объединенный
институт
ядерных
исследований
дубна

E6-89-412

C.L.Kathat, M.A.Ousmane*

ON THE INFLUENCE OF SECOND CLASS CURRENTS ON THE SPIN ASYMMETRIES IN GAMOW-TELLER β -TRANSITIONS

Submitted to International Conference
on Electromagnetic Transitions in Atomic Nuclei,
April 18-21, 1989, Tashkent, USSR

*People's Friendship University, Moscow, USSR

1989

The classification of weak hadronic currents into the first class currents (FCC) and second class currents (SCC), in accordance with their properties under the G-parity transformation (where $G=C\exp(i\pi T_2))$, for the first time was given by Weinberg [1]. According to this classification, Dirac (F_1), Pauli (F_2), axial (F_A) and pseudoscalar (F_P) form factors belong to FCC, and the scalar (F_S) and tensor (F_T) form factors belong to SCC. Note that SCC, being a serious problem (see, for example, [2,3]) for renormalized gauge theories of the electroweak interactions, have a principle significance for our understanding of the weak interaction structure.

Today the situation of the search for SCC in the nuclear β-decay seems to be very uncertain [4]. For example, the values of F_T given in [5], do not contradict (within the limits of experimental errors) the equality of form factors F_2 and F_T. On the other hand, from the data on the angular distribution of electrons with respect to the nuclear spin orientation it folows that the G-parity of the weak nuclear current is strictly conserved, i.e. $F_T = 0$ (see, for example, [6]).

Contradictory and uncertain situation also occurs in the search for SCC in τ-lepton decays in experiments with colliding e^+e^- beams. In 1986-87 the experimental observations of the decay channels $\tau\to\omega\pi\nu_\tau$ [7] and $\tau\to\eta\pi\nu_\tau$ [8], induced by the existence of the SCC, were reported. But the most later reports (see, for example, [9]) questioned the validities of these results.

The search for SCC was carried out in the iso-elastic scattering $\nu n \to \mu p$ [10,11] as well, however, the SCC were not observed. There are also other experimental data [4], which do not agree with the results of the above mentioned papers. It should be underlined that for the final solution of the SCC problem it is necessary to carry out a number of independent experiments on measurement of various physical characteristics of electroweak processes, to which these currents could contribute [12,13].

The present paper, developing the research made in [14,15], is devoted to the study of the correlation characteristics of the Gamow-Teller β-transitions in polarized nuclei with taking into account the form factor F_T, the neutrino mass and the contribution from the right-hand leptonic current.

The matrix element of the semi-leptonic weak processes in the framework of the current-current theory of the weak interaction may be written in the form

$$M_{fi} = G_F l_\alpha J_\alpha, \tag{1}$$

where G_F is the Fermi constant of the weak interaction; $l_\alpha = a_V \bar{u}_2 \gamma_\alpha (1+\varkappa\gamma_5) u_1$ is the leptonic current; u_j ($j = 1, 2$) are the Dirac spinor amplitudes of leptons; $\varkappa = a_A/a_V$ is the parameter characterising the ratio of intensities of the vector and axial parts of the leptonic current

($(1+\varkappa)/2$ defines the left-hand, and $(1-\varkappa)/2$ defines right-hand currents); $J_\alpha = \langle f | \int d\vec{x} \exp(-i\vec{q}\vec{x}) \hat{J}_\alpha(\vec{x}) | i \rangle$ is the hadronic current, $\hat{J}_\alpha(\vec{x})$ is the nuclear current density operator; $q_\alpha = (\vec{q}, iq_0)$ is the 4-momentum transfer.

Following the method of considering nuclear polarization described in [15,16], the differential rate of Gamow-Teller β-transitions may be written in the form:

$$dW_{\beta^\mp} = \xi\, N\, dE_e d\Omega_e d\Omega_\nu p_e p_\nu E_e E_\nu\, F(E_e, \theta, \theta^*, \varphi^*), \tag{2}$$

where $\xi = a_V^2(1+\varkappa^2)$; $N = G_F{}^2/(2\pi)^4$; p_l, E_l and $d\Omega_l$ are the momentum, total energy and solid angle of the electron (positron) at $l = e^-$ (e^+) or neutrino (antineutrino) at $l = \tilde{\nu}_e$ (ν_e); θ is the angle between the electron and antineutrino momenta; the angles θ^* and φ^* give the orientation of the polarization axis; the function $F(E_e, \theta, \theta^*, \varphi^*)$ is defined as follows:

