Neutrino Properties and Their Usefulness Suggested by Recent Electrochemical Neutrino Detection Results

Kenji ISHIBASHI¹*, Norichika TERAO¹, HAO Lijuan¹, NobuhiroSHIGYO¹, and Hidehiko ARIMA¹
¹Kyushu University, 744, Motoooka, Nishi-ku, Fukuoka 819-0395, Japan

Large-scale experimental projects on neutrinos have revealed neutrino properties, particularly on a small finite neutrino mass. Alternative experiments were recently carried out with electrochemical detectors by our group. The experimental results suggest that a neutrino owns two types of potential sources and the neutrino mass generation mechanism is based on both the asymmetry of weak interactions between vector and axial-vector mass states and a scalar auxiliary field. The mass generation mechanism was formulated according to experimental indications. The asymmetry on mass functions in the axial-vector part was useful to explain the neutrino mass generation mechanism. The scalar auxiliary field was adopted which was derived from the Fermi gage. Because of the considerably large reaction rate in the electrochemical detectors, neutrinos and their fragment properties may be useful for engineering purposes in future.

KEYWORDS: neutrino, electrochemical detector, weak interaction, scalar auxiliary field, asymmetry

I. Introduction

Neutrinos make only weak interaction, and own a half spin of left rotation. Their detection has usually been achieved by the use of very large detector systems due to the quite small interaction cross section. Such projects as neutrino oscillation experiments have revealed that neutrinos should have a small mass in relation to the oscillation phenomena.¹³

Neutrinos are treated to make the weak interaction of vector(V) and axial-vector(AV) types.² Electroweak theory³ unified the electromagnetic and weak interaction, and showed that the magnitude of weak charge is completely the same as the electron charge e in the electromagnetic interaction. However, such theory was not applied to the study of neutrino structure. It has recently been reported by our group that some low-energy neutrinos are readily measured with tiny electrochemical detectors.⁴ ⁵

In this paper, results of such experiments are briefly described. On the basis of matters suggested from the experimental data, the possible reason for the reaction occurrence in relation to mass-generation mechanism is attempted to be explained by assuming asymmetry of mass states between V and AV motions.

II. Experiments by Electrochemical Detectors

An electrochemical detector with biological material (passive detector)⁶ utilized a biological product raw silk and a set of electrodes in water. The output signal of the detector varied with or without nuclear-reactor neutrino irradiation. It was inferred that the raw silk produces a certain field (scalar auxiliary field, thereafter), which readily breaks a low-energy neutrino into two groups of fragments. The fragments were considered to produce the output signal.⁶⁷

Another electrochemical detector with non-biological materials required a supersonic vibration (active detector)⁸ under nuclear-reactor neutrino irradiation at an initial stage. After the initial process, the detector was sensitive to reactor neutrinos coming from nuclear power stations located in distances as long as 50-500 km level.⁹ It was supposed that the scalar auxiliary field was actively produced in the initial process.

These experimental data suggest those matters as follows. A neutrino owns two types of potential sources of weak-electric charge and weak-dipole moment. The neutrino mass generation mechanism is based on the asymmetry between vector and axial-vector mass states and on the scalar auxiliary field. After interaction, neutrino fragments produce the scalar auxiliary field in turn.

III. Neutrino Mass and Properties

3.1 Assumptions

The experimental facts induce us to make four major assumptions: (1) Interaction potentials are generated by weak charge and weak dipole moment under the Fermi gauge, (2) neutrino mass retains the property of gamma matrix²⁻¹ when the mass is described in the Dirac equation, (3) neutrino is constituted by four particles, on which four gamma matrices of γ₀ to γ₃ work as space-subspace transformation of momentum and coordinate position, and (4) asymmetry on constituent-mass properties exists between V and AV motions to produce the final neutrino mass. The asymmetry is applied to the potential generation (weak charge and dipole moment) in the AV part in a form of factor to the true mass.

From assumption (1), we postulate that the weak charge Q has the feature of working as a weak dipole moment Qᵢ in the other subspace. The dipole moment Qᵢ is assumed to have a relationship between the weak charge Q and specified length. It is natural to take the de Broglie wavelength ℏ/p to serve as this length: Qᵢ = ℏh/p, where p is the momentum of

*Corresponding Author, E-mail:kisibasi@nucl.Kyushu-u.ac.jp

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for a particle moving with velocity \( v \).

Thereafter, with a left-rotated spiral motion. All the magnetic fields are designated as particle moment. Since there are four principal gamma matrices, this equation is considered to govern the motion of \( v \)-type takes a real value while that of AV-type has an imaginary one. According to assumption (2), we replace \( V \)-type with \( \gamma \)-type potential generation by reversed-type complex motion.

