Several New Cases Violating Time Reversal Symmetry In the Processes of Particle Interactions

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Abstract

It is pointed that we now actually have no enough proofs to prove that time reversal symmetry is universally obeyed in the processes of particle interactions. The analyses show that the time reversal symmetry is obviously violated at least in the processes of particle’s decays, especially in the processes of strange particle’s decays, and some resonance states with only one middle resonance particle to appear, as well as particle pair’s annihilations. So the phenomena of violating time reversal symmetry may exist commonly in the particle’s interactions.

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According to the current viewpoint, except a few cases of $K^0$ particle decays, time reversal symmetry is considered universally tenable in the interaction processes of micro-particles. However, it should be pointed out that only a few experiments show the symmetry of time reversal with low precision at present. Corresponding to so many processes of particle interactions, it is not enough for us to consider the symmetry of time reversal as a commonly obeyed law in the particle physics. The real situations may not be as what we believe now. It can be pointed out that the time reversal symmetry is obviously violated at least in the processes particle’s decays, especially in strange particle’s decays, and some resonance state with only one middle resonance particle to appear, as well as particle pair’s annihilations. So we have to re-examine the conclusion about time reversal symmetry. We only discuss the experimental problems in this paper and will discuss the theoretical problems in the paper titled ”Time reversal symmetry not exist actually in the theories of particle interactions”.

In order to discuss the problems strictly, we first define and classify the processes of time reversals. The processes can be classified as both the determinative and the statistical processes of time reversals.

1. The determinative processes of time reversals

The determinative processes of time reversals can still be divided into both the determinately reversible processes and determinately irreversible processes.

In the determinative processes, let particles A and B collide each other, then C and D particles are certainly produced. The determinately reversible process of time reversal of $A + B \rightarrow C + D$ is defined as follows. When the velocities of the particles C and D are reversed accurately, they would move along the completely same paths as in the positive process so that they would collide to each other. Then particles A and B would be certainly produced again. After that, A and B particles would also move along the completely same paths as they do in the positive process and then apart each other. These processes are called as the determinately reversible processes of time reversals. If they can not do so, the process is called as the determinately irreversible process of time reversal. The concept of the determinately reversible or irreversible process of time reversal is meaningful for the process of a single particle’s decay, so it is also meaningful for a system composed of a large number of particles.

It is obvious that there is no any experiment to show the existence of the determinately irreversible or reversible process of time reversals in the interactions of micro-particles up to now. First, in the nature processes, a particle’s velocity can not reverse automatically, so the process does not exist in nature. Next, we now can not accurately reverse a particle’s velocity by artificial method. No laboratory in the world now can do it. Therefore, both the determinately reversible and determinately
irreversible processes of time reversals are actually unverified at least on the resent experimental level. What we have done now is the statistical processes of time reversals shown as follows.

2. The statistical processes of time reversal

For the statistical process of time reversal of \(A + B \rightarrow C + D\), we do not reverse the velocities of particles C and D directly then make them collide along the completely same orbits as in the positive process. Substitute for it, we take other C and D particles obtained from another method and make them collide each other along the different paths. After collisions, A and B particles may be produced or may not. For the process in which A and B particles are produced, if the transition amplitudes of \(A + B \rightarrow C + D\) and \(C + D \rightarrow A + B\) are the same, we call them the statistically reversible (or symmetry) processes of time reversal. Otherwise, we called them the statistically irreversible processes. The concept of statistically reversible or irreversible processes of time reversal is only meaningful for the system composed of a large number of particles. It is meaningless for the process of a single particle.

It is obvious that all have been done in the current experiments are the statistically processes of time reversal, so we only discuss them below. But the theoretical discussions are beneath determinative and statistical processes, for in the theoretical discussion of time reversal, the directions of particle’s moments and spins are always accurately reversed, but the transition amplitudes are always calculated in the statistical forms. Some time we call the statistical process of time reversal as the time reversal process directly for simplification below.

