Proceedings of ICRC 2001: 1183 © Copernicus Gesellschaft 2001

ICRC 2001

The distinctive feature of weak interactions and some of its subsequences (Impossibility of generation of masses and absence of the MSW effect)

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Abstract. It is show that in the weak interactions the connected states cannot exist and then the weak interactions cannot generate masses and the equation for Green's function of the weak interacting fermions (neutrinos) in the matter coincides with the equation for Green's function of fermions in vacuum. And in the result we come to a conclusion: the mechanism of resonance enhancement of neutrino oscillations in matter (i.e. MSW effect) cannot exist.

1 Introduction

In the strong and electromagnetic interactions the left-handed and right-handed components of spinors participate in a symmetric manner. In contrast to these interactions only the left-handed components of spinors participate in the weak interactions. This is a distinctive feature of the weak interactions. In three different approaches: by using mass Lagrangian [1, 2], by using the Dirac equation [3, 2], and using the operator formalism [4], I discussed the problem of the mass generation in the standard weak interactions. The result was: the standard weak interaction cannot generate masses of fermions since the right-handed components of fermions do not participate in these interactions. Then using this result in works [4] it has been shown that the effect of resonance enhancement of neutrino oscillations in matter cannot exist. At present there is a number of papers published (see [5] and references there) where by using the Green's function method it is shown that the weak interactions can generate the resonance enhancement of neutrino oscillations in matter (it means that the weak interaction can generate masses). This result is a consequence of using the weak interaction term $H^{int}_{\mu} = V_{\mu}\frac{1}{2}(1-\gamma_5)$ in an incorrect manner, and in the result they have obtained that the right-handed components of the fermions participate in the weak interactions.

Now let us come to a common consideration and then consider concrete examples and consequences of the distinctive feature of the weak interactions.

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2 Common Consideration Consequences of Distinctive Feature of Weak Interactions

In the Quantum theory the wave functions form a full and orthonormalized functional space. For this reason we can use the equation on eigenfunctions and eigenvalues

$$\hat{E}\Psi(...) = F(...)\Psi(...) = 0, \qquad (1)$$

and find the eigenenergies E_n and eigenfunctions Ψ_n to determine the physical characteristics of the considered systems [6, 7] (or models). In the Quantum theory the observed values are the average value of operators

$$E_n = (\Psi_n, \hat{E}\Psi_n). \qquad (2)$$

Indeed, since the wave functions create a full and orthonormalized space, the average values of operators coincide with the eigenvalues of operators. This situation takes place in the case of strong and electromagnetic interactions and in concrete objects which appear from these interactions. It takes place since the wave functions and their conjunction function exist in this case. An absolutely another situation takes place in the case of the weak interactions. In these interactions only the left-handed components of the wave function (wave vector) (i.e. the left-handed components of spinors) participate in these interactions. In the weak interaction the P-symmetry is violated. And what is more in the theory for his γ_5 invariance, it is more suitable to use the Dirac [8] or Veil [9] but not the Shr$\ddot{o}$dinger type of equations. Naturally, the following question arises: To which consequences does this distinctive feature of the weak interactions lead? Also as in the strong and electromagnetic interactions in the weak interactions we can use the perturbative theory but in this case propagators must be propagators of free particles (without renormalization).

Let $\bar{\Psi}_L, \Psi_L, \bar{\Psi}_R, \Psi_R$-be wave functions (wave vectors) of spinor particles. Since we consider the weak interactions where the left-handed components of spinors participate, then

$$\bar{\Psi}_R = \Psi_R \equiv 0, \qquad \bar{\Psi}_L = 1/2\bar{\Psi}(1+\gamma_5), \Psi_L = 1/2(1-\gamma_5)\Psi. \tag{3}$$

If $\hat{B}$ is an operator of the weak interactions, then the mean value of this operator (the observed value) is

$$\hat{B}\Psi_L = B\Psi_L, \qquad \bar{B} = (\bar{\Psi}, \hat{B}\Psi_L) = B(\bar{\Psi}_R, \Psi_L) = 0. \tag{4, 5}$$

It is interesting to see: which values are zero in the weak interactions?

