A particle model based on virtual spacetime

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Abstract

This article explores the mathematical and physical foundations of the existence of virtual spacetime. It is pointed out that there are three forms of virtual spacetime. The first is faster-than-light virtual spacetime; The second is black hole virtual spacetime; The third is microscopic virtual spacetime. According to the characteristics of microscopic virtual spacetime, when the spacetime scale is less than a certain radius, an unobservable spacetime region will appear. This unobservable area is virtual spacetime. If the size of a particle falls within the microscopic virtual space, it means that the radius of the particle is not measurable. Naturally, there is no structure inside, just like an electron. But if the radius of the particle exceeds the boundary of spacetime, the electromagnetic radius of the particle can be observed in the real spacetime. Considering that a particle usually has many other parameters, including charge, spin, isospin, etc., this means that some more detailed structural models of the particle can be constructed according to some mathematical methods of symmetry. On this basis, this paper constructs a new model of elementary particles, which can better explain the difference between the radius and mass of electrons and protons, and can explain the properties of neutrons, bosons, neutrinos, etc.

1. The basis of the existence of virtual spacetime

1.1 Virtual spacetime in the physical world

As human exploration of the universe deepens, the evidence for the existence of dark matter becomes clearer. This shows that the current knowledge of physics is still very limited. Any new theory that emerges is very instructive. From a mathematical point of view, the phenomena currently known to mankind can basically be described by mathematics. However, some of the tools commonly used in mathematics have difficulties in the physical world. For example, imaginary numbers in mathematics, in many physical theories, the existence of imaginary numbers in the real physical world is ridiculous. Even in quantum mechanics, the result of obtaining imaginary numbers is simply ignored as a term with no physical meaning.

But on the other hand, we can find that in the physical world, there are two fields with exactly the same properties of electric field and magnetic field. Our spacetime is formed by the interaction of positive and negative charges. The magnetic field is generated by the movement of electric charges. This brings us to the question: why don't magnetic monopoles exist? Why is there no spacetime formed entirely by the interaction of magnetic fields? This leads us to think about whether the spacetime formed by the interaction of magnetic fields is a mirror image of the spacetime we live in.

Because there is no reason to deny that a complete world can be formed through magnetic field interaction, according to the symmetry of the electric field and magnetic field in electromagnetic waves, it seems that the spacetime formed by this magnetic field interaction should even have the same physical laws as the spacetime we live in.

We call these two possible spacetimes as real spacetime and virtual spacetime respectively. Real spacetime refers to spacetime formed by the interaction of electric fields between electric charges. Virtual spacetime is a spacetime composed of magnetic monopoles and based on magnetic field interactions.

There is also a limit to the speed of light in the physical world. That is, none of the particles can move faster than the speed of light. But what happens if a particle exceeds the speed of light?

Will space and time be reversed in regions that exceed the speed of light? According to Maxwell's equations [1] based on supersymmetry of real and virtual spacetime, there should be a virtual spacetime with space and time reversal.

But one thing is certain, during the propagation of electromagnetic waves, since the magnetic field and the electric field are always orthogonal, the virtual spacetime and real spacetime are always orthogonal.

1.2 What is time?

Time should reflect a change in the state of matter. There are two kinds of time in the physical world: one is the time in relativity theories, which can be slowed or faster, and it is also a dimension of spacetime. The other type of time is time in thermodynamics. This time reflects changes in entropy. When an organism has a process of aging, it can mark the location of time with its rate of growth or aging.

Both types of time have only one direction. Essentially, both types of time can be used to depict the changing trends of a complex system. For example, the cosmological model described in general relativity is a cosmic model called the Big Bang. This Big Bang model of the universe also reflects that the number of states in the entire universe is becoming more and more numerous, and the corresponding thermodynamic entropy is constantly increasing.

Therefore, changes in time in general relativity essentially reflect whether thermodynamic entropy is getting faster or slower.