$$F(E_e, \theta, \theta^*, \varphi^*) = f_1\phi_1 + 2f_2\phi_2 + f_3\phi_3 + f_4\phi_4 + f_5\phi_5 +$$
$$+ \frac{A}{2} P_2(\cos\theta^*)[f_1\phi_1 + 2(f_2\phi_2 - f_3\phi_3 - f_4\phi_4 - f_5\phi_5)] +$$
$$+ A P_2^1(\cos\theta^*)\cos\varphi^* \, (f_6 F_{L1}^5 F_{E1}^5 + f_7 F_{L1}^5 F_{M1} + f_8 F_{C1}^5 F_{E1}^5 +$$
$$+ f_9 F_{C1}^5 F_{M1}) - \frac{A}{4} P_2^2(\cos\theta^*)\cos 2\varphi^* \, f_{10} \, [(F_{M1}^5)^2 -$$
$$- (F_{E1}^5)^2] + 3PP_1^1(\cos\theta^*)\cos\varphi^* \, (f_6 F_{L1}^5 F_{M1} + f_7 F_{L1}^5 F_{E1}^5 +$$

$$+ f_8 F^5_{C1} F_{M1} + f_9 F^5_{C1} F^5_{E1}) + \frac{3}{2} P P_1(\cos\theta^*)(2 f_1 \phi_2 + f_2 \phi_1). \tag{3}$$

Here A and P are the alignment and polarization of nuclei; $P^m_L(\cos\theta^*)$ are the associated Legendre functions;

$$\phi_1 = ((F_{M1})^2 + (F^5_{E1})^2), \qquad \phi_2 = F_{M1} F^5_{E1},$$

$$\phi_3 = (F^5_{L1})^2, \qquad \phi_4 = F^5_{L1} F^5_{C1}, \qquad \phi_5 = (F^5_{C1})^2, \tag{4}$$

where F_{M1}, F^5_{C1}, F^5_{L1} and F^5_{E1} are the matrix elements of the vector magnetic , axial-vector Coulomb, longitudinal and electric multipole operators. The longitudinal polarization of electrons (positrons) taken into account, leptonic functions f_i (i = 1, 2, ..., 10) have the form:

$$f_1 = \delta_1 + C + \beta_\nu \delta_2 C_3,$$

$$f_2 = s_e(\beta_\nu C_2 \delta_2 + C_1(\delta_1 + C)),$$

$$f_3 = \delta_1 + C + \beta_\nu \delta_2(\cos\theta - 2C_3),$$

$$f_4 = 2\ (C_1 \delta_2 - \beta_\nu C_2\ \delta_1),$$

$$f_5 = \delta_1 - C_1 - \beta_\nu \delta_2 \cos\theta,$$

$$f_6 = \beta_\nu \delta_2(\beta_\nu E_\nu C_2 - \beta_e E_e C_1)\sin\theta/q\sqrt{2},$$

$$f_7 = -\beta_\nu s_e(E_e \beta_e \delta_2 - E_\nu(\delta_1 + C))\sin\theta/q\sqrt{2},$$

$$f_8 = -\beta_\nu(\beta_e E_e \delta_1 + \delta_2 E_\nu)\sin\theta/\sqrt{2}q,$$

$$f_9 = -s_e \beta_\nu \delta_1 \sin\theta/\sqrt{2},$$

$$f_{10} = -\beta_\nu \delta_2(C_3 - \cos\theta). \tag{5}$$

Here $\delta_1 = 1 - \eta s_e \gamma \beta_e$; $\delta_2 = \eta s_e \gamma - \beta_e$; $\gamma = 2\varkappa/(1 + \varkappa^2)$; $C = m_e m_\nu(1 - \varkappa^2)/[E_e E_\nu(1+\varkappa^2)]$; $\beta_l = p_l/E_l$ (l = e, ν) is the velocity of the leptons; $s_e = \pm 1$ is the helicity of the electrons (positrons), $C_1 = (\beta_e E_e + \beta_\nu E_\nu \cos\theta)/q$, $C_2 = (\beta_\nu E_\nu + \beta_e E_e \cos\theta)/q$, $C_3 = C_1 C_2$; η is "+1" for β^--decay and "−1" for β^+-decay.