We impose that the squared value of mass in eq. (4) should be scalar in \( U^\prime \). The momentum after conversion is indicated by dashed mark. We have an additional constraint of

\[
\rho_{\nu\nu}^o - h\rho_{\nu\nu}^a = 0 ,
\]

in \( U^\prime \). If this is expressed with the values in the original space \( U^\prime \), eq. (6) becomes to

\[
\rho_{\nu\nu}^o - h\rho_{\nu\nu}^a = 0 ,
\]

with \( \kappa = 0, 3, 2 \) for particles \( \nu = 0, 1, 2, 3 \), respectively. The root of squared mass in eq. (4) leads to the kinetic mass

\[
m_{\nu} = \sqrt{\sum_{\mu} (\rho_{\nu\nu}^{\mu})^2 + \sum_{\mu} (\rho_{\nu a}^{\mu})^2} ,
\]

where constraints of eqs. (5) and (7) are applied to momentums. Since the AV momentums are imaginary in eqs. (5) and (7), they disagree with those of \( V \). We admit the AV motions in eqs. (5) and (7) to behave with reversed complex type, that is, they work with apparent imaginary mass of \( im_{\nu} \). This corresponds to apparent change of mass property in AV motion according to assumption (4). The value of \( m_{\nu} \) in eq. (8) takes either plus or minus, which is called positive or negative mass state, respectively.

The Dirac equation describes the motion of half-integer spin particles. The wave function in eq. (2) should express the combination motion of these particles. The situation is explained in Fig. 2. Since particle 1 is hard to reside in \( U^\prime \) due to the conversion property of \( U_{11} \), it is supposed to always work in \( U^\prime \). Particle 1 is considered to offer position bases to other particles, and take the charge-type potential source of \( Q_{\nu} \) in \( U^\prime \). In contrast, particle \( \nu \) basically has the dipole moment \( Q_{\nu 0} \) in subpace \( U^\prime \). Because of sharing of \( x_{\nu 0} \), the motions of \( x_{\nu 0} \) and \( x_{\nu} \) are present in close positions.
canonical conjugate momentum. However, it is useful to
negative mass owning a negative dipole moment
charge is required to magnetically couple with a particle of
The internal negative mass state \( 1^- \) having the negative
polarity to others, in order to achieve a resultant small mass.
of particles among 0, 2 and 3 may have an opposite mass
Meanwhile, we admit particle 1 to have an internal negative
mass state 1- having the negative charge is required to magnetically couple with a particle of
negative mass owning a negative dipole moment \( Q_{10} \).
The second order equation for \( x_{1\mu} \) motion is thus written by
\[
\sum_{\nu} \sum_{\mu} \sum_{\nu} \left\{ \left( \rho_{\nu} \rho_{\mu}^{*} \right)^{1/4} \left( \rho_{\nu} \rho_{\mu}^{*} \right)^{1/4} \right\} \psi_{\nu} = (m) \psi_{\nu}
\]
(9)
\[
m_{1} = \sum_{\nu} \sum_{\mu} \sum_{\nu} \left\{ \left( \rho_{\nu} \rho_{\mu}^{*} \right)^{1/4} \left( \rho_{\nu} \rho_{\mu}^{*} \right)^{1/4} \right\},
\]
(10)
\[ x_{1} = \pm 1, \quad \psi_{\nu} = \psi_{\nu}^{a} \psi_{\nu}^{b}. \]

3.3 Total Kinetic Mass and Total Energy
Total kinetic mass \( m \) of neutrino is given by a linear sum of individual masses with polarity \( x_{\nu} \) as
\[
m = \sum_{\nu} m_{\nu} = \sqrt{\sum_{\nu} x_{\nu}^{2} m_{\nu}^{2}} = \sqrt{\sum_{\nu} x_{\nu}^{2} m_{\nu}^{2}}
\]
(11)
The value of \( m_{\nu}^{int} \) indicates the intrinsic internal mass, while \( m_{\nu} \) is interpreted as an effective mass in a view of external motion. The total neutrino energy \( E \) is expressed by
\[
E = \sum_{\nu} \left\{ \sum_{\mu} \sum_{\nu} m_{\nu} \left( \rho_{\nu} \rho_{\mu}^{*} \right)^{1/4} \right\}
\]
(12)

