On the Neutrino's Model Based on Virtual Space-time and the New Neutrino Detecting Method

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Abstract
In this paper, I build a new neutrino model based on the hypothesis of existing of virtual space-time. I assume that a neutrino is a signal of special electromagnetic wave that across over the real and virtual space-time. I also analyze the interactions between neutrino and photon based on this new model. A new particles decay diagram was given for describing the interactions among neutrinos and parts of particles. I also assume a new neutrinos detecting method in this paper.
Key words
Neutrinos; Neutrinos model; Particles.

1 Introductions

Nearly a century had been past. However, we still have very small knowledge about neutrinos. The main reasons due to that it is very hard to detect neutrinos directly. Therefore, most of the knowledge of neutrinos is based on the indirect experimental data. For example, many knowledge is come from the parameters of electrons and protons that produced by β-decay.

The problem with this indirect method is that the data obtained are all parameters such as the energy and momentum lost by the known particles. The amount of data acquired by the intrinsic properties of the neutrino itself is still too small, which is what caused us to the understanding of neutrinos is not enough for an important reason.

There are also some direct detection methods, but the equipment used in these methods is too large and requires a lot of manpower and material resources to get a small amount of data. For example, Japan's super-Kamioka detector [1], Daya Bay neutrino detection device [2]. Since the number of neutrinos that can be detected is almost negligible relative to the number of neutrinos arriving at the detector, the results obtained are statistically very limited.

Therefore, how to detect more neutrinos and how to make a more compact neutrino detection device has become a problem that plagues neutrino research.

In theory, if we can have a new model that is different from the existing neutrino model, we may be able to give us a new understanding of the characteristics of neutrinos from another aspect.

At present, the theoretical basis on which this article relies is not very solid, but after all, it is still very different from other theories of elementary particles. Therefore, the neutrino model and possible detection methods based on these new theoretical foundations are still able to Inspired.

2 New neutrino model

There are two main neutrino models that are currently successful. One is the two-component model [3], which uses two components in the Dirac equation to represent neutrinos. This model is an important part of the standard model. Although the neutrinos information from which can be obtained are limited, it can still basically match many experimental results. In the two-component model, the static mass of the neutrino must be zero. The second model is the mass eigenstate model [4]. That is to say, if the neutrino has a small mass, the neutrino will have three mass eigenstates. What can be observed in the experiment is three different "flavors" superimposed by three mass eigenstates. The neutrino oscillation predicted by the second model has been supported by more and more experimental results in recent years.

Here I propose another neutrino model based on the assumption that virtual space-time exists [5].

2.1 A special wave function solution

In my previous works, I have derived such a pair of solutions. [5~7]

$$\begin{cases} \mathrm{F} = F_0 e^{-k\cdot X-\frac{\omega}{c}y} e^{ik\cdot Y-i\frac{\omega}{c}x} \\ \mathrm{G} = G_0 e^{-k\cdot Y-\frac{\omega}{c}x} e^{ik\cdot X-i\frac{\omega}{c}y} \end{cases} \qquad (1)$$

In this solution, F represents the generalized electric field. Its relationship with the electric field strength E we usually use is

$$\mathrm{F} = \sqrt{\varepsilon} E$$

G represents the generalized magnetic field, and its relationship with the magnetic field strength H we usually use is

$$\mathrm{G} = \sqrt{\mu} H$$

The reason for choosing generalized parameters is because it ensures that F and G are independent of the dielectric constant εand magnetic permeability μ.

Two situations can be considered. First, if F and G can interact with different electric or magnetic medium, then waves are exhibited as E and H, such as photons. Secondly, if the waves do not interact with these medium, they behave as F and G, which may correspond to weak interactions and strong interactions. The reason why the word "may" is used is because this is the problem that this article is exploring, but I believe that the conclusions of this article do not completely solve this problem.

The uppercase letter X represents the three-dimensional space vector in real space-time. The lowercase letter y indicates the generalized time, y=ct

The uppercase letter Y represents the three-dimensional space vector in the virtual space-time, and the lowercase letter x represents the generalized time in the virtual space-time.

The other parameters k, ω, c, etc. represent the wave vector, angular frequency, and velocity of light, respectively.

From the results of formula (1), we can see that it is a special electromagnetic wave, that is, the electromagnetic wave is located in two different space-times at the same time. Unlike electromagnetic waves that correspond to well-known photon signals, the electromagnetic wave signals showing in formula (1) continuously exchange electric and magnetic field energy in real and virtual space-times.

Since the term $e^{-k \cdot X - \frac{\omega}{c} y}$ becomes smaller and smaller as the distance and time increases. It tends to 0 at infinity distance and time.

However, the term $e^{-ik \cdot Y - i\frac{\omega}{c} x}$ is an oscillation function in virtual space-time. Although the amplitude in the real space-time nearly equal to zero as distance and time increases, the oscillatory term is still capable of transmitting momentum and energy. However the momentum and energy are transmitted in the virtual space-time.

Considering the requirements of quantization, the amplitude of the wave function only reflects the numbers of quantum, so under the limit condition that the amplitude nearly equal to zero, there is still a quantum existed at least.

If such theoretical analysis is reasonable, then we can conclude that formula (1) actually reflects a very special elementary particle. The particle looks like a photon in its form, the propagation velocity is the velocity of light, its momentum is determined by the wave vector k, and the energy is determined by ω.

However, the electric field signal only oscillates in the virtual space-time, and the velocity is the velocity of light. It is therefore difficult to generate electromagnetic interactions with other particles in the real space-time. From the current knowledge, the closest particle is the neutrino.

I also found earlier in my research [8] that the energy of virtual space-time can be measured in real space-time. The energy in the virtual space-time is exhibited as the mass of a particle.

So, if the particle is indeed a neutrino, then the neutrino is a kind of light-speed mass flow in real space. However, since there is no corresponding electric field component (or virtual photon) in real space, this is not contradictory to the special relativity theory.

2.2 Discussion on the propagation velocity of electromagnetic waves in real and virtual space-time

The theoretical photon's propagation velocity is the speed of light c. However, when photons are propagated in a medium, such as water, the actual velocity is smaller than c, which is the basis of the Cherenkov light. In addition, even if it is propagated in vacuum, it may still need to encounter of the problems of vacuum polarization. This will also affect the velocity of the photons.

Therefore, the actual velocity of photons in real space-time will always be smaller than the theoretical value c.

However, according to the theory of virtual space-time, if the real space-time is used as the reference system, the lowest particle's velocity in the virtual space-time is the velocity of c, and the maximum velocity is infinity. Therefore, if the electromagnetic wave propagating in the virtual space-time also encounters the same situation, its velocity in the virtual space-time may be always larger than the theoretical value c observed in real space-time reference.

However, due to the special electromagnetic wave represented by the formula (1), the wave will continuously oscillate across over the real and virtual space-time. Although the electrical wave oscillation in equation (1) may have a problem of superluminal speed, the velocity of the magnetic wave that located in real space-time may always have a problem of smaller than the velocity of light. This will lead to contradictions. Since the neutrinos that we actually observed, according to the current experimental data, in addition to the possible neutrino oscillation phenomenon, are relatively stable. Therefore, the velocity of neutrinos must equal to the velocity of light. That is, there will be no phenomenon of superluminal speed and no phenomenon of smaller than the velocity of light in neutrinos propagation.

At present, there are two main experimental data on neutrino velocity measurement. One is that the OPERA team of European Nuclear Research Center (CERN) claimed to have measured the neutrino's superluminal speed at 2011 [9], but the subsequent experiments confirmed that it was due to the experiment error that caused by the problem of the device. This experiment actually proves that the velocity of the neutrino is equal to the speed of light c within the error range.