As an example let us consider the processes $^{12}B \to {}^{12}C + e^- + \tilde{\nu}_e$ and $^{12}N \to {}^{12}C + e^+ + \nu_e$. The matrix elements F_{M1}, F^5_{C1}, F^5_{L1} and F^5_{E1} have the following form in the nuclear shell model with the harmonic oscillator potential:

$$F_{M1} = \frac{\psi}{6\sqrt{\pi}} \frac{q}{M_n} e^{-y} [F_1 - \mu(2 - y)],$$

$$F^5_{L1} = -\frac{\sqrt{2}\psi}{3\sqrt{\pi}} e^{-y} (1 - y)(F_A - \frac{q^2}{2M_n} F_P),$$

$$F^5_{E1} = -\frac{\psi}{3\sqrt{\pi}} e^{-y} F_A (2 - y),$$

$$F^5_{C1} = -\frac{\psi}{3\sqrt{2\pi}} \frac{q}{M_n} e^{-y} [\frac{3}{2} F_A - (1-y)(q_0 F_P - 2\eta M_n F_T)]. \tag{6}$$

Here $\psi = -0.003$ [17]; M_n is the nucleon mass; $\mu = F_1 + 2M_n F_2$; $q_0 = E_0$ is the transition energy; $y = (bq/2)^2$, where b is the oscillator parameter.

In the long-wavelength limit ($q/M_n \approx 0$, $y \approx 0$) the differential β-decay rate of polarized ^{12}B and ^{12}N nuclei is given by expression (2) in which the factor N and the function $F(E,\theta,\theta^*,\varphi^*)$ are given by the respective expressions:

$$N = \frac{2G_F^2\, \psi^2\, F_A}{27\ (2\pi)^5},$$

$$\begin{aligned} F(E_e,\theta,\theta^*,\varphi^*) &= F_A(2f_1 + f_3) + 4qf_2F_2 + \eta qf_4F_T + \\ &+ AP_2(\cos\theta^*)\ [F_A(f_1 - f_3) + 2qf_2F_2 - \eta qf_4F_T] + \\ &+ AP_2^1(\cos\theta^*)\cos\varphi^*\ \sqrt{2}(f_6F_A + qf_7F_2 + \eta qf_8F_T) + \\ &+ \frac{A}{2}\ P_2^2(\cos\theta^*)\cos 2\varphi^* f_{10}F_A + 3PP_1(\cos\theta^*)(f_2F_A + 2qf_1F_2) + \\ &+ 3\sqrt{2}\ PP_1^1(\cos\theta^*)\cos\varphi^*(f_7F_A + qf_6F_2 + \eta qf_9F_T). \end{aligned} \tag{7}$$

In the case of nuclear polarization along the electron (positron) momentum, the function $F(E_e,\theta,\theta^*,\varphi^*)$, which determines differential rate (2), gets the form

$$\begin{aligned} F(E_e,\theta,\theta^*,\varphi^*) &= H_0 - 2A[F_A\beta_e\beta_\nu\cos\theta - \gamma F_T(H_1 - \frac{3}{2}H_3) + \\ &+ \eta\gamma F_2(H_2 + \frac{3}{2}H_3)] - 3\lambda P[\eta\gamma F_A(\beta_e - \beta_\nu\cos\theta) - \\ &- \gamma\beta_e F_T H_3 - 2F_2(q(C_1 - \beta_e\beta_\nu C_2) + \frac{1}{2}\beta_e H_3)]. \end{aligned} \tag{8}$$

Here

$$H_0 = F_A(3 - \beta_e\beta_\nu\cos\theta + 3C) - 2\gamma F_T H_1 - 4\eta\gamma F_2 H_2,$$

$$H_{1,2} = \beta_e^2 E_e \pm \beta_\nu^2 E_\nu + \beta_e\beta_\nu(E_\nu \pm E_e)\cos\theta,$$

$$H_3 = \beta_\nu^2 E_\nu \sin^2\theta. \tag{9}$$

In (8) the parameter λ is "+1" for $\vec{s}_n \uparrow\uparrow \vec{p}_e$ and "−1" for $\vec{s}_n \uparrow\downarrow \vec{p}_e$. Here (and below) $\vec{s}_n$ is the unit vector in the nuclear polarization direction. Note that H_0 gives a differential rate averaged over the spin states of the initial nucleus.