The time reversal of a single particle’s decay and the double particle’s collision are discussed individually below. For a single particle’s decay, we have following situations:

1. The statistically irreversible processes of time reversals

Suppose the transition amplitude of A particle decaying into B and C particle is \(S_{A \rightarrow BC}\), and the transition amplitude of the reversal process to produce A particle by the collision of B and C particles is \(S_{BC \rightarrow A}\). If \(S_{A \rightarrow BC} = S_{BC \rightarrow A}\), we call the process as the statistically reversible (or symmetry) process of time reversal. If \(S_{A \rightarrow BC} \neq S_{BC \rightarrow A}\), we call the process as the statistically irreversible (or non-symmetry) process of time reversal. Suppose the transition probabilities of positive and reversal processes in the unit time are \(dW_{A \rightarrow BC}\) and \(dW_{BC \rightarrow A}\) individually, according to the definition, we have

\[
dW_{A \rightarrow BC} = \lim_{T \to \infty} \frac{1}{T} \sum_{t=0}^{T} |S_{A \rightarrow BC}|^2 d\mathbf{p}_A^3 d\mathbf{p}_B^3 d\mathbf{p}_C^3 \tag{1}
\]

\[
dW_{BC \rightarrow A} = \lim_{T \to \infty} \frac{1}{T} \sum_{t=0}^{T} |S_{BC \rightarrow A}|^2 d\mathbf{p}_A^3 d\mathbf{p}_B^3 d\mathbf{p}_C^3 \tag{2}
\]

The transition probability \(W_{A \rightarrow BC}\) of positive process is a measurable quantity with the relation \(\tau^{-1} = W_{A \rightarrow BC}\). Here \(\tau\) is particle’s lifetime. But for the reversal process, what can be measured in the experiment is the cross-section of collision \(\Sigma_{BC \rightarrow A}\). We have the relation

\[
d\Sigma_{BC \rightarrow A} = \frac{1}{I} dW_{BC \rightarrow A} = \delta^4(p-q) \frac{\pi K}{2B-1} \frac{1}{J \bar{E}_A} \sum |M_{BC \rightarrow A}|^2 d^3\mathbf{p}_A \tag{3}
\]

In which \(I\) is the unit flow strength, \(J = \sqrt{(p_B \cdot p_C)^2 - M_B^2 M_C^2}\), \(M_{BC \rightarrow A}\) is the invariable amplitude, the four-dimension moments \(\mathbf{p} = \mathbf{p}_A, \mathbf{q} = \mathbf{p}_B + \mathbf{p}_C\), \(p_0 = E_A, q_0 = E_B + E_C\), \(E_A, E_B\) and \(E_C\) are the energies of particle A, B and C. K is the product of Fermion’s masses. If three are no Fermions in the process, K=1. The integral of Eq. (3) can be written as

\[
\Sigma_{BC \rightarrow A} = \delta(E_A - E_B - E_C) \frac{\pi K}{2B-1} \frac{1}{J \bar{E}_A} \sum |M_{BC \rightarrow A}|^2 d^3\mathbf{p}_A \tag{4}
\]

Considering the law of energy conservation, we have \(E_A = E_B + E_C\) and get \(\delta(E_A - E_B - E_C) \to \infty\) according to the nature of \(\delta\) function. If \(M_{BC \rightarrow A} \neq 0\), we have \(\Sigma_{BC \rightarrow A} \to \infty\). This is obviously impossible. In order to let \(\Sigma_{BC \rightarrow A}\) finite, we have to suppose \(M_{BC \rightarrow A} \to 0\) or \(S_{BC \rightarrow A} \to 0\). The result \(M_{BC \rightarrow A} \to 0\) coordinates with the experimental facts. In fact, no any experiment has reported
that in the double particle’s collision only one particle is produced in its final state up to now (in spite of the collisions producing a boson in its middle state.). Even though the process two particles colliding and forming a single particle may be possible, the possibility would be very little so that it can almost be regarded as zero.

We can take the process of $\pi^0$ meson decaying into double photons $\pi^0 \rightarrow 2\gamma$ as an example (1). In this case we have $\sum |M_{\pi^0 \rightarrow 2\gamma}|^2 = m^4/2$. In the center of mass frame, $\pi^0$ meson is at least, $E_\pi = m = 2E_\gamma$, $J = 2E_\gamma |p_{\gamma}| = 2E_\gamma^2$. If the process is reversible, we can get from Eq.(4)

$$\Sigma_{2\gamma \rightarrow \pi^0} = \delta(E_A - E_B - E_C)\frac{\pi m}{4}$$

(5)