But from the current knowledge of physics, if the electron moves around the proton, it will not stop. That is, for an electron, its time is reversible. If we look at the decay process of protons and electrons, the current evidence has shown that protons and electrons cannot decay, which means that for protons and electrons, time stops.

Therefore, from the analysis of the two elements that make up the lowest layer of matter, such as electric and magnetic fields, time is stopped, even reversible.

The magnetic field reflects the motion of the electric field, which can be shown in real spacetime. The electric field, on the other hand, reflects the motion of the magnetic field, which can be displayed in virtual spacetime. Therefore, at the very bottom of matter, we can define time as a state that reflects the movement of basic elements of matter.

If the matter or field does not move, then it appears as three-dimensional space, but once the matter or field moves, time appears.

1.3 Types of virtual spacetime

1.3.1 Faster-than-light virtual spacetime

The existence of this type of virtual spacetime is due to the fact that the speed of particles exceeds the speed of light, resulting in imaginary numbers in the calculation of the formula of relativity.

Like what

$$x' = x\sqrt{1 - \frac{v^2}{c^2}}$$

When $v > c$, x' becomes imaginary. If the time dimension is original imaginary, it becomes real in this condition.

Therefore, due to the existence of faster than the speed of light, a certain dimension of the spatial scale becomes imaginary in the Minkowski metric. Time changes from imaginary numbers to real numbers. This enables a flip between time and space.

According to the existence of such a virtual spacetime, we can obtain two sets of Maxwell's equations with very good symmetry, and also solve the problem of whether magnetic monopoles exist in the Dirac's quantization of charge condition. In other words, magnetic monopoles exist, but they are located in virtual spacetime, and we cannot observe them.

These two sets of Maxwell's equations, which are very symmetrical, are as follows:

The Maxwell equations in real spacetime are

$$\begin{cases} \nabla \cdot \boldsymbol{F} = g_e & (1) \\ \nabla \cdot \boldsymbol{G} = 0 & (2) \\ \nabla \times \boldsymbol{F} = -\dfrac{\partial \boldsymbol{G}}{\partial y} & (3) \\ \nabla \times \boldsymbol{G} = \dfrac{\partial \boldsymbol{F}}{\partial y} + \boldsymbol{J}_e & (4) \end{cases}$$

The Maxwell equations in virtual spacetime are

$$\begin{cases} \nabla_y \cdot \boldsymbol{G} = g_m & (5) \\ \nabla_y \cdot \boldsymbol{F} = 0 & (6) \\ \nabla_y \times \boldsymbol{G} = -\dfrac{\partial \boldsymbol{F}}{\partial x} & (7) \\ \nabla_y \times \boldsymbol{F} = \dfrac{\partial \boldsymbol{G}}{\partial x} + \boldsymbol{J}_m & (8) \end{cases}$$

where G, F, g_e, g_m, J_e, J_m are generalized parameters, and *x* and *y* represent the time of real and virtual spacetime, respectively. The corresponding differential operators ∇ and ∇_y represent the spatial differentiation of real spacetime and virtual spacetime, respectively. It can be seen that these are two sets of equations with very good symmetry. An important conclusion from the solution of these two sets of equations is that electromagnetic waves less than the speed of light can be obtained. This corresponds to the so-called virtual photon solution [1].

1.3.2 Black hole virtual spacetime

It can be seen from the Schwarzschild metric that when a black hole is formed, a virtual spacetime is formed inside the black hole. And this virtual spacetime is exactly the reverse of time and space with the external real spacetime. The radial component of the Schwarzschild metric is

$$dr' = \frac{1}{\sqrt{1 - \frac{2GM}{c^2 r}}} dr \qquad (9)$$

If less than the Schwarzschild radius, then

$$dr' = \frac{i}{\sqrt{\frac{2GM}{c^2 r} - 1}} dr \qquad (10)$$

whereas

$$dt' = \sqrt{1 - \frac{2GM}{c^2 r}} dt = i\sqrt{\frac{2GM}{c^2 r} - 1} dt \qquad (11)$$

It can be seen that the radial component and the time component symbol of Schwarzschild metric are reversed. This is consistent with the properties of faster-than-light virtual spacetime.

