This possibility can only be realized in the s wave, if the low-energy behavior $\tan\delta \sim K^{2l+1}$ is to be preserved. While the position of the Ω^- mass might be shifted by their arguments, it is not possible to argue away its existence within the framework of unitary symmetry.

[3]These sheets are defined by the conditions $\mathrm{Im}E^{1/2}$ is positive (negative) on I and IV (II and III), and $\mathrm{Im}(E-M^2)^{1/2}$ is positive (negative) on I and II (III and IV). Thus sheet I is the physical sheet of this Riemann surface.

[4]For angular-momentum states higher than S-wave these poles will meet at $E=0$. This arises from the well-known result that the width of a resonance goes as E^{l+1}.

[5]The single-channel aspect of this problem is discussed in somewhat more detail by P. V. Landshoff, Nuovo Cimento 28, 123 (1963).

NONLEPTONIC WEAK DECAYS AND THE EIGHTFOLD WAY*

Murray Gell-Mann
California Institute of Technology, Pasadena, California
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Assuming that the strongly interacting particles approximately obey the "eightfold way" symmetry,[1,2] we may try to investigate the consequences of the further assumption that the weak interactions of baryons and mesons have simple transformation properties under the same symmetry.

It was suggested[1] that the weak current for interaction with leptons consists of a vector term, which is the current of a component of the F spin, plus an axial-vector term that constitutes the same component of another unitary octet. This model leads to the selection rules $\Delta Y=0$, $|\Delta\vec{I}|=1$ and $\Delta Y/\Delta Q=+1$, $|\Delta\vec{I}|=1/2$ for the current, as well as a conserved vector current for $\Delta Y=0$ and a nearly conserved vector current for $\Delta Y/\Delta Q=+1$. Let us suppose that the model is correct.

In reference 1, the component of the F spin involved was taken to be $F_1+iF_2+F_4+iF_5$ (equal strength for $\Delta Y=0$ and $\Delta Y/\Delta Q=+1$). However, an alternative and, in some ways, more attractive form for universality was suggested by Gell-Mann and Lévy,[3] which amounts in the eightfold way to taking a different component, namely, $\cos\theta(F_1+iF_2)+\sin\theta(F_4+iF_5)$ with θ small. This form of the eightfold-way model has been studied in an elegant paper of Cabibbo,[4] who finds that several experiments indicate a consistent value of θ around 0.26 radian.

Let us now apply the model to the nonleptonic weak interactions formed from the weak current times its Hermitian conjugate; such a current-current interaction may, of course, be carried by an intermediate boson. The strangeness-changing part of this nonleptonic interaction is then the sixth component of a unitary octet plus a term that transforms like the representation 27. The octet part obeys $|\Delta\vec{I}|=1/2$ while the 27 part has $|\Delta\vec{I}|=1/2, 3/2$. Both obey $|\Delta Y|=1$, of course.

There are two simple possibilities that may explain the predominance[5] of $|\Delta\vec{I}|=1/2$ in nonleptonic decays: (a) There are other terms, formed from neutral current products, such that $|\Delta\vec{I}|=3/2$ is canceled out, with $|\Delta Y|$ still equal to 1, or (b) some mechanism, such as the predominance of scalar and pseudoscalar meson intermediate states, selectively enhances the contribution of $|\Delta\vec{I}|=1/2$ "spurions" compared with that of $|\Delta\vec{I}|=3/2$ "spurions." Let us assume that in either case the mechanism that gets rid of the $|\Delta\vec{I}|=3/2$ term gets rid of the whole 27 and leaves just the octet,[6,7] for $|\Delta Y|=1$.

Now every octet that goes into itself under charge conjugation has a characteristic number $\mathcal{C}=\pm1$, which is the charge-conjugation quantum number C of its 1, 3, 4, 6, and 8 components; the charge-conjugation quantum number C of the 2, 5, and 7 components is $-\mathcal{C}$. When two octets are combined to make a third octet, the value of $\mathcal{C}$ for the third one is the product of the $\mathcal{C}$ values for the first two octets times η, where η is +1 when the octets are coupled through the symmetric symbol d_{ijk} (which is nonvanishing only when an even number of 2's, 5's, and 7's occur among the indices) and -1 when they are coupled through the antisymmetric symbol f_{ijk} (which is nonvanishing only for an odd number of 2's, 5's, and 7's).