The result can be verified by means of experiments. But considering two facts, the result can be considered impossible immediately without the any experiment. First, we have $\Sigma$ The result can be verified by means of experiments. But considering two facts, the result can be considered impossible immediately without the any experiment. First, we have $\Sigma$

$$\sum |M_{\pi^0 \rightarrow 2\gamma}|^2 = \delta(E_A - E_B - E_C) \rightarrow \infty.$$ This is completely impossible. In order to avoid this difficulty, we should have $\sum |M_{\pi^0 \rightarrow 2\gamma}|^2 \neq \sum |M_{2\gamma \rightarrow \pi^0}|^2 \rightarrow 0$, so that $\Sigma_{2\gamma \rightarrow \pi^0}$ becomes finite. Next, it has never been obtained that $\psi^0$ meson can be formed by the collision of two free photons (The details will be discussed later.). So the process $\pi^0 \rightarrow 2\gamma$ violates the symmetry of time reversal obviously. The similar situation is the process $\eta \rightarrow 2\gamma$. Though we have not done the time reversal experiment of a single particle’s decays described above now, we can conclude by means of the theoretical analyses that the processes of a single particle decaying into two or more particles are irreversible for time reversal. Otherwise we would have to face serious contradiction in theory.

We can discuss this conclusion more directly from another angle. Suppose we have an isolated system composed of unstable particles at beginning, for example, a large number of free neutrons. After long enough time, most of neutrons in the system would decay into protons, electrons and neutrinos. Then, let those protons, electrons and neutrinos collide to each other. (Because we only discuss the statistical process of time reversal, not the determinate process, it is unnecessary for us to reverse particle’s velocity directly.). It is obvious that the system is completely impossible to return to its original pure neutron state.

(2). The statistically and completely irreversible processes of time reversals

The statistically and completely irreversible processes of time reversals is defined meaningful for both a single particle and a system composed of a large number of particles. In the reversal processes, we do not directly reverse the velocities of B and C particles coming from A particle’s decay and let them collide. Instead, we use B and C particles coming from other resources and collide them each other. After that, we find that A particle is never produced. The obvious examples of statistically and completely irreversible processes of time reversals are the processes of strange particle’s decays. For example

$$\Lambda^0 \rightarrow \pi^- + p, n + \pi^0, p + e^- + \bar{\nu}_e,$$
$$K^0 \rightarrow \pi^0 + \pi^0, \pi^+ + \pi^-, \mu^+ + \mu^-, \Sigma^0 \rightarrow \Lambda^0 + \gamma$$

(6)

All of these processes above can be achieved through natural or artificial forms. But no any opposite process shown below has been find in nature or in laboratories in the world up to now

$$\psi^- + p \rightarrow \Lambda, n + \psi^0 \rightarrow \Lambda, p + e^- + \bar{\nu}_e \rightarrow \Lambda$$
$$\psi^0 + \psi^0 \rightarrow K^0, \psi^+ + \psi^- \rightarrow K^0, \mu^+ + \mu^- \rightarrow K^0$$

(7)

These processes are regarded to violate the law of strange number conservation and impossible to exist. The strange particles always produce associatively through strong interaction but decay alone through weak interaction. For example, the producing processes of $\Lambda$ and $K^0$ particles

$$\psi^- + p \rightarrow \Lambda + K^0$$
$$\psi^- + p^0 \rightarrow \Sigma^0 + K^0$$

(8)

Therefore, if the transition amplitudes of non-strange particle’s decays are considered to be tending to zero, the transition amplitudes of strange particle’s decays should be considered zero strictly. The law
of strange number conservation forbids the existence of reversal processes of strange particle’s decays. The similar situations are the processes of charmed particle’s decays, but it needs not to discuss any more here.

(2). The other situations.

There are two kinds of experiments used to study the time reversal problems of single particle’s processes at present. One is to measure neutron’s electrical dipole moment. If electromagnetic interaction is symmetry for time reversal, the neutron’s electrical dipole moment should be zero. The current experiments show that the measurement value is \( \mu < 1.0 \times 10^{-25} \text{ecm} \). But this result can only show that the existing process of stable neutron’s existence seems time reversal symmetry. It can not show that the decay process of an unstable particle is also time reversal symmetry.