More important evidence is the result of the supernova SN1987A explosion [10]. The neutrinos produced after the supernova explosion reached the Earth three hours faster than the photons. Of course, this experimental data may show that the velocity of a photon in vacuum is always smaller than c, and it can also be used to show that the velocity of a neutrino is always equal to or slightly greater than the speed of light c.

2.3 The problem of the velocity difference across virtual and real space-time

Since the electromagnetic wave's oscillation in the model is simultaneously happened across over virtual and real space-time. The wave's velocity in real space-time cannot exceed c, and the velocity in virtual space-time cannot be lower than c. Thus, there is a problem that something causes the magnetic wave's velocity to be lower than the speed of light c in the formula (1), and the corresponding electric wave in the virtual space-time is affected by another factor, causing its velocity to be higher than the speed of light c (observed from the real space-time reference system, unless otherwise stated, the same below). At this time, a problem may occur in the virtual and real space-time energy oscillation process, resulting in a phase difference between the electric field oscillation wave and the magnetic field oscillation wave.

There are two situations to discuss here:

1. "Elastic" adjustment

If the phase difference is relatively small, in this case, the deceleration magnetic wave in real space-time will generate a new electric wave in virtual space-time. The new electric wave will decelerate the old one to the velocity of c. In correspondence, the acceleration electric wave in virtual space-time will generate a new magnetic wave in real space-time that will accelerate the old magnetic wave to the velocity of c.

2. "Inelastic" adjustment

If the phase difference is relatively large, the "elastic" adjustment in this case is not enough to maintain the integrity of the neutrino electromagnetic wave, then the "inelastic" adjustment can be involved. It will increase or decrease the wave's energy simultaneously between real and virtual space-time. That will ensure the integrity of the wave and meet the requirement of the wave propagating at the speed of light c. In this case, the types of the neutrino signal will change.

At present, we know that there are three types of neutrinos. If the types of the neutrino signal changes, it means that the neutrino is converted from one type to another. It corresponds to the currently known neutrino oscillation. Of cause, this requires further analysis and requires the support of more experimental data.

2.4 Meaning of the decaying component

If the formula (1) represents a neutrino, the decaying component $e^{-k \cdot X - \frac{\omega}{c} y}$ therein also has a special meaning. It reflects the fact that a very heavy particle was produced before neutrino appearing. The new heavy particle is confined to a very small space-time range and can be detected in real space-time. However, the life of the particle is very short. Therefore, it can be reasonably assumed that the particle is a $W^{\pm}$ or Z^{0} boson. If this hypothesis is confirmed, it will help us understand why neutrinos have different flavor and corresponding leptons always appear in pairs.

2.5 The problems of this model

This model can provide us some of the special properties of neutrinos. However, it may also encounter some of the other issues below. For example, since it is the electric wave oscillation, even in the virtual space-time, it should be able to have electromagnetic interactions with other substances. If electromagnetic interactions can occur, neutrinos should be easily detected. But this is not the fact. Neutrinos do not participate in electromagnetic interactions.

From the form of the formula (1), the special electromagnetic wave is different from the photon's electromagnetic wave. It is only half of the electromagnetic wave corresponding to a normal photon, and its spin is 1/2, instead of the photon's spin being 1. Its electric wave oscillation is located in the virtual space-time, but the corresponding magnetic wave oscillation appears in the real space-time. Whether it will bring some special characteristics for neutrinos, it needs further in-depth discussion and research.

3 Neutrinos propagation and interaction

Neutrinos do not participate in electromagnetic interactions. However, since the energy distribution of neutrinos is very broad during beta decay, this is similar to photons. So neutrinos also have a very wide spectrum, similar to the different "colors" of photons. It can be reasonably inferred that neutrinos may also have problems such as dispersion during propagation.

3.1 Neutrino dispersion

If the neutrino interacts with other particles during the propagation process, it will cause the energy of the neutrino to change, thus affecting the energy spectrum of the neutrino beam.

However, due to the very small number of neutrinos that can have weak interactions with other particles, the neutrino dispersion effect caused by this way is very small.

The other way is that the neutrino energy changes according to section 2.3 in this paper. It can predict that the number of neutrinos participating in this process is large. Therefore, the neutrino dispersion effect caused by this way will be more obvious and easy to observe. This includes both the currently confirmed neutrino oscillations (inelastic adjustment) and the energy variation (elasticity adjustment) of the same type of neutrino itself. This is also the difference between the neutrino oscillation phenomenon and the neutrino dispersion effect.

According to the characteristics of photons, the dispersion effect of neutrinos means that the neutrinos originally produced, its frequency are in a normal distribution state (corresponding to white visible light). However, in the process of propagation, if the elastic adjustment happened, there may be a change in energy distribution, i.e. from normal distribution to others. This change may cause more neutrino's energy to locate in a lower energy or high energy region. If it is inelastic adjustment, it shows the oscillation of neutrinos.

Since many devices are capable of measuring neutrino oscillations, the elastically adjustment neutrino dispersion can also be measured under existing equipment conditions.

3.2 Neutrino reflection

Neutrinos and protons can have weak interactions. A large part of the existing experimental devices for detecting neutrinos utilizes this reaction process.

If the neutrino model established in this paper is reasonable. It can be foreseen that the interaction of neutrinos and protons can also be divided into elastic scattering and inelastic scattering.

The experimental devices now used to detect neutrinos take advantage of the inelastic scattering effects of neutrinos. That is, after the neutrinos interact with the protons, neutrons and positrons will be produced. That is, the neutrino is absorbed.

Elastic scattering does not lead to the production of neutrons and positrons. Elastic scattering only changes the momentum and energy of neutrinos and protons.

Since the mass of the proton or other baryons is relatively large, it is easier to generate a high-energy intermediate boson such as Z^0. Therefore, the cross section of the elastic scattering should be much larger than the very small cross section corresponding to the inelastic scattering, which will help to the miniaturization of the neutrino detect devices. At the same time, due to the larger weight of the proton, the collision energy obtained by the proton will be relatively small. At this time, the interaction of neutrino and proton is mainly reflected as the reflection of neutrinos.

For elastic scattering, since particles such as positrons which are easily observed are not generated, it means that other methods are required for detection. For example, heavy atomic materials such as lead plates can be used as reflection tools to increase the number of neutrinos in the neutrino detector.

However, unlike the reflection of photons, the actual situation may be that only a small part of the neutrinos are reflected back by heavy atoms. After all, the scattering cross section of the neutrino is very small, and even if the scattering cross section is increased by 100 times, the number of neutrinos that can be reflected back is still very small. Whether these reflected neutrinos can cause inelastic scattering again is also a serious problem.

Therefore, although the reflection of neutrinos is theoretically predicted, new techniques and equipment support are needed for detection.

3.3 Neutrino interference and diffraction

As the microscopic particles, neutrinos must also have interference and diffraction phenomena. Under certain conditions, a single neutrino will have a higher probability of occurrence in some spatial regions, and the will have a smaller probability of occurrence in other regions due to the superposition of wave function states.

When a large number of neutrinos act synergistically, phenomena similar to interference and diffraction of light can occur.

However, since there are too few substances known to be able to easily interact with neutrinos, it is difficult to use a double slit device or a lattice to generate interference and diffraction phenomena of neutrinos like photons or electrons. Specific experimental designs may need to wait for further development of experimental techniques.

Here, a possible solution is proposed, which uses heavy nuclei to generate interference and diffraction effects of neutrinos.

Due to the large number of protons and neutrons in the heavy nuclei, it is relatively easier to capture neutrinos. However, if the neutrino produces elastic scattering only with protons or neutrons, it may change its direction of propagation, resulting in superposition of states, forming interference and diffraction effects.

The difficulty with this solution is what is the right way to measure the neutrinos that produce the effects?