After integration of differential rate (2) over the neutrino (antineutrino) solid angle with allowance for (8), for the electron asymmetry coefficient defined as

$$A_e = \frac{dW_{\beta^\mp}(\vec{s}_n \uparrow\uparrow \vec{p}_e) - dW_{\beta^\mp}(\vec{s}_n \uparrow\downarrow \vec{p}_e)}{dW_{\beta^\mp}(\vec{s}_n \uparrow\uparrow \vec{p}_e) + dW_{\beta^\mp}(\vec{s}_n \uparrow\downarrow \vec{p}_e)}, \tag{10}$$

we obtain

$$\begin{aligned} A_e &\cong -\beta_e P\{\eta\gamma(1-C) + \frac{4}{3}\gamma^2\tilde{F}_2(\beta_e^2E_e - \beta_\nu^2E_\nu) + \frac{2}{3}\gamma\beta_e^2E_e\tilde{F}_T - \\ &- \frac{2}{3}\gamma\beta_e^2E_eA(\tilde{F}_T - \gamma\tilde{F}_2) - 2\tilde{F}_2(E_e - \frac{2}{3}\beta_\nu^2E_\nu)\}, \end{aligned} \tag{11}$$

where $\tilde{F}_X = F_X/F_A$ $(X = 2,\ T)$.

By neglecting the terms of order m_eF_2 and m_eF_T in eq. (10) we obtain

$$\begin{aligned} A_e &\approx -\beta_e\gamma P[\eta(1-C) + \frac{2}{3}E_e(1-A)(\tilde{F}_T - \gamma\tilde{F}_2) + \\ &+ \frac{2}{3}(1/\gamma - \gamma)(2E_0 - 5E_e)\tilde{F}_2]. \end{aligned} \tag{12}$$

The behaviour of the coefficient A_e as a function of the electron energy at various values of the alignment ($A = 0.6$ and 0.01) and tensor form factor ($MF_T = -5$, 0 and $+5$) is shown in Fig. 1. From the figure it is seen that for determination of the

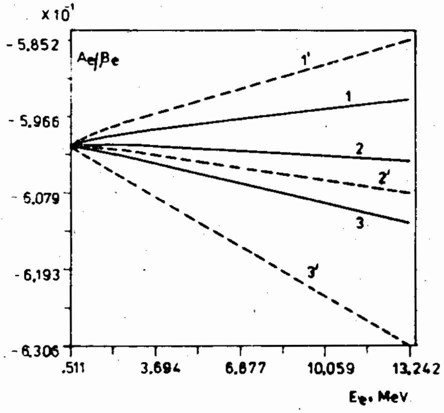

Fig. 1. Energy dependence of the coefficient A_e (normalized by β_e) with $\varkappa = 1$, $m_\nu = 0$ and $P = 0.6$. The solid curves (1, 2, 3) belong to the case of $A = 0.6$ and the dashed curves (1′, 2′, 3′) – to the case of $A = 0.01$.

form factor F_T it is advisible to measure the coefficient A_e for the small values of the alignment and high energies of electrons (because the discrepancy between the curves of this case and of the case, when $A = 1$ and the form factor F_T is absent, tends to be visibly high).

In a case, when nuclei are polarized along the neutrino (antineutrino) momentum, the function $F(E_e,\theta,\theta^*,\varphi^*)$ gets the form

$$F(E_e,\theta,\theta^*,\varphi^*) = H_0 - 2A[F_A\beta_e\beta_\nu\cos\theta - \gamma F_T(H_1 - \frac{3}{2}H_4) + \eta\gamma F_2(H_2 - \frac{3}{2}H_4)] + 3\lambda P[\eta\gamma F_A(\beta_\nu - \beta_e\cos\theta) - \gamma\beta_\nu F_T H_4 + 2F_2(q(C_2 - \beta_e\beta_\nu C_1) + \frac{1}{2}\beta_\nu H_4)], \quad (13)$$

where $H_4 = \beta_e^2 E_e \sin^2\theta$; the parameter λ is "+1", for $\vec{s}_n \uparrow\uparrow \vec{p}_\nu$ and "−1", for $\vec{s}_n \uparrow\downarrow \vec{p}_\nu$.