Another experiments for the time reversal of a single particle’s processes are to measurement the phase angles of decay particles. Because the calculations of phase angles invoice the theory of interaction, it is difficult for us to know what is the theoretical effect and what is the experimental effect. These two kinds of experiments are indirect. From them we can not decide whether or not time reversal is symmetry for micro-particle’s decays. Therefore, we can get conclusion from discussion above that for the decay processes of micro-particles, the reversibility of determinative time reversal is only an unverified suppose, and the reversibility of statistical time reversal is actually impossible.

The collision processes of double particles are discussed as follows. They can also be divided into several classes below.

(1). The statistically reversible processes of time reversal.

Suppose the transition amplitude of producing B and C particles by the collision of A and B particles is \( S_{AB \rightarrow CD} \), the transition amplitude that A and B particles are produced by the collision of B and C particles is \( S_{CD \rightarrow AB} \). If the invariable amplitudes are the same, i.e., \( M_{AB \rightarrow CD} = M_{CD \rightarrow AB} \), we say that the process has reached the detail balance and call the process as the statistically reversible (or symmetrical) process of time reversal. Otherwise, the process is considered as the statistically irreversible (or non-symmetry) process of time reversal. At present it is generally thought that the collision processes of double micro-particles are reversible or symmetrical for time reversals. But only a few experiments support this conclusion actually shown as follows

a). The processes of strong interaction with (2)

\[
24 Mg + d \leftrightarrow 25 Mg + p
\]

and

\[
24 Mg + \alpha \leftrightarrow 27 Al + p
\]

The experiments support the symmetry of time reversal with about 0.5 per cent precision.

b). The process of electromagnetic interaction with (4)

\[
n + p \leftrightarrow d + \gamma
\]

Only 20 per cent precision supports the symmetry of time reversal. The precision seems too low.

c). The experiments used to measurement \( \pi \) meson’s spin (3)

\[
\psi^+ + d \leftrightarrow p + p
\]

Because there exist so many collisions of double particles, only based on such a few experiments, it is not enough for us to affirm that all collision processes of double particles are reversible for time reversal.

(2) The statistically irreversible processes of time reversal

It can be pointed out that there exists a kind of processes of double particle’s that obviously violate the symmetry of time reversal. They are the processes in which particle pairs collide, annihilate and produce new particles with only one resonant particle appearing in the middle state. For example

\[
ee^+ + e^- \rightarrow \rho^0(770) \rightarrow \pi^+\pi^-, \mu^+\mu^-, e^+e^-
\]
Now we analyze the process \( e^+ + e^- \rightarrow \rho^0(770) \rightarrow \psi^+ + \psi^- \) in detail. Because the process involves strong interaction with \( \pi \) mesons in the final state, the accurate form of transition amplitude \( S_{e^- \pi} \) can not be obtained, so that the section of the process can not be calculated. However, because the initial and final states are definite, we can always write the cross-section of collision in the center-of-mass frame as follows

\[
d\sigma_{e^- \pi} = \frac{m_e^2 \sqrt{s - 4m_e^2}}{16\pi^2 s \sqrt{s - 4m_e^2}} \sum | M_{e^- \pi} |^2 d\Omega(\theta, \varphi)
\]

(13)

Here \( m_e \) is electron and positive electron’s mass \( m_\pi \) is positive and negative meson’s mass, \( s \) is the total energy of the system in the center-of-mass frame. For the process of time reversal \( \psi^+ + \psi^- \rightarrow \rho^0(770) \rightarrow e^+ + e^- \)

(14)

The cross-section of collision can be write as

\[
d\sigma_{\pi^- e} = \frac{m_e^2 \sqrt{s - 4m_e^2}}{16\pi^2 s \sqrt{s - 4m_e^2}} \sum | M_{\pi^- e} |^2 d\Omega(\theta, \varphi)
\]

(15)

After the average of the initial state and the sum of the final state are taken, we have individually

\[
\bar{\Sigma} | M_{e^- \pi} |^2 = \frac{1}{4} \sum_{r,s} | M_{e^- \pi} |^2
\]

\[
\bar{\Sigma} | M_{\pi^- e} |^2 = \sum_{r,s} | M_{\pi^- e} |^2
\]

(16)

If the process is reversible for time reversal, we have \( M_{e^- \pi} = M_{\pi^- e} \) so

\[
\frac{d\sigma_{\pi^- e}}{d\sigma_{e^- \pi}} = \frac{4(s - 4m_e^2)}{s - 4m_e^2}
\]