1.3.3 Microscopic virtual spacetime

Considering that physical spacetime should not exist on an infinitesimally small scale, physical spacetime should be finite. And this finitude means that if we divide the real spacetime infinitely, we will reach the minimum scale of the spacetime. Time and space will not be able to continue to divide.

If we take the radius of a sphere with a radius of r_c as the minimum scale of the composition of real spacetime. Spacetime smaller than within that radius will also become virtual spacetime. Because we don't have a way to detect the structure inside that radius in any real spacetime way.

The most basic factor that forms this virtual spacetime is the uncertainty principle. Because in the microscopic world, you can't measure position and momentum, or time and energy, at the same time. This means that there is a very small scale of space-time in the microscopic world.

However, according to currently known experimental observations, photons can reach energies of more than 10^{15} electron volts. This also means that its wavelength can reach $10^{-22}m$. Again, this is a very small spatial scale.

Of course, if the energy of photons is large enough, tiny black holes will be formed. At this point, according to the relationship between the wavelength of the photon and the Schwarzschild radius, we can get:

$$r = \frac{2GM}{c^2} = \frac{2Ghc}{2\pi r c^4}$$

Then

$$r = \sqrt{\frac{2G\hbar}{c^3}} \qquad (12)$$

But this length is too small. And such a high energy also means that according to the uncertainty principle, it can exist only for a very short time. That is, in a very short time, this energy will decay rapidly and produce many different particles.

The unit of Planck's constant is energy multiplied by time, which reflects the parameter of rotational angular momentum. Like what

$$J = mrv = \frac{mc^2rv}{c^2} \tag{13}$$

It can be seen that as long as the radius is fixed, even if the time increases, the angular momentum will not have a cumulative effect. This also means that time will be reversible. This is caused by the angular momentum of rotation.

And if it's momentum

$$p = mv = \frac{mc^2v}{c^2}$$

It can be seen that momentum reflects energy multiplied by speed, that is, the ratio of space and time. There is no cumulative effect of simultaneous changes in space and time. That is to say, considering only the change in momentum, time has only one direction, which is irreversible. However, if we consider the proportional relationship of space and time at the same time, we can find that this proportional relationship between space and time is reversible. After all, speed can be positive or negative.

So in order to get reversible time, we need to spin the energy. If the speed of energy or mass m rotating around radius r is the speed of light.

namely

$$mrc = \hbar$$

Then we can get a more special radius

$$r = \frac{\hbar}{mc} \tag{14}$$

Outside this radius are all energy rotating at a speed less than the speed of light, and inside this radius are all energy rotating faster than the speed of light. But in real spacetime, energy spinning faster than the speed of light is unobservable.

In other words, the uncertainty principle reflects the rotation of electric or magnetic field energy. Its angular momentum has a minimum value. This minimum is the Planck constant. Therefore, we can further infer that the existence of all particles actually appears in the form of energy rotation. Without rotation, the temporal variation of the electric and magnetic fields would be irreversible.

In this way, according to the nature of superluminal virtual spacetime, the speed of light is the boundary between virtual spacetime and real spacetime, then this virtual spacetime boundary division method based on the speed of light can be applied to the rotational speed of electric field and magnetic field energy. That is to say, when the speed of the electromagnetic field energy rotation is equal to the speed of light, there is a boundary between virtual spacetime and real spacetime at the microscopic scale.

The electromagnetic field or virtual photon solution below the speed of light can be solved by supersymmetric Maxwell's equations (1~8) [1].

2 The boundary between virtual and real spacetime

In this way, when the speed of matter or energy exceeds the speed of light, it enters the virtual spacetime. So the speed of light can be seen as the boundary between virtual spacetime and real spacetime.