3.4 Interactions between neutrinos and photons

Neutrinos and photons are relatively similar particles. Therefore, exploring the interactions between neutrinos and photons are also a very interesting topic.

Since neutrinos do not participate in electromagnetic interactions, neutrinos do not interact directly with photons in the standard model. However, other particles released by elastic or inelastic scattering of neutrinos and other particles can then release photons by electromagnetic interaction.

For example, the elastic scattering of neutrinos and electrons, the neutrino collides with a electron, and will form a Z^0 boson. The Z^0 boson decays to form a positron and electron pair, and after the positron and electron pair is annihilation, the photon can be released. Another way is to form a W^- boson after collision, and the W^- boson decays to release a high-energy electron. Since high-energy electron carry virtual photons, this forms the indirect interaction of neutrinos and photons.

In the beta decay process, the neutrinos are released, and the electrons carrying the virtual photon are also released, and the kinetic energy of the electrons is directly related to the energy of the neutrino. This is also an interaction of neutrinos and photons. Unlike particles such as electrons that carry virtual photons, neutrinos may not be able to carry virtual photons. Therefore, no matter what state, the spin of the neutrino is always 1/2. However, the energy spectrum of the neutrinos should be very close to that of the photons.

That is to say, photons mainly interact with intermediate bosons, so even in the new theoretical framework, whether photons can directly interact with neutrinos remains need to be further explored. Even according to the neutrino model proposed in this paper, the theoretical obstacles may still exist. For example, a photon can interact with a neutrino's real space-time field or magnetic field part. However, if it does not interact with the virtual space-time field or electric field part, it will affect the integrity of the neutrino's wave signal. Fortunately, even photons cannot interact with the electromagnetic field parts of the virtual space-time. According to the discussion in Section 2.3 of this paper, the photon can still interact with the electromagnetic field part of the real space-time, and the energy of the neutrino can also be changed according to the elastic adjustment. If the energy of the neutrino is changed, the energy of the photon will also change according to the law of conservation of energy. The concrete manifestation is the phenomenon that the photons involved in this process will appear red or blue shift.

If a photon collides with a neutrino and loses some of its energy, then a red shift should theoretically occur. Conversely, if the neutrino collides with the photon, the neutrino will lose some of its energy, and in theory there will be a blue shift. The experimental detecting device should be very simple, that is, the laser with a relatively large power is used in the place where there are many neutrinos, such as near a nuclear reactor, the interactions among the neutrinos and the photons can be determined by measuring the frequency variation of the laser.

Another very interesting phenomenon can be used to illustrate the frequency shift effect. This is the light from the distant galaxies will appear red shift in the cosmology. If this redshift is interpreted as the rapid departure of the galaxy, the conclusion that the velocity of the galaxy will exceed the speed of light will be drawn. This is contradictory to special relativity. However, if this redshift is interpreted as there are many interactions with the neutrinos in the universe before reaching the earth after the light emitted by distant galaxies, and the interpretation of this redshift phenomenon does not have these obstacles.

4 Particle decay diagram

4.1 Some conventions for particle decay diagram

The above analysis is relatively abstract. In order to more intuitively reflect the interaction between neutrinos and other particles, my past work also tried to use a kind of particle decay diagram [11]. Some simple conventions for particle decay diagram are shown in Figure 1.

It can be seen from the figure that each particle is represented by a circle, and the radius with the arrow direction reflects the size of the particle and the difference between the positive and negative particles. The meson and the intermediate boson consist of two overlapping circles, in which the two particles are usually positive and negative particles.

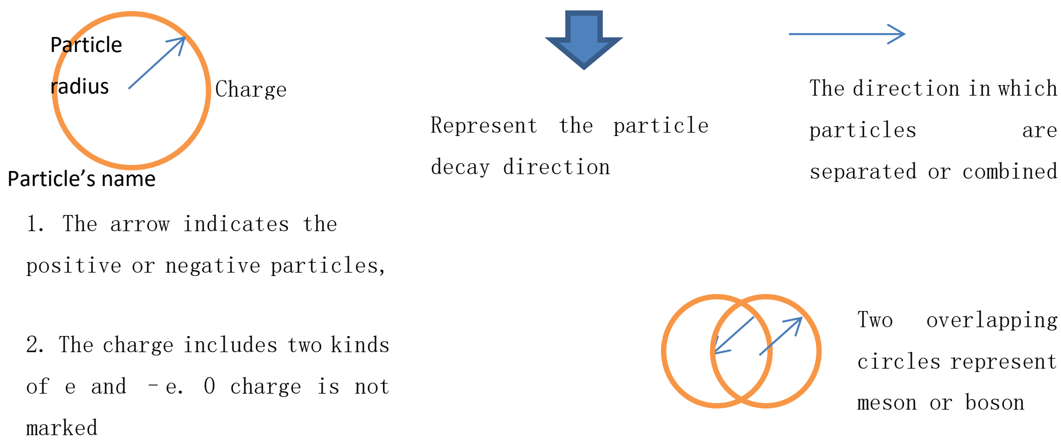

Figure 1. Some conventions of diagram

Figure 2 shows three typical examples of particle's diagrams. Here the radius of the electron is smaller than the proton. The radius "a" represents electron, and "-a" represents positron. The radius of the antineutrino is –a, and the difference between the electronic neutrino's diagram and the electron's diagram is mainly manifested the fact that the neutrino has no charge.

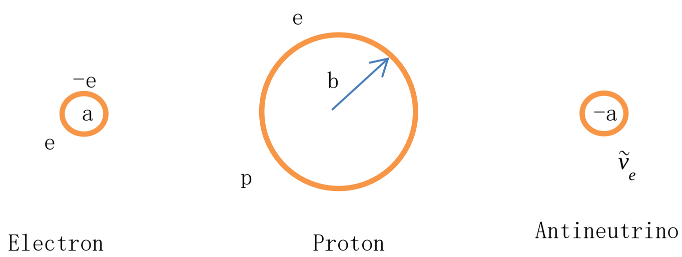

Figure 2. The examples of three particles

4.2 Neutrino detection methods represented by decay diagram

There are three main types of commonly used neutrino detection methods, namely:

1. Neutrino electron elastic scattering

2. Neutrino proton reaction

3. Radiation chemical technology

The first method utilizes the elastic scattering of neutrinos and lepton. However, since neutrinos do not participate in electromagnetic interactions and can only participate in weak interactions, it will require relatively high energy. This directly leads to the scattering cross section becoming very small. This elastic scattering can be represented by Figure 3.

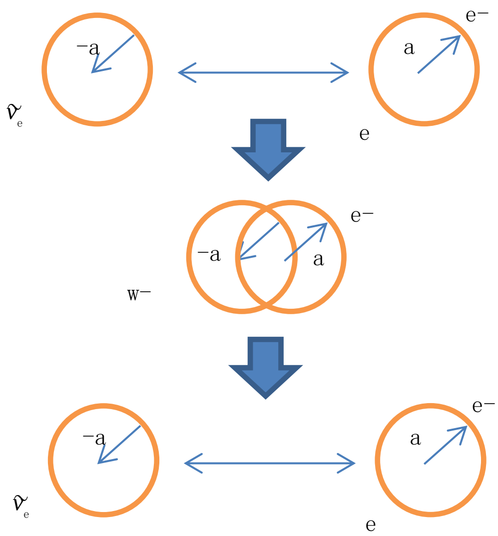

Figure 3. The diagram of neutrino-electron scattering

It can be seen that in Figure 3, the electron and the antineutrino collide elastically, at which time the intermediate particle W^- boson is generated. However, due to the large mass of the W^- boson, it means that the incident neutrino or electron's energy must also be very high. The number of neutrinos to meet this requirement is usually very small. The same analysis is also performed if the intermediate particles are Z^0 bosons.