(17)

Suppose the middle particle \( \rho^0 \) is at lest, its static mass is \( m_\rho = 770 MeV \) so \( \sqrt{s} = 770 MeV \). Taking \( m_e = 0.51 MeV \) \( m_\pi = 139.6 MeV \) the ratio between the differential cross-sections of positive and opposite processes is

\[
\frac{d\sigma_{\pi^- e}}{d\sigma_{e^- \pi}} \approx 4.14
\]

(18)

That is to say, the differential cross-section of reversal process is 4.14 times more than that of positive process. Besides, there is another relation

\[
dW_{fij} = I_{fij} d\sum_{fij} = I_{fij} \delta^4(P - Q) d\sigma_f d^4Q
\]

(19)

The relative flow intensities of incident particles in the center-of-mass frame are individually

\[
I_{e^- \pi} = \lim_{V \rightarrow \infty} \frac{J_{e^- \pi}}{V E_{e}^2} = \lim_{V \rightarrow \infty} \frac{\sqrt{s(s - 4m_e^2)}}{2V E_{e}^2}
\]

(20)

\[
I_{\pi^- e} = \lim_{V \rightarrow \infty} \frac{J_{\pi^- e}}{V E_{\pi}^2} = \lim_{V \rightarrow \infty} \frac{\sqrt{s(s - 4m_\pi^2)}}{2V E_{\pi}^2}
\]

(21)

Because of \( E_e = E_\pi \) in the center-of-mass frame, by using Eq.(17) the ratio of the transition probabilities between the positive and opposite processes is

\[
\frac{dW_{\pi^- e}}{dW_{e^- \pi}} = \frac{I_{\pi^- e} d\sigma_{\pi^- e}}{I_{e^- \pi} d\sigma_{e^- \pi}} = \frac{4\sqrt{s - 4m_e^2}}{\sqrt{s - 4m_\pi^2}}
\]

(22)
Similarly, we have

\[ \frac{dW_{\pi^+e}}{dW_{e^-\pi}} \approx 4.27 \]  

That is to say that the transition probability of reversal process is 4.27 times more than that of the positive process.

However, these results are completely impossible. It can be known from Meson Particle Listings (5) that the decay branching ratio of \( \rho^0 \to \pi^0 \pi^0 \) nearly 100

\[ e^+ + e^- \to \psi(3770) \to D\bar{D}, e^+e^- \]  

\[ e^+ + e^- \to \omega(782) \to \pi^+\pi^0\pi^0, e^+e^- \]  

\[ e^+ + e^- \to \phi(1020) \to K^+K^-, e^+e^- \]  

\[ e^+ + e^- \to J/\psi(3100) \to \text{hadrons, e}^+e^- \]  

In the processes, the decay branching ratio of \( \pi(3770) \to D\bar{D} \) nearly 100.

Another kind of the processes in which the symmetry of time reversal is seriously violated are that the particle pairs of low energy annihilate into radiation. Taking the annihilation process of electron pair \( e^+ + e^- \to 2\gamma \) as an example, we have the cross-section of electron pair annihilating into two photons in the center-of-mass frame (6)

\[ \sigma_{e^+e^- \to 2\gamma} = \frac{\pi r_0^2 m_e^2}{4V E_e^2} \left[ 3 - \frac{V^2}{2} \ln \left| \frac{1 + V}{1 - V} \right| + 2(V^2 - 2) \right] \]  

Here \( r_0 \) is electron’s classical radius, \( E_e \) is electron’s mass, \( V = \sqrt{1 - m_e^2/E_e^2} \) is electron’s speed in the center-of-mass frame. Let \( m = 0.5 MeV, E_e = 1 MeV \), we can get \( \sigma_{e^+e^- \to 2\gamma} = 0.32\pi r_0^2 \). For the reversal process \( e^+ + e^- \to e^+ + e^- \), suppose the transition amplitudes of positive and opposite processes are the same, according to quantum electrodynamics, the cross-section of photon pair collides and transforms into electron pair in the center-of-mass frame is (5)

\[ \sigma_{\gamma^+\gamma^- \to 2e^+e^-} = \frac{\pi r_0^2 m_e^2}{2\omega^2} [(2 + \frac{m_e^2}{\omega^2} - \frac{m_e^4}{\omega^4})\ln |\frac{\omega}{m_e} + \sqrt{\frac{\omega^2}{m_e^2} - 1}| - \sqrt{1 - \frac{m_e^2}{\omega^2}}(1 + \frac{m_e^2}{\omega^2})] \]  