After integration of differential rate (2) over the solid angle $d\Omega_e$ with allowance for (13), for the neutrino (antineutrino) asymmetry coefficient defined as

$$A_\nu = \frac{dW_{\beta^\mp}(\vec{s}_n \uparrow\uparrow \vec{p}_\nu) - dW_{\beta^\mp}(\vec{s}_n \uparrow\downarrow \vec{p}_\nu)}{dW_{\beta^\mp}(\vec{s}_n \uparrow\uparrow \vec{p}_\nu) + dW_{\beta^\mp}(\vec{s}_n \uparrow\downarrow \vec{p}_\nu)}, \quad (14)$$

we obtain the expression

$$A_\nu \cong \beta_\nu P\{\eta\gamma(1-C) + \frac{2}{3}\gamma\beta_\nu^2 E_\nu \tilde{F}_T(1-A) + 2\tilde{F}_2[E_\nu - \frac{2}{3}\beta_e^2 E_e(1-\gamma^2) - \frac{1}{3}\gamma^2\beta_\nu^2 E_\nu(2+A)]\}. \quad (15)$$

On neglecting the terms of order $m_e F_2$ and $m_e F_T$ the asymmetry coefficient A_ν takes the form

$$A_\nu \cong \beta_\nu \gamma P[\eta(1-C) + \frac{2}{3}E_\nu(1-A)(\tilde{F}_T + \gamma\tilde{F}_2) - \frac{2}{3}(1/\gamma - \gamma)(2E_0 - 5E_\nu)\tilde{F}_2]. \quad (16)$$

In Fig. 2 the energy dependence of the coefficient A_ν for various values of the alignment ($A = 0.6$ and 0.01) and SCC form factor ($MF_T = -5$, 0 and $+5$) is shown. Unlike the coefficient A_e, the coefficient A_ν is sensitive to the form factor F_T at small electron energies.

Note that the coefficients A_e and A_ν are sensitive to the SCC and greatly depend on the value

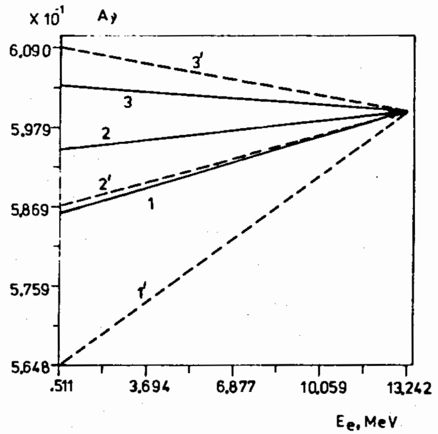

Fig. 2. Energy dependence of the asymmetry coefficients A_ν with the same value of $\varkappa$, m_ν, P and A as for the coefficient A_e.

and the sign (with respect to F_2) of the form factor F_T only for $A \neq 1$. The contribution of the form factors F_T and F_2 to coefficients A_e and A_ν are correlated and therefore the form factor F_T may be estimated using the value of the form factor F_2 obtained from the CVC-hypothesis or determined by the other observables.

Thus, the experimental study of the energy dependence of the asymmetry coefficients A_e and A_ν for the ensemble of nuclei with $A \neq 1$ might add to improvement of the present limits on F_T.

Now let the nuclei be polarized along $\vec{u}_s = (\vec{p}_\nu \times \vec{p}_e) \times \vec{p}_e$. Then the function $F(E_e,\theta,\theta^*,\varphi^*)$ determining differential rate (2) summed over the spin states of electrons (positrons) is given by the expression

$$F(E_e,\theta,\theta^*,\varphi^*) = H_0 + A[F_A\beta_e\beta_\nu\cos\theta + \eta F_T(H_1-3H_3) +$$

$$+ \eta\gamma F_2(H_2+3H_3)] - 3\lambda' P\beta_\nu\sin\theta[\eta\gamma F_A -$$

$$-\gamma q\beta_e' C_1 F_T + F_2(2E_\nu - q\beta_e C_1)]\}, \qquad (17)$$

where λ' is "+1" for $\vec{s}_n \uparrow\uparrow \vec{u}_s$ and "−1" for $\vec{s}_n \uparrow\downarrow \vec{u}_s$.