The second method uses the reaction process shown in Figure 4.

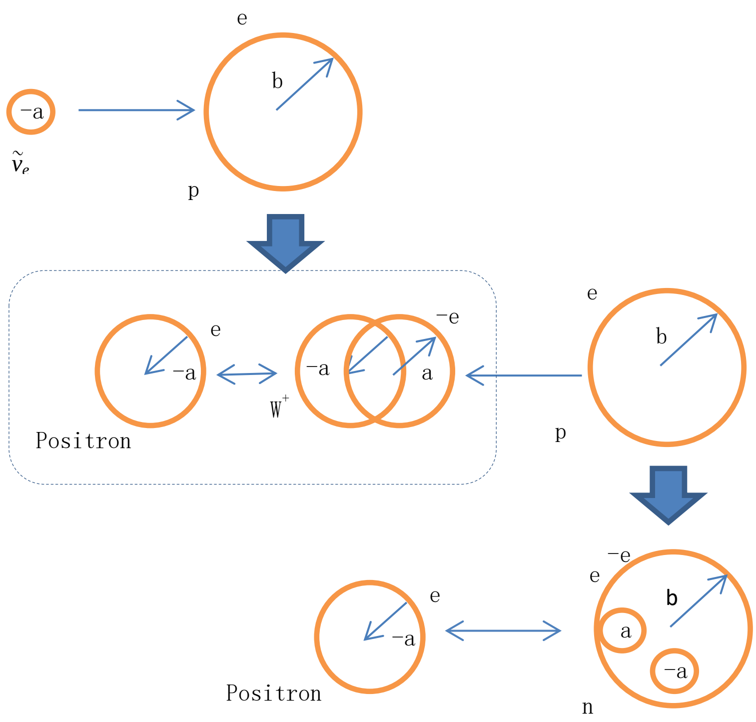

Figure 4. The reaction of antineutrino and proton

During the reaction shown in Figure 4, positron and neutron will be produced. The positron will interaction with the electrons in detector, and annihilate for the first time, emitting strong photons. The neutron will next produce beta decay, again emitting photons. By analyzing the time interval between two stage photons, it can be determined whether an anti-beta decay reaction has occurred.

Like the first method, the neutrino and proton reaction also produced an intermediate boson, and in order to ensure the conservation of the lepton number, a positron is also required, which means that the reaction requires a relatively high energy neutrino incidence. However, due to the large mass of proton, it can be expected that the energy required is lower than the first one.

The third detection method is similar in principle to the second.

4.3 Elastic scattering diagram of neutrino and proton

All of the above three neutrino detection methods have been put into use, and much more valuable experimental data have been obtained. However, these devices are relatively large devices, so they often require a large amount of human and material resources. How to make the neutrino detection equipment miniaturized is a problem worth exploring.

It is mentioned in Section 3.2 of this paper that neutrinos and protons may undergo elastic scattering. The specific process can be analyzed by particle decay diagram shown in figure 5. During the reflection of the neutrino, a Z^0 boson is generated, and then the boson may rapidly decay into a positron and electron pair, and then annihilate into photons.

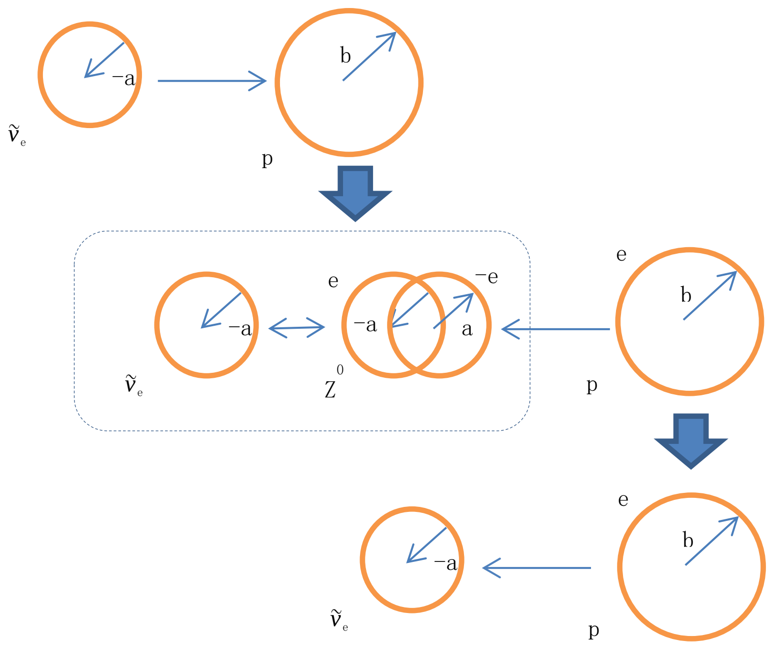

Figure 5. The elastic scatting between neutrino and proton

5 Discussion

This paper presents a new neutrino model. The model is based on the assumption that virtual space-time exists. The characteristic of this model is that neutrinos are also an electromagnetic wave. But unlike photons, the electromagnetic waves of neutrinos exist across over virtual and real space-time. Therefore, the change in neutrino energy involves energy conversion across two space and time. From the form of neutrino's electromagnetic waves, if the initial state represents a very high-intermediate boson in the neutrino electromagnetic wave form, it means that each time the neutrino interacts with other particles, it will produce a very high energy intermediate boson, which can make it more difficult for neutrinos to interact with other particles.

However, the interaction of neutrinos and photons that this paper attempts to explore is interesting. From the particle decay diagram of this paper, the structure of photons is different from the structure of neutrinos, electrons, protons, etc. Photons at least indirectly participate in weak interactions. If the photon does interact directly with the neutrino, it may be possible to avoid the role of the intermediate boson and thus reduce the energy required for the entire interaction. Thus the interaction of neutrinos with photons becomes easier.

According to the discussion in this paper, the interaction of neutrino with photon will result in red or blue shift of photons. Therefore, in some place that strong neutrino radiation sources and light sources existed at the same time, the presence of neutrinos or their various characteristics can be detected by measuring the red shift or blue shift of the photons.

References：

[1] Collaboration, T. S. K. (2002). Determination of solar neutrino oscillation parameters using 1496 days of Super-Kamiokande-I data. *arXiv preprint hep-ex/0205075*.

[2] An, F. P., Bai, J. Z., Balantekin, A. B., Band, H. R., Beavis, D., Beriguete, W., ... & Cai, B. (2012). Observation of electron-antineutrino disappearance at Daya Bay. *Physical Review Letters*, *108*(17), 171803.

[3] Lee, T. D., & Yang, C. N. (1957). Parity nonconservation and a two-component theory of the neutrino. Physical Review, 105(5), 1671.

[4] Cheng, T. P., and Ling-Fong Li. "Neutrino masses, mixings, and oscillations in SU (2)× U (1) models of electroweak interactions." Physical Review D 22.11 (1980): 2860.

[5] Zhi Cheng. (2016).On the New Quark and Neutrino Model Based on Virtual Space-Time. http://vixra.org/abs/1606.0326

[6] Zhi Cheng. (2016). On the Hyper-Symmetric Maxwell Equations and Its Applications. http://vixra.org/abs/1408.0149

[7] 程智. (2012). 时空对称结构的麦克斯韦方程组. 北京：中国科技论文在线. http://www.paper.edu.cn/html/releasepaper/2012/08/132/.

[8] Zhi Cheng. (2016). On the Origin of Gravitational Force. http://vixra.org/abs/1605.0136.

[9] Fargion, D., & D'Armiento, D. (2011). Inconsistence of super-luminal Opera neutrino velocity with SN1987A neutrinos burst and with flavor neutrino mixing. Czechoslov. J. Phys. G, 39(arXiv: 1109.5368), 085002.