Let \( \omega = 1 MeV \), we can get \( \sigma_{\gamma^+\gamma^- \to 2e^+e^-} = 0.53\pi r_0^2 \). The result show that \( \sigma_{\gamma^+\gamma^- \to 2e^+e^-} \approx 1.67\sigma_{e^+e^- \to 2\gamma} \), that is to say, the cross-section of photon pair collides and transforms into electron pair is 1.67 times more than that of electron pair annihilating into two photons. This conclusion is unimaginable. It is easy for the electron pair of low energy annihilating into photons. But up to now it has no any report to show that two free photons can collide and transform into electron pair with bigger possibility than that in the process of electron pair annihilating into photons. What has been observed in the current experiment is the process \( \gamma + Z \to e^+ + e^- + Z \), in which \( \gamma \) is a photon of high energy, \( Z \) is a heavy atomic nucleus. It is supposed in the process that a free photon collides with an imaginary photon then electron pair is produced, not two free photons collide. In fact, even though two free photons can collide and transform into electron pair, its probability should be very low, otherwise our university would not like what we now see mainly to compose of positive particles.

We can discuss this problem further. The scatter of two photons is a four-order process. Let \( \omega \) represent photon’s energy, \( m \) represent electron’s mass, \( r_0 \) represent electron’s classical radius, by the calculation of re-normalization (6), we know that its cross-section directs ratio to \( \omega^6 \) in the low energy process when \( \omega < < m \)

\[ \sigma_L = \frac{\pi r_0^2}{\pi^2} \frac{\alpha^2}{5} 56 \times 139 \frac{\omega^6}{m^2} \approx 10^{-6} \pi r_0^2 \frac{\omega^6}{m^6} \]
Here $\alpha = e^2/4\pi = 1/137$. Suppose $\omega/m = 0.01$ we get $\sigma_L = 10^{-18}\pi r_0^2$. So the probability of collision of two low energy photons is very small, almost can be seen as zero. On the other hand, in the high-energy process with $\omega >> m$, the scattering cross-section directs ratio to $\omega^{-2}$ with

$$\sigma_H = b\pi r_0^2 \frac{m^2}{\omega^2}$$  \hspace{1cm} (31)

Here $b$ is a constant without dimension. The order of magnitude of constant $b$ is estimated as follows. It can be known from Eq,(30) that the scattering cross-section increases with the increase of photon’s energy under the condition of low energy, but decreases with the increase of photon’s energy under the condition of high energy. So it must exist an energy value on this value the scattering cross section does not increase or decrease with energy’s change. For simplification, taking this energy as the middle value with $\omega = m$, and let $\sigma_H = \sigma_L$, we can get $b = 10^{-6}$, and have

$$\sigma_H = 10^{-6}\pi r_0^2 \frac{m^2}{\omega^2}$$  \hspace{1cm} (32)

Under the condition of high energy, suppose $\omega/m = 100$ we can get $\sigma_H = 10^{-10}\pi r_0^2$. This is also very small, almost can be regarded as zero, though it is quite big than $\sigma_L$.

On the other hand, we known that the orders of magnitudes of the cross-section of electron pair’s scatter and annihilation are the same with $\sigma \sim \pi r_0^2 m^3/E^2$. So the orders of magnitudes of the cross-section of photon pair’s scatter and annihilation should also be the same. But according to the estimation above, if the process of electron pair annihilating into photons is reversible, according to Eq,(29), the orders of magnitudes of the cross-section of two high energy photons ($\omega/m = 100$) annihilating into electron pair is about $\sigma \sim 10^{-4}\pi r_0^2$. This is about $10^6$ times more than that of the scatter of two photons. The result is unimaginable.

From the cases shown above, it is reasonable for us to consider that in the other processes of particle’s reactions, no matter what kind of interaction, strong or weak or electromagnetic interactions, the symmetry of time reversal would be widely violated more or less. The situation seems like the law of parity conservation several decades ago, the symmetry hypothesis of time reversal in the processes of particle physics is an unverified one, and in fact, it may be completely wrong. So we should re-examine this hypothesis by the further theoretical and experimental researches.

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