The other boundary is the black hole event horizon. From the Schwarzschild metric, it can be seen that when a particle passes through the black hole event horizon, the entire space-time is reversed. This is consistent with some important features of virtual spacetime.

For the boundary between the virtual spacetime and real spacetime of the microscopic world, it can be analyzed from the rotational angular momentum of electromagnetic waves. Due to the requirements of quantization, the minimum angular momentum of the rotation of electric or magnetic fields is $h/2$.

In a suitable space-time radius, if the rotation speed of electric or magnetic fields is exactly the speed of light, a spherical boundary between virtual spacetime and real spacetime should be formed. Beyond the boundary is real spacetime, where the speed of virtual photons will be less than the speed of light. Inside the boundary is virtual spacetime, where the speed of virtual photons is greater than the speed of light.

We can determine the size of the boundary radius between virtual spacetime and real spacetime by the following formula.

Suppose mc^2 is the energy of a particle. Of course we can also express it as a wave, ie

$$h\nu = \frac{hc}{2\pi r} = mc^2$$

If this energy is rotating at the speed of light around the *z*-axis on a spherical shell of radius *r*, the spin angular momentum can be found as

$$J = mrc = \frac{h}{2\pi rc} rc = \hbar$$

It can be seen that this is the angular momentum of the photon. However, consider the symmetry between electrons and protons. Its spin angular momentum is only half that of a photon. Thus we can find that the radius of this boundary surface is

$$r_c = \frac{r}{2} = \frac{\hbar}{2mc} \tag{15}$$

Then this r_c can be seen as the boundary between virtual spacetime and real spacetime formed by particles with mass or energy m. Particles smaller than this boundary, we cannot detect its radius. A particle larger than the boundary, we think it has an internal structure.

3 Structure of particles

Considering the requirements of symmetry, the particles we can currently see in real spacetime should also have a corresponding particle in virtual spacetime. This is determined by the supersymmetric Maxwell equations (1~8). From these two sets of equations, it can be seen that the electric and magnetic fields are perfectly symmetrical. Since the electric field can form various elementary particles, the magnetic field should also be able to form the corresponding particles.

This allows us to assume that the energy of an elementary particle must consist of two parts. One part is the energy in real spacetime, and the other part is the energy in virtual spacetime. This can achieve a more perfect symmetry.

Particle energy consists of two parts, based mainly on the following facts:

First, from the energy formula of relativity, the rest mass and the energy of motion are two different dimensions. These two different dimensions can be represented by the Dirac equation.

Second, there is a switchable relationship between mass and energy. That is, the intrinsic properties of mass and energy are exactly the same. From Einstein's field equations, both mass and energy can cause the curvature of space-time. In other words, the effects of the two on space-time are consistent.

Therefore, we can make a reasonable assumption that mass is actually the energy of virtual spacetime. In this way, we can establish an equation for the mass-energy relationship between electrons and protons. namely

$$E_1 = \sqrt{(m_e c^2)^2 + {E_e}^2} \tag{16}$$

$$E_2 = \sqrt{\left(m_p c^2\right)^2 + {E_p}^2} \tag{17}$$

The m_e and m_p are the masses of electrons and protons, respectively. E_e and E_p are the electric field energies of electrons and protons, respectively.

From this formula, we can also see that if the electrostatic field of electrons and protons has energy, then from the above formula we can also reasonably assume that the mass of electrons and protons may come from the static magnetic field energy of the particle magnetic monopole corresponding to virtual spacetime.

