exists a group of SU(2) symmetry of somewhat modified operators (2).

The operator

$$X_2' = [K^2(H^2 - m^2) + \ell^4 Z^2 m^2]^{-1/2} [-iK\rho_1(H - m\rho_3) - \ell^2 mZ \frac{\vec{\sigma}\mathbf{r}}{r}] \quad (10)$$

is an integral of motion in the relativistic Coulomb problem [5].

The operator

$$X_1' = [(H^2 - m^2)K^4 + \ell^4 Z^2 m^2 K^2]^{-1/2} [K^2 \rho_1(H - m\rho_3) - i\ell^2 mZ \frac{K\vec{\sigma}\mathbf{r}}{r}] \quad (11)$$

is also an integral of the motion.

The operators $X_1'X_2'X_3'$ obey the commutation relations (3). The existence of a symmetry group of SU(2) symmetry in the relativistic Coulomb problem explains the double degeneracy with respect to the number j. The details of the calculation will be published later.

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UNITARY STRUCTURE OF THE PARITY- AND STRANGENESS-CHANGING NONLEPTONIC WEAK INTERACTION

E. M. Lipmanov
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It is shown in this note that in the model of the unified electromagnetically-weak interaction [1], the assumption that the (V + A)-form strangeness-changing hadron currents in the nonleptonic current-current, $|\Delta S| = 1$, CP-odd weak interaction makes it possible to determine the unitary structure of the latter, which is in satisfactory quantitative agreement with the experimental data on $K \to 2\pi$ decays and in general qualitative correspondence with the nonleptonic rule $|\Delta T| = 1/2$ for all nonleptonic processes.

The assumption that in the nonleptonic current-current interaction the strangeness-changing currents have a Lorentz (V + A) form, and the strangeness conserving currents have a (V - A) form, lifts, as is well known, the forbiddenness [3] of the $K_1^0 \to 2\pi$ decays in the approximation of exact unitary symmetry of strong interactions. Accepting this assumption and supposing that the hadron currents of the unified electromagnetically-weak interaction [1] transform like the components of a unitary octet, we obtain with the aid of the tables of the C-G coefficients of the SU(3) symmetry group [4] the following unitary structure of the nonleptonic $|\Delta S| = 1$, CP-even, and P-odd weak interaction (see formula (23) of [1]; in this formula the component currents of the unitary octet must be normalized in accordance with the "eightfold-way" model [5], in particular $j^{Y(0)} \to (1/\sqrt{3}) j^{Y(0)}$):

$$\Delta L^{(e^2)}(CP = +1,\ P = -1,\ |\Delta S| = 1) \approx b_3 10_{3/2} + b_2 10_{1/2} + b_1 8^*_{1/2} + h.c., \tag{1}$$

where

$$b_3 = 1,\ b_2 = 2 - x,\ b_1 = -3 + 2x, \tag{2}$$

and the symbol $\approx$ denotes proportionality *. Here $x = (M/k)^4$, where k/M is the dimensionless parameter of the isotopic-symmetry-violating two-particle interaction in the model of [1].

Let us assume that in the approximation of unitary symmetry of strong interactions the matrix elements of the nonleptonic weak processes can be obtained directly from a renormalized Lagrangian of type (1), made up of the operators participating in the weak hadron process under consideration. Constructing then the "ten" and "eight" in the form of fully symmetrized normalized sums of products of the components of three identical meson octets M^{α}_{β},

$$[8]^{\alpha}_{\beta} = \frac{1}{2\sqrt{30}} \sum_{(1,2,3)} M^{\alpha}_{\beta}(1) M^{\nu}_{\mu}(2) M^{\mu}_{\nu}(3), \tag{3}$$

$$[10]_{\alpha\beta\gamma} = \frac{1}{6\sqrt{3}} \sum_{\substack{(1,2,3)\\(\alpha,\beta,\gamma)}} \epsilon_{\nu\mu\alpha} M^{\nu}_{\beta}(1) M^{\mu}_{\rho}(2) M^{\rho}_{\gamma}(3), \tag{4}$$

where the summation is over all the permutation of the indices, we obtain the following expressions for the matrix elements of the $K \to 2\pi$ decays:

$$M(K^+\pi^-\pi^0) \approx -1/2, \tag{5}$$

$$M(K_1^0\pi^0\pi^0) \approx \frac{\sqrt{2}}{3} - \frac{\sqrt{2}}{3}(2 - x) \pm \sqrt{\frac{1}{5}}(-3 + 2x), \tag{6}$$

$$M(K_1^0\pi^+\pi^-) \approx -\frac{1}{3} - \frac{2}{3}(2 - x) \pm \sqrt{\frac{2}{5}}(-3 + 2x). \tag{7}$$

The double sign in (6) and (7) is connected with the uncertainty of the relative phase of the "ten" and "eight." The reality of this phase, on the other hand, follows from the CP-invariance and the hermiticity of the Lagrangian (1). From (1) and (5) - (7) follows the well known sum rule for the amplitudes [7]

$$M(K_1^0\pi^+\pi^-) - \sqrt{2}M(K_1^0\pi^0\pi^0) \approx M(K^+\pi^-\pi^0) + M(K^-\pi^+\pi^0). \tag{8}$$

But here we can obtain even more. We shall attempt to determine the numerical parameter x and the unknown phase in (6) and (7) by comparison with the experimental value of the ratio

$w(K^+\pi^-\pi^0)/w(K_1^0\pi^+\pi^-) \simeq 1/470$ (see [8]). With the aid of (1), (5), and (7) we obtain two solutions:

1) lower sign in (6) and (7) with $x \simeq 19$,

2) upper sign in (6) and (7) with $x \simeq 7$.