For the asymmetry coefficient, defined as

$$A_S = \frac{dW_{\beta^\mp}(\vec{s}_n \uparrow\uparrow \vec{u}_s) - dW_{\beta^\mp}(\vec{s}_n \uparrow\downarrow \vec{u}_s)}{dW_{\beta^\mp}(\vec{s}_n \uparrow\uparrow \vec{u}_s) + dW_{\beta^\mp}(\vec{s}_n \uparrow\downarrow \vec{u}_s)}, \qquad (18)$$

integrating eq. (2) over the antineutrino (neutrino) solid angle with allowance for eq. (17) we obtain

$$A_S \simeq -\frac{1}{4}\pi\gamma\beta_\nu P\{\eta(1-C) + \frac{1}{3}[E_\nu(\beta_\nu^2\tilde{F}_T + (6/\gamma - 5\gamma\beta_\nu^2)\tilde{F}_2) +$$

$$+ (1+A)(\beta_\nu^2E_\nu - \beta_e^2E_e)\tilde{F}_T + \gamma(1-A)(\beta_\nu^2E_\nu + \beta_e^2E_e)\tilde{F}_2] +$$

$$+ (\gamma - 1/\gamma)\beta_e^2E_e\tilde{F}_2\}. \qquad (19)$$

Unlike the case with the coefficient A_e here the maximum contribution from the form factor F_T to A_S is obtained at the end of the β-spectrum for $\gamma = 1$ and $A = 1$. In this case for massless neutrino ($m_\nu = 0$) the asymmetry coefficient A_S takes a simple form:

$$A_S = -\frac{1}{4}\pi P(\eta - \frac{2}{3}\beta_e^2E_e\tilde{F}_T). \qquad (20)$$

For other values of the alignment A the energy dependence of the coefficient A_S at various values of F_T is shown in Fig. 3.

In the case of nuclear polarization along the direction perpendicular to the reaction plane $(\vec{s}_n \uparrow\uparrow \vec{p}_\nu \times \vec{p}_e)$, the function $F(E_e,\theta,\theta^*,\varphi^*)$ is given by the expression

$$F(E_e,\theta,\theta^*=\varphi^*=\pi/2) = H_0+A(F_A\beta_e\beta_\nu\cos\theta-\eta F_T H_1+\eta\varkappa F_2 H_2). \tag{21}$$

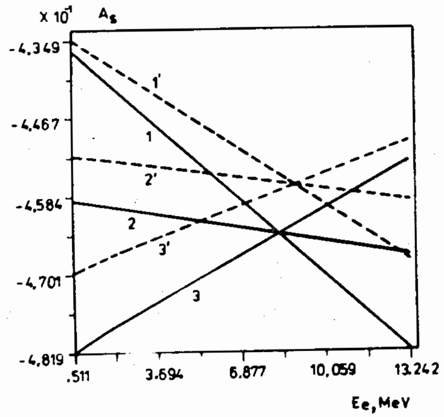

Fig. 3. Energy dependence of the asymmetry coefficients A_S with the same value of $\varkappa$, m_ν, P and A as for the coefficients A_e and A_ν.

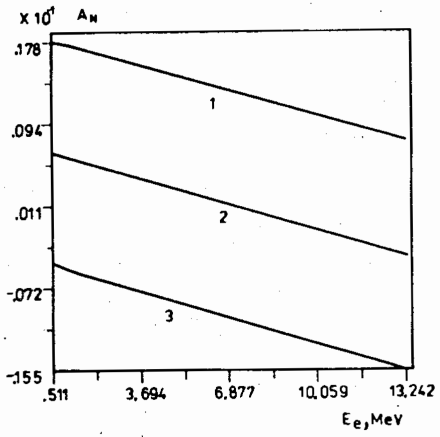

Fig. 4. Energy dependence of the asymmetry coefficients A_N with $\varkappa$ = 1 and A = 0.6. curves 1, 2 and 3 correspond to MF_T = -5, 0 and +5.

Note that in this case the contributions of form factors F_T and F_2 may be separated, since they enter into (21) with different functions H_1 and H_2. In particular, in the middle of the β-spectrum H_2 is small and so the contribution from the weak magnetism (a term proportional to F_2) may be neglected.