Then we can also consider symmetry, which states that the total energies of electrons and protons should be equal. namely

$$E = E_1 = E_2$$

So if $m_e \neq m_p$, then

$$m_e c^2 = E_p$$

and

$$m_p c^2 = E_e$$

Considering:

$$m_p \gg m_e$$

So the total energy of each particle is approximately equal to:

$$E \approx m_p c^2$$

In this way, combined with Equation (15), we can solve for elementary particles such as electrons or protons, the interface between virtual spacetime and real spacetime is about the radius

$$r_c = \frac{\hbar}{2m_p c} \approx 2.10309 \times 10^{-16} m \tag{18}$$

If the elementary particles that make up all matter have such symmetry. Then we can think of this boundary radius r_c as a constant suitable for all particles. That is, if a particle is smaller than this radius, its radius will be in virtual spacetime. Particles larger than this radius will be located in real spacetime. The radius of a particle located in virtual spacetime is undetectable. The radius of particles located in real spacetime is detectable. Since there is a detectable radius, because the particle has a variety of parameters such as mass, magnetic moment, spin, and isospin in addition to electric charge, it is natural to further divide its internal structure according to the requirements of various symmetry.

If the charge of a particle is evenly distributed over a spherical shell, we can calculate its electrostatic field energy as

$$E = \frac{e^2}{8\pi\varepsilon r} \tag{19}$$

In this way, according to the above formula, the electrostatic field energy of the proton can be calculated as:

$$E_p = \frac{e^2}{8\pi\varepsilon r_p} = m_e c^2 \quad (20)$$

The electromagnetic radius of the proton is

$$r_p = \frac{e^2}{8\pi\varepsilon m_e c^2} \approx 1.4089924 \times 10^{-15}(m) \quad (21)$$

The electromagnetic radius of electrons is:

$$r_e = \frac{e^2}{8\pi\varepsilon m_p c^2} \approx 7.6736127 \times 10^{-19}(m) \quad (22)$$

It can be seen that the electromagnetic radius of an electron is much smaller than r_c interface radius, so its internal structure cannot be measured. This is consistent with current experimental measurements.

The radius of the proton is larger than the interface radius r_c, so its electromagnetic radius will be detected. Combined with other parameters, a more complex model of the internal structure of the proton can be constructed. For example, the quark model of hadrons and so on.

In this way, according to how many times the mass of the particle is that of an electron or proton, we can roughly estimate the electromagnetic radius of other particles. Table 1 shows the electromagnetic radii of eight particles.

Table 1. The electromagnetic radius of some particles

Radius name	**Values (*m*)**
r_c	2.10309×10^{-16}
Electron and electronic neutrino	$7.6736127 \times 10^{-19}$
Muon (μ) and Muon neutrino	1.586660×10^{-16}
Tau (τ) and Tau neutrino	2.668230×10^{-15}
Proton and neutron	$1.4089924 \times 10^{-15}$

As can be seen from Table 1, the electromagnetic radii of electron, Muon (μ) and corresponding neutrinos are less than r_c, so the electromagnetic radius of these particles has no observable physical effects. This also means that there are no other structures inside these particles. The available experimental data also show that the electron and Muon have no internal structure.

The electromagnetic radii of proton, neutron, Tau (τ) and Tau neutrino are greater than r_c, which means that the electromagnetic radii of these four particles are greater than the virtual spacetime electromagnetic radius boundary, so these four particles may have internal structures. Among them, proton and neutron have been shown to be composed of quarks, and τ can decay into hadrons composed of quarks.

However, the currently measured mass of protons can actually be divided into two parts. Part of it is electromagnetic mass. The other part is the isospin mass of the proton. where the electromagnetic mass of a proton is approximately $m_{pf} \approx 0.5984 m_p$

It can be seen from here that only this part of the electromagnetic mass may affect the electromagnetic radius of the electron, ie

$$r_e' = \frac{e^2}{8\pi\varepsilon m_{pf} c^2} \approx \frac{7.6736127}{0.5984} \times 10^{-19} \approx 1.3 \times 10^{-18}(m)$$

The electromagnetic radius of the electrons thus calculated will be slightly larger. However, this does not affect the conclusion of this article. However, the electromagnetic radius of the μ may increase and reach the position of the boundary radius.

4 A new particle model

We can use this relationship between virtual spacetime and real spacetime to construct a new particle model. The boundary between virtual spacetime and real spacetime is represented by a dotted circle. This allows electrons, protons, and electron neutrinos to be represented in Fig. 1.