The vector current has $\mathcal{C}=-1$, like the vector-meson octet, while the axial-vector current has $\mathcal{C}=+1$ (with no $\mathcal{C}=-1$ impurity ever proved) like the pseudoscalar meson octet. In forming the nonleptonic interaction, the symmetric coupling through the d_{ijk} symbol is what comes in and thus the octet that results has $\mathcal{C}=+1$ for the parity-conserving (p-c) term and $\mathcal{C}=-1$ for the parity-violating (p-v) term. The sixth component thus has $CP=+1$ in each case.

By contrast, the $K_1{}^0$ particle, in the eightfold way, is the seventh component of a pseudoscalar octet with $\mathcal{C} = +1$. Again $CP = +1$, but the transition between the p-v spurion and K_1^0 is forbidden by SU(3). This fact tends to make alternative (b) above somewhat less attractive than it was without unitary symmetry.

Next, consider the transition from the p-v spurion to $K_1^0 + \pi^+ + \pi^-$ or $K_1^0 + \pi^0 + \pi^0$ in a symmetrical state, which is responsible for the decays $K_1^0 \to 2\pi$. Since the K and π's all belong to the same octet, the unitary spin coupling of the three octets to form the fourth must be totally symmetric. With this coupling, we can form out of $K_1^0 + 2\pi$ the seventh component of a pseudoscalar octet with $\mathcal{C} = +1$ (like K_1^0) but not the sixth component of a pseudoscalar octet with $\mathcal{C} = -1$ (like the p-v spurion). Thus, $K_1^0 \to 2\pi$ is forbidden[8] by SU(3).

Finally, the property $\mathcal{C} = -1$ of the p-v spurion gives one condition on the four independent observable p-v amplitudes A in the weak decay of strange baryons into baryon plus pion:

$$-A(\Lambda \to p + \pi^-) + 2A(\Xi^- \to \Lambda + \pi^-) = \sqrt{3}A(\Sigma^+ \to p + \pi^0).$$

This condition, compatible with experimental evidence, is valid in the limit of unitary symmetry in the model presented here. In references 6 and 7, the same condition is found for both p-v and p-c amplitudes, but on the basis of R invariance, which does not appear to be a good approximation, at any rate for baryons.

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[1]M. Gell-Mann, California Institute of Technology Synchrotron Laboratory Report CTSL-20, 1961 (unpublished); Phys. Rev. 125, 1067 (1962).

[2]Y. Ne'eman, Nucl. Phys. 26, 222 (1961).

[3]M. Gell-Mann and M. Lévy, Nuovo Cimento 16, 705 (1960). See also M. Gell-Mann, Proceedings of the Tenth Annual International Rochester Conference on High-Energy Physics, 1960 (Interscience Publishers, Inc., New York, 1960).

[4]N. Cabibbo, Phys. Rev. Letters 10, 531 (1963).

[5]The current evidence for this rule is reviewed by R. H. Dalitz (to be published).

[6]Benjamin Lee (to be published).

[7]Hirotaka Sugawara (to be published).

[8]The author is much indebted to Professor Cabibbo for a discussion of this matter. N. Cabibbo (to be published) points out that with $K_1^0 \to 2\pi$ forbidden by SU(3), the comparatively high rate of $K^+ \to 2\pi$ need not be an obstacle to a theory of purely electromagnetic violation of the nonleptonic rule $|\Delta \vec{I}| = 1/2$, in accordance with possibility (a) above. One simple theory of type (a) would involve a single neutral current, transforming like $(-F_3 - 3^{-1/2}F_8)\cos\theta + (F_6 + iF_7)\sin\theta$, to accompany the single charged current transforming like $(F_1 + iF_2) \times \cos\theta + (F_4 + iF_5)\sin\theta$. Each would be multiplied by its Hermitian conjugate.

ERRATA

Σ-RADIATIVE DECAY AS A METHOD OF DETERMINING THE ANGULAR MOMENTUM OF THE Σ-PIONIC DECAY. Saul Barshay, Uriel Nauenberg, and Jonas Schultz [Phys. Rev. Letters 12, 76 (1964)].

In Fig. 3 the dashed lines refer to the P-wave case and the solid lines to the S-wave case.

VARIATIONAL PROPERTY OF FREE-ENERGY PERTURBATION THEORY. Harold Falk [Phys. Rev. Letters 12, 93 (1964)].

A printer's error occurred in the last term of Eq. (4). In the upper limit of the $d\lambda_1$ integral, the subscript p should be deleted. In Eq. (7), the exponent of $(-\beta)$ should be $m - 1$.