After integration of differential rate (2) over the solid angle $d\Omega_\nu$ with allowance for (21), the asymmetry coefficient, which is defined as

$$A_N = \frac{dW_{\beta^\mp}(\vec{\xi}_n\uparrow\uparrow\vec{p}_\nu\times\vec{p}_e) - dW_{\beta^\mp}(\text{unpolar.})}{dW_{\beta^\mp}(\text{unpolar.})}, \tag{22}$$

gets the form

$$A_N = -\frac{1}{3}\eta A[\tilde{F}_T(\beta_e^2E_e+\beta_\nu^2E_\nu)-\gamma\tilde{F}_2(\beta_e^2E_e-\beta_\nu^2E_\nu)]. \tag{23}$$

Fig. 4 represents the energy dependence of the coefficient A_N for $\varkappa$ = 1 and A = 0.6. Curves 1, 2 and 3 relate to the values MF_T = -5, 0 and +5, respectively. In the middle of the β-spectrum the pure effects ($A_N \sim F_T$) of SCC are predicted. (In this case the contribution of the weak magnetism form factor F_2 is suppressed).

Note that using eqs. (8), (13), (17) and (21) one can study also the angular dependence of the coefficients A_e, A_ν, A_S and A_N, which may give important information on the form factor F_T.

Now we consider the electron longitudinal polarization degree defined by the formulae:

$$P_e = \frac{dW_{\beta^\mp}(s_e=1) - dW_{\beta^\mp}(s_e=-1)}{dW_{\beta^\mp}(s_e=1) + dW_{\beta^\mp}(s_e=-1)} \tag{24}$$

In the case of decay of nuclei, aligned along the direction of the electron (positron) emission, the polarization P_e is given by

$$P_{e\mp} \cong -\eta\beta_e\{\gamma(1-C)+\frac{2}{3}\eta[\tilde{F}_2[E_e(2+A)(1-\beta_e^2\gamma^2) -$$

$$- 2\beta_\nu^2 E_\nu(1-\gamma^2)]-\gamma E_e \tilde{F}_T(1-A)(1-\beta_e^2)]\}. \quad (25)$$

In the case of pure (V–A)-structure of leptonic current (γ = 1) the polarization P_e gets the form

$$P_e \cong -\eta\beta_e\{1 - \frac{2}{3}\eta E_e(1-\beta_e^2)[\tilde{F}_T(1-A)+\tilde{F}_2(2+A)]\}. \quad (26)$$

It follows from eq. (25) and (26) that the form factor F_T contribute to P_e only for $A \neq 1$. Eq.(25) for A=0 gives the expression for the polarization P_e which is the same as in the case of the decay of unpolarized nuclei [12,13,18]. The energy dependence of the polarization P_e for various values of the alignment and form factor F_T is shown in Fig. 5.

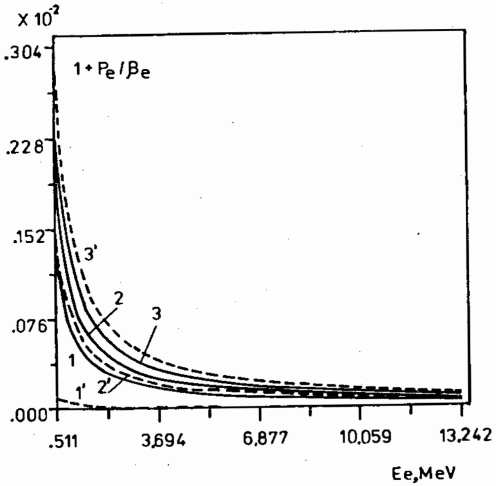

Fig. 5. Energy dependence of the electron longitudinal polarization degree P_e with P = 0 and the same value of $\varkappa$, m_ν, and A as for the coefficient A_e.