[10] Hirata, K., Kajita, T., Koshiba, M., Nakahata, M., Oyama, Y., Sato, N., ... & Suda, T. (1987). Observation of a neutrino burst from the supernova SN1987A. Physical Review Letters, 58(14), 1490.

[11] Zhi Cheng. (2016). The Diagrams of Particles Decay Process and the Prediction of New Particle. http://vixra.org/abs/1609.0116.

Appendix: Chinese Version

基于虚时空中微子模型及新中微子探测方案的探讨

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摘要： 本文给出了一个新的中微子模型，该模型基于存在虚时空的假设。该模型指出中微子是一种跨越虚实时空的特殊电磁波信号。在此基础上本文分析了中微子与其他粒子以及光子之间的相互作用。并利用一种新颖的粒子衰变图来描述中微子与部分粒子的相互作用过程。本文也提出一种可能的中微子探测方案。
关键词：中微子；中微子模型；基本粒子

1 概述

中微子的发现已经过去了将近一个世纪的时间，然而对于中微子的了解，现有的知识还比较少。这是由于中微子的直接探测比较困难。目前有关中微子的知识大部分都是间接的。通常通过分析诸如 β 衰变后电子以及质子的各种参数来确定中微子的性质。

这种间接的方法问题在于所获得的数据都是已知粒子所失去的能量动量等参数，对于中微子本身所具备的内在属性所获取数据量还是太少了，这也是造成我们现在对于中微子的认识不够充分地一个重要原因。

目前也有一些直接探测的方法，但是这些方法所使用的设备太过庞大，需要非常大量的人力和物力的投入才能获得很少量的数据。比如日本的超级神冈探测器[1]、大亚湾中微子探测装置[2]等。由于相对于到达探测器中微子的数量，能够被探测出来的中微子数量几乎可以忽略，因此所获得的结果在统计学意义上来看作用都是非常有限的。

因此如何探测到更多的中微子、如何制造出更加小型化的中微子探测装置成为了一个困扰中微子研究的难题。

而在理论上，如果能够给出一个有别于现有中微子模型的新模型，也许能够从另一个侧面让我们对中微子的特性有一个新的认识。

目前来看，本文所依赖的理论基础虽然不是很扎实，但毕竟与其他的基本粒子理论还是有很大的区别，因此基于这些理论基础所提出的中微子模型和可能的探测方案相信还是能够有所

启发的。

2 新的中微子模型

目前比较成功的中微子模型主要有两个。一是二分量模型[3]，即使用狄拉克方程中的两个分量来表示中微子。这种模型是标准模型的一个重要组成部分，尽管能够从中获得中微子的信息有限，但基本上都能够比较好地符合实验结果。二分量模型中要求中微子的静止质量必须为 0. 第二种模型是质量本征态模型[4]。即假设中微子有微小的质量，这样中微子就具备了三个质量本征态。而实验中所能够观察到的则是由三个质量本征态叠加出来的三种不同的“味”。第二种模型所预言的中微子振荡近年来获得了越来越多的实验结果支持。

我这里结合虚时空存在的假设，提出另一种中微子模型[5]。

2.1 一个特殊波函数解

在我过去的工作中，曾经推导出这样一对解[5~7]：

$$\begin{cases} \mathrm{F} = F_0 e^{-k\cdot X-\frac{\omega}{c}y} e^{ik\cdot Y-i\frac{\omega}{c}x} \\ \mathrm{G} = G_0 e^{-k\cdot Y-\frac{\omega}{c}x} e^{ik\cdot X-i\frac{\omega}{c}y} \end{cases} \quad (1)$$

在该解中，F 表示广义电场，它与我们平常使用的电场强度 E 之间的关系为：

$$\mathrm{F} = \sqrt{\varepsilon}E$$

G 表示广义磁场，它与我们平常使用的磁场强度 H 之间的关系为：

$$\mathrm{G} = \sqrt{\mu}H$$

之所以选择广义参数，是因为这样可以保证 F 和 G 与介质无关。

可以考虑两种情况，首先如果 F 和 G 能够与不同的传播介质发生作用，这时候就表现为 E 和 H，比如光子的传播等。其次如果电磁波不与介质发生作用，则表现为 F 和 G，这可能对应了弱相互作用和强相互作用。之所以使用“可能”一词，原因在于这也正是本文正在探讨的问题，但相信本文的结论并没有完全解决这一问题。

而大写字母 X 表示实时空的三维空间矢量。小写字母 y 表示广义时间，y=ct

大写字母 Y 表示虚时空的三维空间矢量，小写字母 x 表示虚时空中的广义时间。

其他的参数 k, ω，c 等分别表示波矢、角频率和光速。

从公式（1）的结果来看，这是一个比较特殊的电磁波，即该电磁波同时位于两个时空中。

及与我们所熟知的光子信号对应的电磁波不同，该电磁波信号不断在两个时空中交换电场和磁场能量。

由于$e^{-k\cdot X-\frac{\omega}{c}y}$项随着实时空中的距离增加和时间推移变得越来越小，并在无穷远处趋于 0.

然而，$e^{-ik\cdot Y-i\frac{\omega}{c}x}$则是一个振荡函数。尽管由于实时空对应的函数趋于零导致其振幅很小或近似等于零，但该振荡项还是能够传递动量和能量。只不过动量和能量都是在虚时空中传递。

考虑到量子化的要求，波函数的振幅只是反应了量子的数量，因此在振幅趋于零的极限条件下，对应的就是一个量子。

如果这样的理论分析是有道理的，那么我们就可以得出公式（1）实际上反映的就是一个非常特殊的基本粒子。该粒子形式上看起来很像光子，传播速度为光速，其动量由波矢 k 决定，而能量由 ω 决定。

然而该电场信号只在虚时空中振荡，速度为光速。因此难以在实时空中与其他粒子产生电磁相互作用。从目前以有知识来看，与之最接近的粒子就是中微子。

再进一步分析，我更早一些时间的研究也发现[8]，虚时空的能量是可以在实时空中测量的。虚时空的能量在实时空中表现出来的就是粒子的质量。

也就是说如果这种粒子确实就是中微子的话，则中微子在实空间中就是一种光速运行质量流。然而由于实空间中的没有相应的电场分量，这与狭义相对论并不矛盾。

2.2 实时空和虚时空电磁波传播速度的讨论

理论上的光子传播速度是光速 c. 然而当光子在介质中运行的时候，其实际速度要比 c 小，这是切伦科夫光环产生的基础。另外即便是在真空中传播，也可能会遇到真空极化等情况产生正负电子对。这也会影响到光子的运行速度。

因此在实时空中测量光子的实际运行速度，总是会比理论值 c 要小一些的。

而根据虚时空的理论，如果以实时空为参照系，则虚时空中的粒子运行速度最低就是光速 c,最大速度为无穷大。因此如果在虚时空中传播的电磁波也遇到了实时空电磁波传播同样的情况，则以实时空为参照系，虚时空中的电磁波传播速度可能会比理论值 c 要大一些。

不过由于公式（1）反映出来的特殊电磁波，其振荡信号不断在虚时空和实时空之间振荡。虽然公式（1）中的电信号振荡可能会出现超光速的问题，但是其磁信号的振荡则是位于实时空，却有可能出现在传播过程中低于光速的情况。这样就会出现矛盾。而我们实际观察到的中微子，以目前的实验数据来看，除了可能出现的中微子振荡现象，相对来说，中微子还是比较稳定的。因此至少其中某种中微子的速度是恒等于光速的。即既不会出现超光速现象，也不会出现低于光速的现象。