3.4 Total spin
The total z-direction and squared-total angular momentum operators \( L^{2} \) and \( (L^{2})^{2} \) defined as eigenvalues for \( V \) and \( AV \) angular momentum sum in matrices. The operators \( L^{2} \) and \( (L^{2})^{2} \) and those of sum of right-hand side on particles \( \nu = 0, 2, 3 \) in eq. (3) should be exchangeable in a commutor operation. The commutor between \( L^{2} \) and \( (L^{2})^{2} \) in mass operators gives an eigenvalue of \( L^{2} = 1/2 \) and the corresponding eigenvector state of
\[
\sum_{\nu=0,2,3} \sin \theta_{\nu} \rho_{\nu}^{a} = \sum_{\nu=0,2,3} \left\{ \sin \theta_{\nu} \rho_{\nu}^{a} \right\}
\]
(13)
Since \( \rho_{\nu}^{a} \) gives a fixed value, the total value in right-hand-side gives a constraint to the radial momentum in the left-hand-side. Equation (13) forbids the state of all \( \rho_{\nu}^{a} \neq 0 \) due to the non-zero sum in the right-hand side. It is considered that the radial motions appear in either expanding or shrinking state. When the periodical radial-velocity polarity change is always followed by a simultaneous mass polarity change, \( \rho_{\nu}^{a} \) is kept in a continuous value during the transition. For this reason, there are two cases, where the radial velocity is either positive (case 1) or negative (case 2). The view leads to periodical vibration of radial motion, with keeping canonical conjugate radial momentum at the transition.

3.5 Spherical Functions with Linear Combination
The candidates of angular wave functions are listed in Table 1 with symbolized forms. The wave functions are basically expressed by a linear combination to two functions, for example,
\[
Y_{\nu}^{\nu} = \cos \Theta \cdot R \cdot Y_{\nu}^{\nu} + \sin \Theta \cdot R \cdot Y_{\nu}^{\nu}
\]
(14)
where the mixing angle \( \Theta \) constitutes linear coefficients. Since an expected value of \( z \) varies with \( \Theta \), the mixing angle determines the particle form variation in the \( z \) direction. If difference between \( \Theta_{1\nu} \) and \( \Theta_{1\nu} \) for particles \( \nu = 0, 2, 3 \) are set
Potential sources with asymmetry in AV2.

<table>
<thead>
<tr>
<th></th>
<th>V</th>
<th>AV1</th>
<th>AV2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle 0</td>
<td>Q_{d0}</td>
<td>Q_{d0}</td>
<td>iQ_{d0}</td>
</tr>
<tr>
<td>Particle 2</td>
<td>Q_{d2}</td>
<td>Q_{d2}</td>
<td>Q_{d2}</td>
</tr>
<tr>
<td>Particle 3</td>
<td>Q_{d3}</td>
<td>Q_{d3}</td>
<td>iQ_{d3}</td>
</tr>
</tbody>
</table>

at \( \pi/2 \), the sum of orbital angular momentums on particles 0,2,3 leads to the state of \( Y_{0}^{2} \) under anti-symmetrization of wave functions between V and AV types. When particle 1 makes four wave functions of \( Y_{0}^{0} \) and \( Y_{0}^{2} \), their summation with the state \( Y_{0}^{2} \) leads to \( Y_{0}^{0} \). The orbital angular momentums, thus, cancel out in neutrino, and subsequently the spin part of \(-1/2\) remains in the total angular momentum.

3.6 Asymmetry

When potentials \(^{3}\) are included, the momentums in eqs. (8), (10) and (12) are replaced in such a way as

\[ p_{\text{ext}}^\alpha \rightarrow p_{\text{ext}}^\alpha - \sigma Q_{\text{ext}} A_{\text{ext}}^\alpha \quad \text{or} \quad p_{\text{lat}}^\alpha \rightarrow p_{\text{lat}}^\alpha - \sigma Q_{\text{lat}} A_{\text{lat}}^\alpha . \]

It is straightforward to show that masses of eqs. (8) and (10) become zero after anti-symmetrization of wave functions between V and AV types. Symmetry breaking in mass property between V and AV types will generate the mass working in the AV-part was useful to explain the experimental indications. The scalar auxiliary field was derived with the Fermi gage. Assumption of asymmetry on mass working in the AV-part was useful to explain the neutrino mass generation. It was inferred that the application of external AV-type scalar auxiliary field may bring about neutrino break up into fragments.

4 Conclusion

The experimental results by recent electrochemical detectors suggest that a neutrino owns two types of potential sources of weak charge and weak dipole moment, and the neutrino mass generation mechanism is based on asymmetry of mass factors and on the scalar auxiliary field. The mass generation mechanism was formulated on the basis of experimental indications. The scalar auxiliary field was derived with the Fermi gage. Assumption of asymmetry on mass working in the AV-part was useful to explain the neutrino mass generation. It was inferred that the application of external AV-type scalar auxiliary field may bring about neutrino break up into fragments.

References