Now consider the problem of eigenstates and eigenvalues in the weak interactions. Let $\hat{F}$ be an operator and we divide it into two parts. The first part $\hat{A}$ characterizes the free particle, and the second part $\hat{B}$ is responsible for the weak interaction, then

$$\hat{F} = \hat{A} + \hat{B}, \qquad \hat{F}\Psi = \hat{A}\Psi + \hat{B}\Psi, \tag{6}$$

and the mean value of $\hat{F}$ is

$$(\bar{\Psi}, \hat{F}\Psi) = (\bar{\Psi}, \hat{A}\Psi) + (\bar{\Psi}_R, \hat{B}\Psi_L) + (\bar{\Psi}_L, \hat{B}\Psi_R) =$$
$$(\bar{\Psi}, \hat{A}\Psi) + (\bar{\Psi}_R \equiv 0)(\bar{\Psi}_R, \hat{B}\Psi_L) +$$
$$(\Psi_R \equiv 0)(\bar{\Psi}_L, \hat{B}\Psi_R) = (\bar{\Psi}, \hat{A}\Psi). \tag{7}$$

The obtained result means that in the weak interactions there cannot arise the connected states in contrast to the strong and electromagnetic interactions. Besides, the average value of the polarization operators is equal to zero, i.e. the polarization of the matter is absent. In the same way we can show that the equation for renormcharge for the weak interaction is equivalent to the equation for the free charge, i.e. renormcharge $Q^2(t)$ in the weak interactions [10] (where t is a transfer momentum squared) does not change and $Q^2(t) = const$ in contrast to renormcharges $e^2(t), g^2(t)$ of the electromagnetic and strong interactions [11] (it is necessary to remark that the neutral current of the weak interactions includes a left-right symmetrical part which is renormalized). Let us consider the equation for Green's function of fermions taking into account the standard weak interactions.

3 Equation for Green's Function in Weak Interactions

The Green's function method is frequently used for taking into account effects of electromagnetic interactions and strong interactions (chromodynamics) [12]. The equation for Green's function has the following form:

$$[\gamma^\mu(i\partial_\mu - V_\mu) - M]G(x, y) = \delta^4(x - y), \tag{8}$$

where V_μ characterizes the electromagnetic or strong interactions and

$$iG(x, y) =< T\Psi(x)\bar{\Psi}(y) >_o .$$

Usually the equation for Green's function for fermion (neutrino) with weak interactions [5] is taken in the following form:

$$[\gamma^\mu(i\partial_\mu - V_\mu) - M]G(x, y) = \delta^4(x - y), \tag{9}$$

where V_μ is $V_\mu = V_\mu\frac{1}{2}(1 - \gamma_5) = V_\mu P_L$.

It is supposed that the term V_μ in Eq.(9) reproduces the distinctive feature of the weak interactions. If we directly use the distinctive feature of these interactions, then the equation for Green's function must be rewritten in the form

$$[\gamma^\mu(i\partial_\mu - V_\mu \begin{bmatrix} \Psi_R = 0 \\ \bar{\Psi}_R = 0 \end{bmatrix}) - M]G(x, y) = \delta^4(x - y). \tag{10}$$

Then the interaction term in Eq.(10) is

$$V_\mu \begin{bmatrix} \Psi_R = 0 \\ \bar{\Psi}_R = 0 \end{bmatrix} T(\Psi_L\bar{\Psi}_R) = T(\Psi_L\bar{\Psi}_R(\bar{\Psi}_R = 0) +$$
$$(\Psi_R = 0)\Psi_R\bar{\Psi}_L) = V_\mu 0 \equiv 0, \tag{11}$$

and then Eq.(10) is transformed in the following equation:

$$[\gamma^\mu(i\partial_\mu) - M]G(x, y) = \delta^4(x - y), \tag{12}$$

which coincides with the equation for free Green's function (i.e. equation without interactions). So, we see that the equation for Green's function with weak interactions (in matter) coincides with the equation for Green's function in vacuum.

4 Impossibility to Realize the Mechanism of Resonance Enhancement of Neutrino Oscillations in Matter

In the previous part we have obtained that the equation for Green's function of fermions with weak interactions has the form (13). It is a consequence of the fact that the right-handed components of fermions (neutrinos) do not participate in the weak interactions. It means that the weak interaction cannot generate masses (see also works [1-4]) and, correspondingly, the weak interactions do not give a deposit to effective masses of fermions (neutrinos) therefore, the mixing angle cannot be changed in weak interactions (in matter) and it coincides with the mixing angle in vacuum.