目前有关中微子速度测量的实验数据主要有两个，一个是2011年欧洲核子研究中心（CERN）的 OPERA 团队虽然声称测量到了超光速的中微子[9]，然而后续实验证实是由于实验装置的问题所引起的误差。这个实验实际上是证明了在误差范围之内中微子的速度与光速 c 相等。

另一个比较重要的证据是超新星 SN1987A 爆发所测量到的结果[10]。该超新星爆发后所产生的中微子比光子快 3 个小时到达地球。当然这个实验数据也许能够说明真空中光子的速度总是比 c 小，也可以用来说明中微子的速度总是恒等于或者略大于光速 c。

2.3 虚实时空的速度差问题

由于该模型中的电磁波能量是在虚实时空之间同时进行的。而实时空的速度不能超过 c，虚时空的速度不能低于 c. 这样就可以出现一个问题，即公式（1）中，实时空的磁场分量受到某种因素的影响，导致其速度低于光速c，而对应的虚时空中的电场分量受另一种因素影响，导致其速度高于光速 c（从实时空参照系来进行观察，如无特别说明，下同）。则这时候虚实时空能量振荡过程就可能出现问题，导致电场振荡信号与磁场振荡信号产生相位差。

这里分两种情况进行讨论：

1、“弹性”调整

如果所引起的速度变化比较小，在这种情况下，实时空减速后的磁场分量伴生的新虚时空的电场分量，可以将加快速度的虚时空电场分量进行减速。相对应虚时空“加速”以后的电场分量可以对实时空中已经减速的磁场分量进行加速，从而确保两个时空的电磁场振荡信号能够始终按照光速 c 进行传播。

2、“非弹性”调整

如果外部因素所引起的速度变化幅度比较大，这种情况下用“弹性”调整不足以保持中微子电磁波信号的完整性，此时就可以能涉及到“非弹性”调整。即中微子信号自行增减两个时空的信号能量从而保证信号的完整性，满足信号以光速运行的需求。在这种情况下，中微子信号的性质也就发生了变化。

目前我们已知存在三种类型的中微子，如果中微子信号的性质发生了变化，就意味着中微子从一种类型转换成了另一种类型。那么这种中微子信号传播过程中类型的转换是否就是目前已知的中微子振荡？这还需要进一步的分析，并需要本文提出的方案获得更多实验数据的支持。

2.4 衰减项的意义

如果公式（1）表示的就是中微子，则其中的衰减项$e^{-k\cdot x-\frac{\omega}{c}y}$也是有特殊的意义的。它反映的是中微子产生的最初存在一个能量非常大的粒子，该粒子局限在一个非常小的时空范围之内，且可以在实时空中被探测到。但是该粒子的寿命非常短。因此可以合理假设该粒子就是 $W^{\pm}$

或 Z^0 玻色子。如果该假设被证实，则有助于我们理解为何不同味道的中微子和对应的轻子总是成对出现。

2.5 模型的问题

该模型能够解决中微子的一些特殊性质的问题。然而也可能会遇到下面的其他一些问题。比如既然是电场振荡，那即便是在虚时空也应该能够与其他物质产生电磁相互作用。如果能够产生电磁相互作用，则中微子应该很容易被探测到。但实际上并不是这样，中微子并不会参与电磁相互作用。

从公式（1）的形式上来看，将这个电磁波与光子相比，还是有所区别的。它只是正常光子对应的电磁波的一半，它的自旋是 1/2，而不是光子的自旋为 1。它的电场分量振荡位于虚时空，但是对应的磁场振荡分量则是出现在实时空中。是否会因此而带来一些比较特殊的性质，有待进一步的深入探讨和研究。

3 中微子的传播与相互作用

中微子不参与电磁相互作用。但是由于在 β 衰变的时候，中微子的能量分布范围是非常广泛的，这一点跟光子比较类似。因此中微子也有一个非常宽的频谱，类似于光子的不同“颜色”。可以合理推论，中微子也可能存在光子传播过程中的色散等问题。

3.1 中微子的色散

如果中微子在传播的过程中与其他的粒子产生相互作用，则将导致中微子的能量发生变化，从而影响到中微子波束的能谱。

不过由于能够与其他粒子产生弱相互作用的中微子数量非常少，这种方式引起的中微子色散效应是很小的。

另一种则是上面提到的当中微子在传播过程中，由于虚实时空的广义电场和磁场分量速度变化不一致而导致的中微子能量的变化，参与这种变化的中微子数量很多，故这种方式引起的中微子色散效应会比较明显，也容易观测到。这其中既包括了目前已经确认的中微子振荡现象（非弹性调整），也包括同种类型中微子本身的能量变化（弹性调整）。这也是中微子色散效应与中微子振荡现象的区别所在。

按照光子的特性来看，中微子的色散效应反映出的就是最初产生的中微子，整体上各种能量（频率）都处于一个正态分布的状态下的（对应白色的可见光）。然而在传播过程中，如果属于弹性调整，则虽然都是同种类型的中微子，但可能会出现能量分布的变化。这种变化可能导致部分中微子的能量集中于比较低能或者高能的区域。而如果属于非弹性调整，则表现出中微子的振荡现象。

由于现在有很多装置都能够测量到中微子振荡现象，故在现有设备条件下，弹性调整的中微

子色散现象也是可以测量到的。

3.2 中微子的反射

中微子与质子等重子是可以产生弱相互作用的。现有的检测中微子的实验装置有很大一部分就是利用了这一反应过程。

如果本文所建立的中微子模型是合理的。则可以预见中微子与质子的相互作用也可以分为弹性散射和非弹性散射两种。

现在用来探测中微子的实验装置利用了中微子的非弹性散射效应。即中微子与质子产生了相互作用以后，将产生中子和正电子。即中微子被吸收了。

而弹性散射则不会导致中子和正电子的产生。弹性散射只会改变中微子和质子的动量和能量。

由于质子等重子的质量比较大，要产生诸如 Z^0 等高能量中间玻色子也会比较容易一些。因此相对于非弹性散射对应的非常小的反应截面来说，弹性散射的反应截面应该会大很多，这将有助于探测中微子设备的小型化。同时由于质子重量很大，故质子获得的碰撞能量也会比较小。这时候中微子与质子的相互作用主要表现为中微子的反射。

对于弹性散射而言，由于不产生正电子等容易被观察到的粒子，意味着需要采用其他的方法来进行检测。比如通过铅板之类的重原子材料作为反射装置，用来增加中微子探测器中的中微子数量。

然而与光子的反射不同，实际情况可能是只有很少部分的中微子会被重原子反射回来。毕竟中微子的反应截面非常小，即便将反应截面增加 100 倍，能够反射回来的中微子数量也还是极少。而这些反射回来的中微子能否再次引起非弹性散射，也是一个很严重的问题。

故尽管理论上预测中微子的反射存在，但要进行探测还需要新的技术和设备支持。

3.3 中微子的干涉和衍射

作为微观粒子，中微子也必然有干涉和衍射现象的出现。在特定条件下，单个中微子由于波函数状态的叠加等原因导致其出现在某些空间区域的几率会大一些，而在另一些区域出现的几率就会小一些。

当大量的中微子协同作用，就可以出现类似于光的干涉和衍射的现象。

不过由于目前已知的能够很容易地与中微子产生相互作用的物质太少，故很难像光子或者电子那样利用双缝装置或者晶格来产生中微子的干涉和衍射现象。具体的实验设计可能需要等待实验技术的进一步发展。

这里提出一种可能的方案，即利用重原子核来产生中微子的干涉和衍射效应。

由于重原子核中的质子和中子数量较多，故比较容易捕获中微子。而如果中微子仅仅与质子或者中子产生弹性散射，就可能改变其传播方向，从而造成状态的叠加，形成干涉和衍射效应。

