decreases the current; this in the above example of an anode potential of 1 v the current is less than the value for the "3/2-law" by 20%.

Equations (13) and (14) enable us to calculate the diode characteristic directly, and not in parametric form as is usually done.[5]

As we have shown above, the present method of integrating the kinetic equation for charged particles makes it possible to construct a distribution function satisfying boundary conditions of emission and reflection on two boundaries and to find the self-consistent field.

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CORRELATION OF POLARIZED QUANTA IN THE CASE OF NONCONSERVATION OF PARITY

IU. V. GAPONOV and V. S. POPOV

Moscow State University

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The angular correlation between the electron and the circularly polarized γ-quantum emitted in a cascade β-transition is considered in the case when parity is not conserved. The effect of the nuclear coulomb field is neglected.

As it has been shown by Lee and Yang[1] (see also the review by Shapiro[2]), parity nonconservation in β-decay implies an angular correlation between the circularly polarized γ-quantum and the electron. We calculated of this effect for allowed transitions, without taking into account the influence of the nuclear Coulomb field. If the β-decay is followed by a γ-transition, the probability for the γ-quantum to be emitted at an angle θ with respect to the direction of emission of the electron is equal to:

$$w(\theta) = 1 - (\mu\alpha v/c)\cos\theta, \qquad (1)$$

where $\mu = \pm 1$ corresponds to right-hand or left-hand polarization of the γ-quantum, v is the election velocity, and α a coefficient depending on the interaction constants, on the momenta of the nuclei, and on the multipole order of the γ-quantum:

$$\alpha = \frac{2B\sqrt{j_2(j_2+1)}\,\delta_{j_2 j_1} + D\,[2 + j_2(j_2+1) - j_1(j_1+1)]}{2\sqrt{j_2(j_2+1)}\,(A\,\delta_{j_2 j_1} + C)}\;\frac{j_2(j_2+1) + L_1(L_1+1) - j_3(j_3+1)}{2L_1(L_1+1)\sqrt{j_2(j_2+1)}}. \qquad (2)$$

Here j_1, j_2 and j_3 are the total angular momenta of the initial nucleus and of the excited and of the ground-state of the final nucleus, while L_1 is the multipole order of the γ-quantum. The coefficient α does not depend on the type of radiation (electric or magnetic), but only on its multipole order. The constants involved in Eq. (2) are

$$A = \{ |c_s|^2 + |c_s'|^2 + |c_v|^2 + |c_v'|^2 + (2mc^2/E)\,\mathrm{Re}\,(c_s^* c_v + c_s'^* c_v')\} |a|^2, \quad B = 2\,\mathrm{Re}\,\{(c_s^* c_t' + c_s'^* c_t - c_v^* c_a' - c_v'^* c_a)\, a^* b\},$$
$$C = \left\{ |c_t|^2 + |c_t'|^2 + |c_a|^2 + |c_a'|^2 + \frac{2mc^2}{E}\,\mathrm{Re}\,(c_t^* c_a + c_t'^* c_a')\right\} |b|^2, \quad D = 2\mathrm{Re}\,\{c_t^* c_t' - c_a^* c_a'\} |b|^2. \tag{3}$$

The quantities $c_S c_S'$ etc. are constants involved in the β-decay Hamiltonian, in which parity non-conservation is taken into account (see, for instance, Ref. 1). The primed constants correspond to the terms arising because of parity nonconservation in β-decay (if parity is conserved all the c' are 0), m and E are the mass and energy of the electron, while a and b are the nuclear matrix elements and do not depend on the magnetic quantum numbers:

$$a = \langle j_1 \| 1 \| j_1 \rangle \delta_{j_2 j_1} \quad b = \langle j_2 m_1 | \sigma_z | j_1 m_1 \rangle \varepsilon_{j_1 j_2}^{m_1}, \qquad \varepsilon_{j_1 j_2}^{m_1} = \begin{cases} \left[\dfrac{(2j_1+1)(j_1+1)}{(j_1-m_1+1)(j_1+m_1+1)}\right]^{1/2}, & j_2 = j_1+1, \\ \dfrac{\sqrt{j_1(j_1+1)}}{m_1}, & j_2 = j_1, \\ -\left[\dfrac{j_1(2j_1+1)}{(j_1+m_1)(j_1-m_1)}\right]^{1/2}, & j_2 = j_1 - 1. \end{cases} \tag{4}$$

A and B enter Eq. (2) when $j_2 = j_1$. As seen from Eqs. (3) and (2), the angular distribution is anisotropic only if parity is not conserved.

The experiments of Wu and Lederman (see Ref. 2) confirm the hypothesis of a longitudinal neutrino, made independently by Landau[3] and Lee and Yang.[4] In this case, the equations in (3) take a simpler form because $c = \pm c'$. It follows from Wu's experiment that $c = -c'$.

Then:

$$A = 2\{ |c_s|^2 + |c_v|^2 + (2mc^2/E)\,\mathrm{Re}\, c_s^* c_v\} |a|^2, \qquad B = -4\,\mathrm{Re}\,[(c_s^* c_t - c_v^* c_a)\, a^* b],$$
$$C = 2(|c_t|^2 + |c_a|^2 + (2mc^2/E)\,\mathrm{Re}\, c_t^* c_a) |b|^2, \qquad D = -2(|c_t|^2 - |c_a|^2)|b|^2. \tag{5}$$

