\quad = (1/15)^{1/2}(\tfrac{1}{4}D+(5/36)A-(25/54)C+(2/27)B) \\
&\qquad\qquad \times[\epsilon_S-(\surd\tfrac{4}{5})\epsilon_A]\,,
\end{aligned} \tag{13}$$

where $\epsilon_S(\epsilon_A)$ is a multiplet coefficient for $8\otimes 8=8_S(8_A)$. A 10^4 can also be formed from $1^3\otimes 10^2$ in $\mathbf{35}\otimes\mathbf{70}$. Should evidence be found for the existence of a $J^P=\frac{3}{2}^-$ decuplet, this should be considered as a possible model. The decay amplitudes are

$$\begin{aligned}
&\langle 10_{3/2}^4(1^3\otimes 10^2)\,|\,(8_0^1\otimes 10_{3/2}^4)\rangle = \tfrac{1}{5}(\surd\tfrac{1}{6})(4D+B)\alpha\,, \\
&\langle 10_{1/2}^4(1^3\otimes 10^2)\,|\,(8_0^1\otimes 10_{1/2}^4)\rangle \\
&\qquad = (\surd\tfrac{1}{6})(\tfrac{1}{5}D+(7/9)A+(1/45)B)\alpha\,, \\
&\langle 10_{1/2}^4(1^3\otimes 10^2)\,|\,(8_0^1\otimes 10_{1/2}^2)\rangle \\
&\qquad = \tfrac{1}{3}(\surd\tfrac{1}{6})((1/20)D+(7/12)A-(2/15)B)\rangle\delta\,.
\end{aligned} \tag{14}$$

We have applied this model to the $J^P=2^+$ mesons and have obtained the same ratio of amplitudes for decay into vector or pseudoscalar meson final states as that previously found by Horn *et al.*,[18] although our calculation goes through the **280** and $\overline{\mathbf{280}}$ channels.

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