该方案的困难在于用什么方法来测量产生效应的中微子？

3.4 中微子与光子的相互作用

中微子与光子是比较类似的粒子。因此探讨中微子与光子的相互作用也是一个很有兴趣的话题。

由于中微子不参与电磁相互作用，标准模型中，中微子不会同光子产生直接的相互作用。然而通过诸如中微子与其他粒子的弹性或者非弹性散射释放出来的其他粒子，然后再通过电磁相互作用方式，还是可以释放出光子的。

比如中微子与电子的弹性散射，当中微子与电子碰撞，将形成 Z^0 玻色子。而 Z^0 玻色子衰变以后形成正负电子对，正负电子对淹没以后，就可以释放出光子。另一种方式就是碰撞之后形成 W^-玻色子，W^-玻色子衰变以后释放出高能电子。由于高能电子携带有虚光子，这样也就间接形成了中微子与光子的相互作用。

而在 β 衰变中，释放出中微子的同时，也释放出了携带虚光子的电子，且电子的动能与中微子的能量有直接关系。这也是一种中微子与光子的相互作用。与电子等粒子携带虚光子不同，中微子可能无法携带虚光子。因此不论处于何种状态，中微子的自旋始终都是 1/2. 不过中微子的能谱与光子的能谱应该是很接近的。

也就是说光子主要跟中间玻色子产生相互作用，因此即便在新的理论框架中，光子是否能够与中微子产生直接的相互作用还有待深入探讨。按照本文提出的中微子模型，理论上的障碍还是存在的。比如一个光子可以与中微子实时空电场或磁场分量产生相互作用，然而如果不能够同虚时空的磁场或者电场分量产生相互作用，将影响中微子的完整性。不过虽然光子不能够同虚时空的电磁场分量产生相互作用。按照本文 2.3 节的讨论，光子同实时空的电磁场分量产生相互作用，也可以按照弹性调整的方式改变中微子的能量。如果中微子的能量得以改变，按照能量守恒定律，光子的能量也将改变。具体表现出来就是光子出现蓝移或者红移的现象。

如果光子碰撞了中微子，将损失部分能量，则理论上应该可能出现红移现象。而反过来如果中微子碰撞了光子，则中微子将损失部分能量，理论上就会出现蓝移的现象。实验测量装置应该可以很简单，就是利用功率比较大的激光，在中微子比较多的场合，比如核反应堆附近等，通过测量激光的频率变化来确定中微子与光子的相互作用。

另一个很有趣的现象可以用来说明问题。这就是宇宙学中，遥远的星系发出的光线都会出现红移现象。如果将这种红移现象解释为星系的快速离开，则将得出星系离开的速度超光速的结论。这与相对论是矛盾的。而如果将这种红移解释为遥远的星系发出的光线到达地球之前，与宇宙中的中微子发生了多次相互作用，并产生的红移现象，则没有这些问题。

4 粒子衰变图

4.1 粒子衰变图的一些约定

上面的分析都比较抽象，为了能够更直观地反映出中微子与其他粒子之间的相互作用，我过去的工作也尝试使用了一种粒子衰变图[11]。粒子衰变图的一些简单约定如图 1 所示。

从图中可以看出每个粒子都是由一个圆圈表示，内部带箭头方向的半径反映了粒子的大小以及正反粒子的区别。介子和中间玻色子由两个重叠的圆圈组成，所组成的两个粒子通常互为正反粒子。

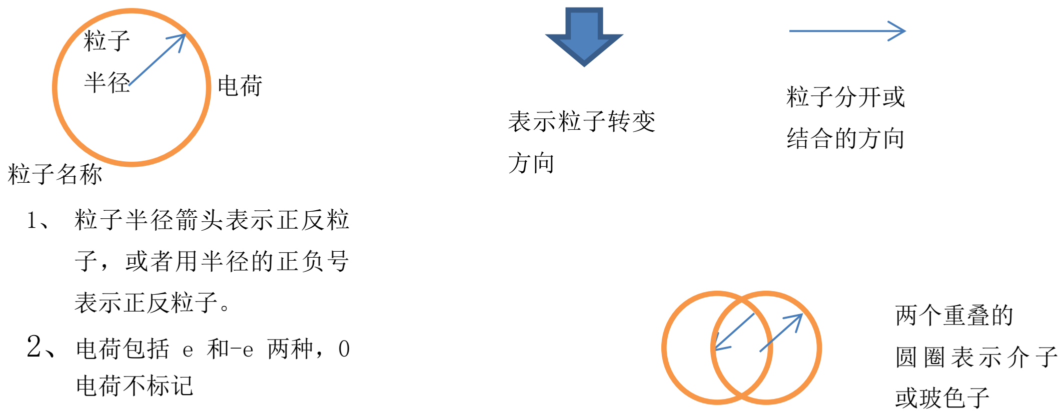

图 1 图解约定

图 2 显示的是三个比较典型的粒子图解实例。这里电子的半径比质子小。电子半径 a 表示正粒子，而如果-a 则表示反粒子。反中微子的半径为 –a，电子中微子与电子图解上的区别主要表现在中微子不带电荷。

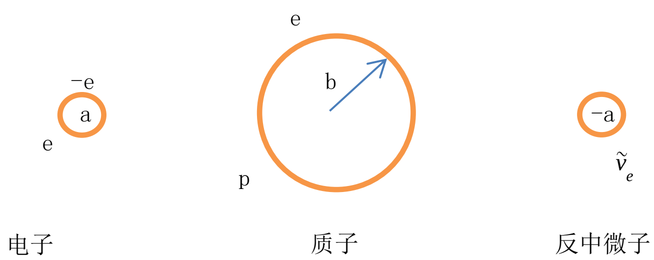

图 2 三个粒子图解实例

4.2 用衰变图表示中微子探测方案

常用的中微子探测方案主要有三种，分别是：

1、中微子电子弹性散射

2、中微子质子反应

3、辐射化学技术

第一种方案利用了中微子与轻子的弹性散射。不过由于中微子不参与电磁相互作用，而要能够参与弱相互作用，则需要比较高的能量。这直接导致反射截面变得非常小。这种弹性散射可以用图 3 来表示。

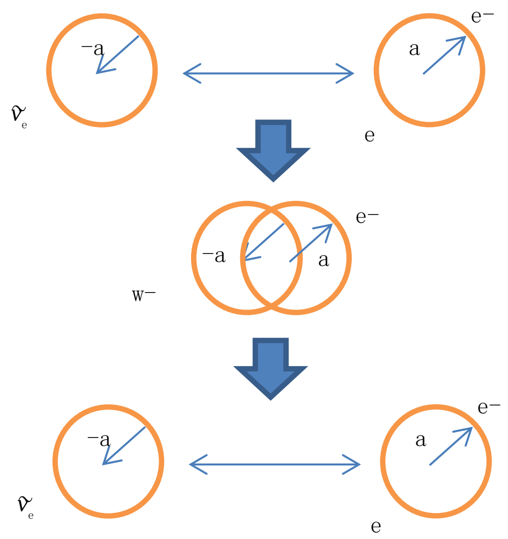

图 3 中微子电子弹性散射图解

可以看出在图 3 中，电子和反中微子进行弹性碰撞，这时候将生成中间粒子 W^- 玻色子。然而由于 W^-玻色子的质量很大，意味着入射的中微子或者电子能量也必须非常高。要满足这一要求的中微子数量通常是非常少的。如果中间粒子为 Z^0 玻色子，也是同样的分析。