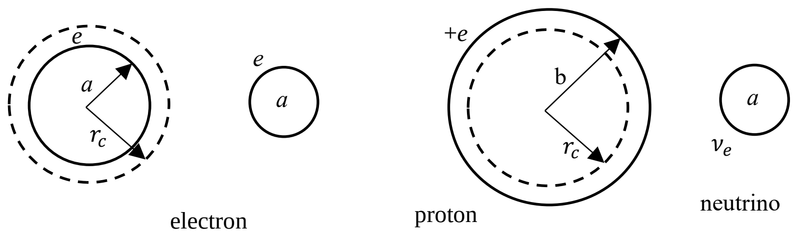

Fig. 1. Electromagnetic structure of electrons, protons, and electron neutrinos

The direction of the inner arrow and the marked radius symbol are used to distinguish between particles and antiparticles. For example, if the arrow inside the electron points to the center of the circle, it represents an antiparticle. If the radius is negative, it also represents the corresponding antiparticle. For μ and τ, the electromagnetic radius is expressed in u and t.

Since there is no structure inside the electron, we can also directly represent the electron with a small circle. Since the electromagnetic radius of an electron is smaller than the boundary between virtual spacetime and real spacetime, it can be put into virtual spacetime. So that we can construct the structure of the neutron. The π mesons and W^- bosons can be composed of two overlapping leptons. This is shown in Fig. 2. It can also be seen that the properties of bosons such as π mesons and W^- are very similar.

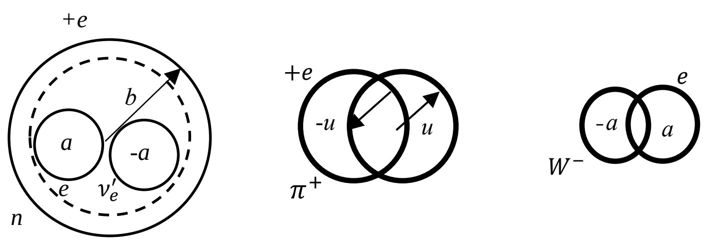

Fig. 2. Electromagnetic structure of neutrons, mesons and bosons

5 Conclusions

From the above analysis, it can be seen that on the one hand, the existence of virtual spacetime has a mathematical and physical basis. The mathematical basis is the existence of imaginary numbers. The physical basis is the two properties of electromagnetic waves: electric field and magnetic field. And the space-time we live in is made up of electric charge interactions. According to symmetry considerations, the way in which magnetic monopoles (that is, magnetic fields) interact should also constitute a complete space-time. This means that it is physically reasonable for two space-time to exist at the same time.

On the other hand, there are three types of virtual spacetime. The first is faster-than-light virtual spacetime; The second is the black hole virtual spacetime; The third is the microscopic virtual spacetime caused by the spin of the electromagnetic field.

All three virtual spacetimes are essentially identical. The first two virtual spacetimes can be unified by general relativity. The third type of virtual spacetime is manifested at the interface between virtual spacetime and real spacetime, and electromagnetic waves are generated by spinning at the speed of light. This results in the spin of electromagnetic waves occurring faster than the speed of light at very small scales. Beyond the speed of light interface, electromagnetic waves will spin at a speed lower than the speed of light. This conclusion can be obtained by solving two sets of supersymmetric Maxwell's equations (1~8) spanning two space-times.

If this microscopic virtual spacetime does exist, we could use it to construct a new particle model. Because the electromagnetic radii of protons and τ are larger than the interface of virtual spacetime, these two particles exhibit an internal structure. Such as quark structure and so on. The τ, on the other hand, can decay into hadrons. Electrons and μ have less electromagnetic radii than the virtual spacetime interface, so they do not exhibit internal structure. On the other hand, from the electromagnetic radius of the boson, we can also estimate the size of its mass.

References

[1] Cheng, Z. (2019). Foundations of Virtual Spacetime Physics. LAP LAMBERT Academic Publishing.