We then obtain with the aid of (1), (6), and (7)

$$\frac{w(K_1^0\pi^+\pi^-)}{w(K_1^0\pi^0\pi^0)} \cong \begin{cases} 2.4 & \text{for solution 1)} \\ 1.6 & \text{for solution 2)} \end{cases} \tag{9}$$

and for the coefficients of the unitary structure (1) we obtain the possible ratios:

$$b_3 : b_2 : b_1 \simeq 1 : -17 : -35 \quad \text{for solution 1)} \tag{10}$$

$$b_3 : b_2 : b_1 \simeq 1 : 5.4 : 12 \quad \text{for solution 2)} \tag{11}$$

These numbers are meaningful accurate to within the proposed unitary symmetry of the strong interactions. Thus, the solution 1) is in satisfactory agreement with the experimental value $w(K_1^0\pi^+\pi^-)/w(K_1^0\pi^0\pi^0) = 2.26 \pm 0.13$ [8] and is also preferable because the unitary structure (10) agrees better with the approximate rule $|\Delta T| = 1/2$, which follows from the aggregate of the experimental data for all the nonleptonic processes [9].

The assumption that the strangeness-changing hadron currents as the (V + A) form contradicts the experimental data on the angular correlations in the β decay of the Λ hyperon [10]. It is of interest to note, however, that in view of the unitarity forbiddenness of the $K \to 2\pi$ decays for a nonleptonic current-current interaction of the form $j^{(V-A)}(|\Delta S| = 1) \times j^{(V-A)}(|\Delta S| = 0)$, the (V - A) form of the hadron currents may predominate under certain conditions in strangeness-changing hadron-lepton processes, whereas the (V + A) form of these strangeness-changing hadron currents can dominate in nonleptonic $|\Delta S| = 1$ processes. For example, a rough estimate shows that once the contribution of the (V + A) coupling in the current-current $|\Delta S| = 1$ Lagrangian reaches only ~30%, this coupling will dominate in the nonleptonic processes, whereas the corrections to the predictions of the Cabibbo model [11] for lepton-hadron processes will be insignificant.

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* In light of the known experimental data on nonleptonic decays of hyperons, it is essential that the unitary structure of the nonleptonic P-even, $|\Delta S| = 1$ interaction have a

different form [6]:

$$\Delta L^{(e^2)}(CP = +1,\ P = +1,\ |\Delta S| = 1) = a_3 27_{3/2} + a_2 27_{1/2} + a_1 8^s_{1/2} + h.c.,$$

where

$$a_3 = 1,\ a_2 = \frac{1}{\sqrt{5}}(4 - 3x),\ a_1 = \frac{1}{\sqrt{5}}(7 - 4x).$$

PHOTOELECTRIC SPECTROSCOPY OF IMPURITIES IN SEMICONDUCTORS

T. M. Lifshitz, N. P. Likhtman, and V. I. Sidorov
Institute of Radio Engineering and Electronics, USSR Academy of Sciences
Submitted 5 November 1967
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Photothermal ionization of impurities, a phenomenon observed and investigated in germanium doped with impurities of group III or V, was reported in [1-4]. We recall that the gist of this phenomenon consists in optical excitation of the impurity center with subsequent absorption of one or several photons. As a result of such a process, the carrier goes over into one of the free bands of the crystal, where it can take part in the charge-transport processes. Thus, the photothermal ionization of the impurities leads to the occurrence of photoconductivity whose spectral distribution constitutes under certain conditions a system of lines located in the photon energy region below the impurity ionization energy. The number of these lines and their arrangement on the wavelength scale is a reflection of the energy spectrum of the states produced by an impurity of a given type in the crystal.

In the present note we wish to point out one feature of the photoconductivity, connected with photothermal ionization of the impurities. This feature makes it possible to use this ionization to reveal very small amounts of impurities in a semiconductor and to establish their chemical nature.

It is known that the energy spectrum of an impurity center in a crystal can be determined by measuring the optical absorption spectra of the corresponding materials. However, the magnitude of the impurity optical absorption is connected linearly with the concentration of the impurities, and decreases with decrease of the latter. Therefore such measurements can be made in materials having not too low an impurity concentration. For example, in germanium with impurities of groups III and V, the impurity absorption is small even at a concentration $\sim 10^{14}$ cm^{-3}, and its measurement is a difficult task, which becomes practically impossible at a concentration $\sim 10^{13}$ cm^{-3}.

To the contrary, the photoresponse of the impurity photoconductivity (the ratio of the signal voltage to the power of the incident radiation), which is proportional to the relative change of the carrier density upon irradiation, $\Delta n_{phot}/n_{dark}$, does not depend on the impurity concentration or on the method of impurity compensation (see [5]). The photoconductivity due to photothermal ionization, on the other hand, even increases noticeably when the impurity concentration decreases, and its spectral lines, which characterize the chemical nature of