第二种方法则是采用了图 4 所示的反应过程。

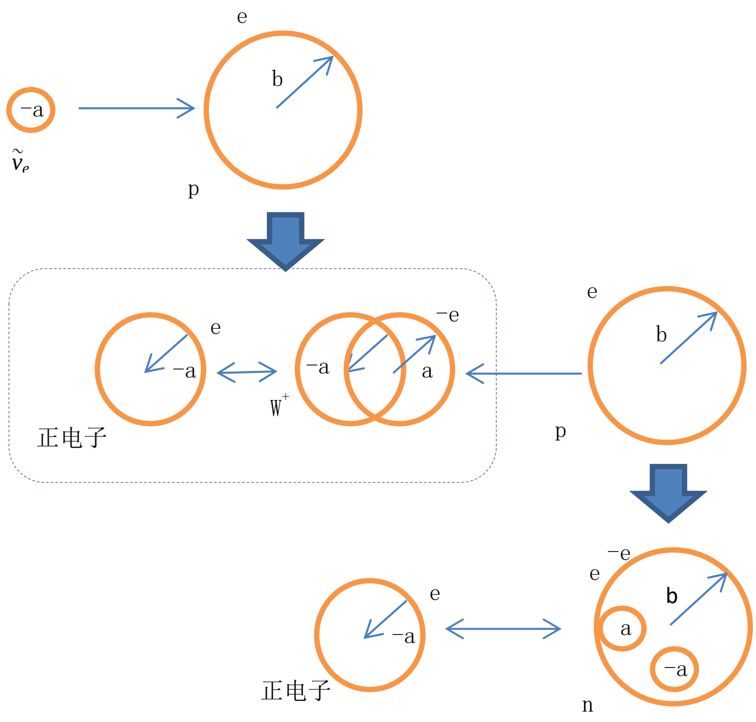

图 4 反中微子与质子的反应

在图 4 的反应过程中，将产生正电子和中子。正电子和探测器中的电子第一时间湮没，发射出强光子，然后所形成的中子产生 β 衰变，再一次发射出光子。通过分析两个光子之间的时间间隔就可以确定是否发生了反 β 衰变反应。

同第一种方法一样，中微子与质子发生作用也要形成一个中间玻色子，同时为了保证轻子数守恒，还需要生成一个正电子，这都意味着该反应过程需要比较高的入射中微子的能量才可以发生。不过由于质子质量比较大，可以预期它所需要的能量比第一种要低一些。

第三种探测方法原理上与第二种类似。

4.3 中微子与质子的弹性散射图解

上述三种中微子探测方案都已经投入使用，获得了实验的检验。不过这些设备都属于比较大型的设备，因此往往需要较大的人力和物力的投入。如何使中微子探测设备小型化，是值得探讨的一个问题。

本文 3.2 节中提到了中微子与质子可能发生弹性散射。具体过程如何，可以通过粒子衰变图来进行分析。在中微子的反射过程中，会产生一个 Z^0 玻色子，然后该玻色子可能迅速衰变成正负电子对，然后湮灭转换成光子。图 5 显示了中微子与质子的弹性散射过程。

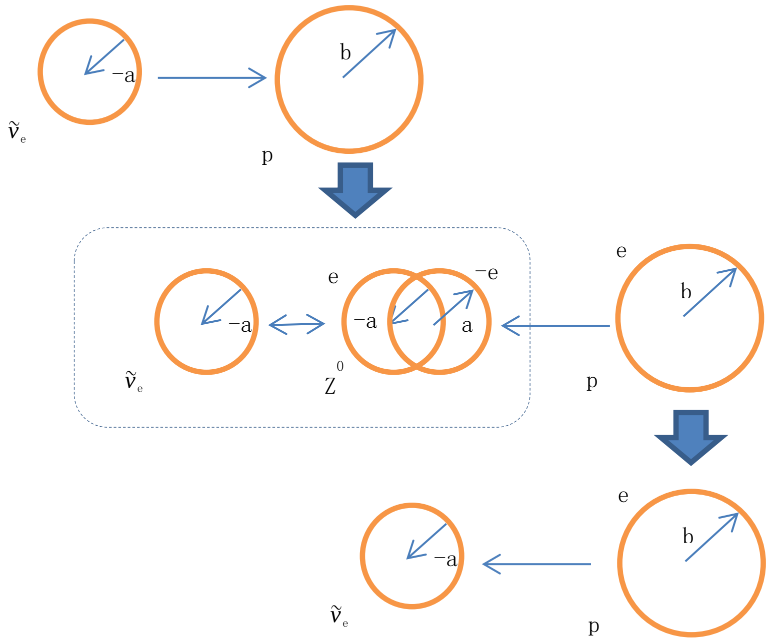

图 5 中微子与质子的弹性散射

5 讨论

本文给出了一个新的中微子模型。该模型基于虚时空存在的假设。该模型的特点表现在中微子也是一种电磁波。但是与光子不同，中微子的电磁波跨越了虚实时空而存在。因此中微子能量的变化涉及到两个时空之间的能量转换。而从中微子电磁波的形式来看，如果中微子电磁波形式中，初始状态表示一个能量非常高的中间玻色子，那就意味着每次中微子与其他的粒子产生相互作用的时候都会产生一个能量非常高的中间玻色子，这可能会导致中微子与其他粒子相互作用变得比较困难。

不过本文尝试探讨的中微子与光子的相互作用则很有趣。从本文的粒子衰变图模型来看，光子的结构与中微子、电子、质子等的结构不相同。而光子至少会间接参与弱相互作用。如果光子确实能够与中微子产生较为直接的相互作用，也许可以避开中间玻色子的角色，从而使整个相互作用所需要的能量降低下来。这样中微子与光子的相互作用就变得比较容易。

按照本文的讨论结果，这种中微子与光子的相互作用将导致光子的红移或者蓝移。因此通过观察一些强烈的中微子放射源和光源同时存在的对象，测量其中光子的红移或者蓝移情况，就可以探测到中微子的存在或者及其各种特性。

参考文献：

[1] Collaboration, T. S. K. (2002). Determination of solar neutrino oscillation parameters using 1496 days of Super-Kamiokande-I data. arXiv preprint hep-ex/0205075.
[2] An, F. P., Bai, J. Z., Balantekin, A. B., Band, H. R., Beavis, D., Beriguete, W., ... & Cai, B. (2012). Observation of electron-antineutrino disappearance at Daya Bay. Physical Review Letters, 108(17), 171803.
[3] Lee, T. D., & Yang, C. N. (1957). Parity nonconservation and a two-component theory of the neutrino. Physical Review, 105(5), 1671.
[4] Cheng, T. P., and Ling-Fong Li. "Neutrino masses, mixings, and oscillations in SU (2)× U (1) models of electroweak interactions." Physical Review D 22.11 (1980): 2860.
[5] Zhi Cheng. (2016).On the New Quark and Neutrino Model Based on Virtual Space-Time. http://vixra.org/abs/1606.0326
[6] Zhi Cheng. (2016). On the Hyper-Symmetric Maxwell Equations and Its Applications. http://vixra.org/abs/1408.0149
[7] 程智. (2012).时空对称结构的麦克斯韦方程组. 北京：中国科技论文在线. http://www.paper.edu.cn/html/releasepaper/2012/08/132/.
[8] Zhi Cheng. (2016). On the Origin of Gravitational Force. http://vixra.org/abs/1605.0136.
[9] Fargion, D., & D'Armiento, D. (2011). Inconsistence of super-luminal Opera neutrino velocity with SN1987A neutrinos burst and with flavor neutrino mixing. Czechoslov. J. Phys. G, 39(arXiv: 1109.5368), 085002.
[10] Hirata, K., Kajita, T., Koshiba, M., Nakahata, M., Oyama, Y., Sato, N., ... & Suda, T. (1987). Observation of a neutrino burst from the supernova SN1987A. Physical Review Letters, 58(14), 1490.
[11] Zhi Cheng. (2016). The Diagrams of Particles Decay Process and the Prediction of New Particle. http://vixra.org/abs/1609.0116.