The two neutrino (a, b) mixing angle in vacuum is given by the expression [13]

$$sin^2 2\theta = (2m_{\nu_a\nu_b})^2/(m_{\nu_a} - m_{\nu_b})^2 + (2m_{\nu_a\nu_b})^2, \tag{13}$$

and this mixing angle θ_m in the matter is

$$sin^2 2\theta_m = (2m_{\nu_a\nu_b})^2/(m'_{\nu_a} - m'_{\nu_b})^2 + (2m_{\nu_a\nu_b})^2, \tag{14}$$

where $m_{\nu_a}, m_{\nu_b}, m_{\nu_a\nu_b}$ are masses of neutrinos a, b, non-diagonal mass term, and m'_{ν_a}, m'_{ν_a}-effective masses of the same neutrinos in matter. Since the masses of neutrinos a, b in vacuum and in the matter $m'_{\nu_a} = m_{\nu_a} \quad m'_{\nu_b} = m_{\nu_b}$ are equal for the distinctive feature of the weak interactions, then the mixing angles in vacuum $sin^2 2\theta$ and in the matter $sin^2 2\theta_m$ coincides. Hence, the mechanism of the resonance enhancement of neutrino oscillations in the matter (MSW effect) cannot exist.

The problem of the resonance enhancement of neutrino oscillations in the matter can be solved by another approach. Namely, while neutrino passing through the matter there can arise a polarization of the matter [15]. If ϵ is the operator for polarization energy of matter by neutrinos, then the average value is

$$\bar{\epsilon} = (\bar{\psi}_R, \hat{\epsilon}\Psi_L) = \epsilon(\bar{\Psi}_R \equiv 0)(\Psi_R, \Psi_L) = 0. \qquad (15)$$

We see that the Wolfenstein's equation for (real) neutrino in the matter coincides with the equation for free neutrinos, then no resonance enhancement of neutrino oscillations in the matter appears.

In conclusion I would like to stress that in the experimental data from [16] there is no visible change in the spectrum of the B^8 Sun neutrinos. The measured spectrum of neutrinos lies lower than the computed spectrum of the B^8 neutrinos [17]. In the case of realization of the resonance enhancement mechanism this spectrum must be distorted. Also, the day-night effect on the neutrinos regeneration in bulk of the Earth is preserved within the mistakes [16], i.e. it is not observed.

References

1. Kh.M. Beshtoev, JINR Communication P2-93-44, Dubna, 1993.
2. Kh.M. Beshtoev, Fiz. Elem. Chastitz At. Yadra (Phys. Part. Nucl.), **27**, 53(1996).
3. Kh.M. Beshtoev, JINR Communication E2-93-167, Dubna, 1993.
4. Kh. M. Beshtoev, HEP-PH/9912532, 1999; Hadronic Journal, **22**, 235(1999).
5. C.Y. Cardall, D.J. Chung, Phys. Rev. **D60**, 073012(1999).
6. V. Pauli, Principles of Wave Mechanics, OGIS, Moscow, 1947; P. Dirac, Principles of Quantum Mechanics, Oxford, Clarendon Press, 1958.
7. S. S. Schweber. An Introduction to Relat. Quantum Field Theory, Row, Peterson and Co., N.Y., 1961.
8. Particles and Fields, Phys. Rev. **D45**, N11(1998); L.B. Okun, Leptons and Quarks, M., Nauka, 1990.
9. S.S. Schweber, An Introduction to Relativistic Quantum Field Theory, Row, Peterson and Co., N. Y., 1961, p.114.
10. Kh.M. Beshtoev, JINR Communication E2-94-31, Dubna, 1994.
11. T. Izikson amd K. Suber, Quant. Field Theory, M., 1984;
12. J. Schwinger, Phys. Rev. **76**, 790(1949); Y. Nambu and G. Jona-Lasinio, Phys. Rev. **122**, 345(1961);
13. Kh.M. Beshtoev, JINR Communication E2-99-307, Dubna, 1999; HEP-PH/9911513.
14. L. Wolfenstein, Phys. Rev. **D14**, 2369(1978).
15. Kh.M. Beshtoev, Hadronic Journ., **22**, 477(1999).
16. K.S. Harita, et al., Phys. Rev. Lett. **65**, 1297(1991); Phys. Rev., **D44**, 2341(1991); Y. Totsuka, Rep. Prog. Physics 377, (1992). Y. Suzuki, Proceed. of the Intern. Conf. Neutrino-98, Japan, 1998.
17. J.N. Bahcall, Neutrino Astrophysics, Cambridge U.P. Cambridge, 1989.