Thus, it follows from the analysis carried out that the SCC effects induced by the form factor F_T are correlated with the contributions from the form factor F_2 and the parameter $\varkappa$. So, for the unambiguous solution of the SCC problem a large number of independent experiments on the study of the energy and angular dependence of different characteristics of the nuclear β-decay is needed. These characteristics are, for example, the spin correlation coefficients A_e, A_ν, A_S, and A_N as well as the electron longitudinal polarization degree P_e in the β-decay of oriented nuclei. These characteristics have different sensitivities to the tensor form factor in different energy regions of the β-spectrum and for different values of alignment A. So, it is preferable to measure the coefficient A_e for small alignment A and at high electron energies, and the coefficient A_ν for the same alignment, but at low electron energies. The electron polarization P_e is most sensitive to SCC at the middle of the β-spectrum. For A = 1 the coefficients A_e, A_ν and the polarization P_e do not depend on the form factor F_T and therefore one can determine the deviation of the parameter $\varkappa$ from unity (i.e., the contribution from the right-hand current). The maximum contribution from the form factor F_T to the coefficient A_S is reached at the end of the β-spectrum for A = 1. The measurement of the coefficient A_N in the middle of the β-spectrum may give direct information on the value and the sign of the form factor F_T. In the case of the absence of SCC (F_T = 0) the experimental study of the energy dependence of the coefficient A_N will give information on the value of the parameter $\varkappa$.

R e f e r e n c e s

1. Weinberg S. Phys. Rev., 1958, v. 112, p. 1375.
2. Langacker P. Phys. Rev., 1977, v. D15, p. 2386.
3. Lobov G.A. Preprint ITEP-65, 1987.

4. Morita M. Hyperf. Interact., 1985, v. 21, p. 143.
5. Lobov G.A. Sov. J. Izv. Akad Nauk. (ser. fiz.) 1972, v. 36, p. 881.
6. Minamisono T. et al. Hyperf. Interact., 1987, v. 34, p. 135.
7. Albrecht W.H. et al. Preprint DESY 86-142, 1986.
8. Derrick M. Preprint ANL-HEP-CP-87-42, 1987.; Derrick M. et al. Phys. Lett., 1987,v.B189,p.260.
9. Albrecht W.H. et al. Preprint DESY 88-113, 1988.
10. Baker N.J. et al. Phys. Rev., 1981,v.D23,p.2499.
11. Kurihara Y. J. Sci. Hirochima Univ., 1987, v. A51, p. 1.
12. Samsonenko N.V., Samgin A.L., Kathat C.L. Sov. J. of Nuclear Phys. 1988, v. 47, p. 348.
13. Samsonenko N.V., Kathat C.L., Samgin A.L. Nucl. Phys., 1989, v. A491, p.642.
14. Samsonenko N.V., Ousmane Manga Adamou, Samgin A.L. Abstracts of Papers Presented at the XXXYIII Meeting on Nuclear Spectroscopy and structure Conference. L.: Nauka, 1988, p. 263.
15. Samsonenko N.V., Ousmane M.A., Kathat C.L., Samgin A.L. Preprint JINR P6-88-925, Dubna,1988.
16. Donnelly T.W. New Vistas in Electro-Nuclear Physics. - New York-London,Plenum Press,1986,p.151.
17. Donnelly T.W., Peccei R.D. Phys. Reports, 1979, v. 50, p. 1.
18. Kerimov B.K., Samsonenko N.V., Kathat C.L., Elegavhari A.I. Sov. J. Izv. Akad Nauk. (ser. fiz.) 1986, v. 50, p. 185.; 1987, v. 51, p. 994.

Received by Publishing Department
on June 6, 1989.

Катхат Ч.Л., Усман М.А. E6-89-412

О влиянии токов второго рода на спиновые асимметрии в гамов-теллеровских β-переходах

Получено выражение для дифференциальной вероятности гамов-теллеровских β-переходов в поляризованных ядрах с учетом токов второго рода, массы нейтрино и вклада лептонного $(V+A)$-тока. Исследовано влияние формфактора F_T на коэффициенты корреляций A_e, A_ν, A_S и A_N, а также на поляризацию электронов P_e. Показано, что экспериментальное исследование энергетической зависимости этих коэффициентов позволит улучшить имеющиеся ограничения на формфактор F_T.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1989

Kathat C.L., Ousmane M.A. E6-89-412

On the Influence of Second Class Currents on the Spin Asymmetries in Gamow-Teller β-Transitions

An expression for the differential rate of Gamow-Teller β-transitions in polarized nuclei with allowance for the second class currents, the neutrino mass and the contribution from the leptonic $(V+A)$-current is obtained. The influence of the form factor F_T on the correlation coefficients A_e, A_ν, A_S, and A_N, as well as on the electron polarization P_e is studied. It is shown that the experimental investigation of the energy dependence of these observables will allow improvement of the present limits on F_T.

The investigation has been performed at the Laboratory of Nuclear Problems, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1989