Equation (1) can be generalized to the case when the β-decay is followed by several consecutive γ-transitions. The probability of emission of the n-th ($n > 1$) γ-quantum at an angle θ with respect to the direction of emission of the electron is determined by the same formula (1) where

$$\alpha = \frac{2B\sqrt{j_2(j_2+1)}\,\delta_{j_2 j_1} + D[2 + j_2(j_2+1) - j_1(j_1+1)]}{2\sqrt{j_2(j_2+1)}\,(A\delta_{j_2 j_1} + C)} \; \frac{j_{n+1}(j_{n+1}+1) + L_n(L_n+1) - j_{n+2}(j_{n+2}+1)}{2L_n(L_n+1)\sqrt{j_{n+1}(j_{n+1}+1)}}$$
$$\times \prod_{i=1}^{n-1} \frac{j_{i+1}(j_{i+1}+1) + j_{i+2}(j_{i+2}+1) - L_i(L_i+1)}{2\sqrt{j_{i+1}(j_{i+1}+1)\, j_{i+2}(j_{i+2}+1)}}. \tag{6}$$

Here j_1 is the total angular momentum of the initial nucleus, which makes a γ-transition to an excited state of the final nucleus with a total angular momentum j_2, emitting consecutive γ-quanta with multipole orders $L_1, L_2, \ldots L_n$, and making transitions to states $j_3, \ldots j_{n+2}$; A, B, C, and D are determined, as before by Eq. (3) or, for a longitudinal neutrino; by Eq. (5).

The experimental data indicate that $c_V = c_a = 0$ (see Ref. 6), and this yields a considerable simplification of Eq. (4). The values of α have been computed in this assumption for a series of nuclei, and the results are shown in Tables 1 and 2. Let us note that in the case of transitions with $j_2 = j_1 \pm 1$ the nuclear matrix elements a and b are not involved in the expression for α. In the case $j_2 = j_1$, α does obviously depend on the values of a and b which, at the present time, are known well enough only for light and mirror nuclei.[7]

In Tables 1 and 2, A, B, C and D have been computed using Eq. (5) with $c_V = c_a = 0$. The nuclear decay schemes used in Tables 1 and 2 are taken from Ref. 8.

In conclusion let us note that, although the measurement of the γ-quantum polarization involves difficulties (see Ref. 2), an experimental investigation of the effect considered here would be interesting, especially for the case $j_2 = j_1$, for the following reasons: the value of α depends on the relative phase of the constants c_S and c_t which can, generally speaking, be complex (let us note that the nuclear matrix elements a and b, which are involved in α in this case, are real). However, if Landau's hypothesis[3] on the conservation of the combined parity is true, c_S and c_t have to be either both real or both pure imaginary. In this fashion the investigation of the effect considered here can give information on the properties of the Hamiltonian for β-decay, which is very interesting from the point of view of the question on the nature of parity nonconservation.

TABLE I

Initial nucleus	j_1	j_2	γ-transition	α	E_γ (kev)
			$5/2^+ (E1)\ 3/2^-$	-0.700	373
K^{43}_{19}	$3/2^+$	$5/2^+$	$3/2^- (M1)\ 5/2^-$	0.420	258
			$5/2^- (M1)\ 7/2^-$	0.420	369
			$3/2^- (E2)\ 7/2^-$	0.280	627
Co^{60}_{27}	5^+	4^+	$4^+ (E2)\ 2^+$	0.333	1172
			$2^+ (E2)\ 0^+$	0.333	1332
			$5/2^+ (E2)\ 1/2^+$	0.333	284
J^{131}_{57}	$7/2^+$	$5/2^+$	$1/2^+ (M1)\ 3/2^+$	-0.167	80
			$5/2^+ (M1)\ 3/2^+$	0.500	364
			$5/2^+ (E2)\ 3/2^+$	0.262	364
			$5/2^- (E1)\ 5/2^+$	-0.200	686
			$5/2^- (E1)\ 7/2^+$	0.500	552
			$7/2^+ (M1)\ 5/2^+$	-0.643	134*
W^{187}_{74}	$3/2^-$	$5/2^-$	$5/2^- (E2)\ 9/2^-$	0.333	480
			$9/2^- (M2)\ 5/2^+$	-0.407	206
			$9/2^- (E3)\ 5/2^+$	-0.259	206
			$9/2^- (E1)\ 7/2^+$	-0.611	72
			$7/2^+ (M1)\ 5/2^+$	-0.611	134**

*2nd γ-quantum in the cascade $3/2^-$ (β^-) $5/2^-$ $(E1)$ $7/2^+$ $(M1)$ $5/2^+$.
**3rd γ-quantum in the cascade $3/2^-$ (β^-) $5/2^-$ $(E2)$ $9/2^-$ $(E1)$ $7/2^+$ $(M1)$ $5/2^+$.

TABLE II

Initial nucleus	j_1	j_2	γ-transition	$(A+C)\,\alpha$	E_γ (kev)
Na^{24}_{11}	4^+	4^+	$4^+ (E2)\ 2^+$	$0.373\ B + 0.083\ D$	2750
			$2^+ (E2)\ 0^+$	$0.373\ B + 0.083\ D$	1370
Sc^{46}_{21}	4^+	4^+	$4^+ (E2)\ 2^+$	$0.373\ B + 0.083\ D$	890
			$2^+ (E2)\ 0^+$	$0.373\ B + 0.083\ D$	1120
Sc^{48}_{21}	6^+	6^+	$6^+ (E2)\ 4^+$	$0.360\ B + 0.056\ D$	1050
			$4^+ (E2)\ 2^+$	$0.360\ B + 0.056\ D$	1325
			$2^+ (E2)\ 0^+$	$0.360\ B + 0.056\ D$	990

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Note added in proof (June 25, 1957). One of the authors (Iu. G.) calculated the effect of the nuclear Coulomb field on the coefficient α (1) for allowed β-transitions. It has been shown that the coefficient α does not change if $c_V = c_{V'} = c_a = c'_a = 0$.

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