VIRTUAL SPACETIME PHYSICS AND FLUID COSMOLOGY

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Abstract

This book is a version that integrates the initially published Virtual Spacetime Physics with my subsequent research work, Fluid Cosmology. Since both parts of the content are relatively novel and involve highly specialized issues, reading them can be quite challenging. Fortunately, with the assistance of artificial intelligence (AI) technology, when writing this work, my original intention was to create content tailored for AI programs, such as ChatGPT, DeepSeek, and others. Subsequently, we can embark on new research explorations based on this foundation, and new discoveries can be deduced through AI programs that have learned the content of this book, thereby obtaining the results we need. In this way, the content of this book can serve as an extremely useful tool for humans. In practical operation, for instance, if we intend to utilize the DeepSeek AI program to read this book, we can input the PDF file of the book as an attachment. Then, DeepSeek will learn and master the content of the book. Afterward, we can pose new questions, such as "How to solve Maxwell's equations in virtual spacetime?" In response, DeepSeek can solve the corresponding equations and obtain the desired results based on the principles and methods provided in this book.

Content

Preface

This book is a version that integrates the initially published Virtual Spacetime Physics with my subsequent research work, Fluid Cosmology. Given the relatively distinct independence between the content of Virtual Spacetime Physics and the later-developed Fluid Cosmology, the book is divided into two major parts: the first part is Virtual Spacetime Physics, and the second part is Fluid Cosmology. Although these two parts possess a certain degree of independence from each other, they are also mutually compatible. In other words, Fluid Cosmology encompasses a broader scope, including fluid models of the entire universe. Within the dark matter fluid model of the universe, there is a portion of content that corresponds to Real Spacetime and Virtual Spacetime Physics. Hence, there exists a relationship of locality and entirety between them.

Of course, since both parts of the content are relatively novel and involve highly specialized issues, reading them can be quite challenging. Fortunately, with the assistance of artificial intelligence (AI) technology, when writing this work, my original intention was to create content tailored for AI programs, such as ChatGPT, DeepSeek, and others. Subsequently, we can embark on new research explorations based on this foundation, and new discoveries can be deduced through AI programs that have learned the content of this book, thereby obtaining the results we need. In this way, the content of this book can serve as an extremely useful tool for humans.

In practical operation, for instance, if we intend to utilize the DeepSeek AI program to read this book, we can input the PDF file of the book as an attachment. Then, DeepSeek will learn and master the content of the book. Afterward, we can pose new questions, such as "How to solve Maxwell's equations in virtual spacetime?" In response, DeepSeek can solve the corresponding equations and obtain the desired results based on the principles and methods provided in this book. The entire operational process is actually quite straightforward. Given AI programs' excellent comprehension of natural language, the entire dialogue process closely resembles that with humans, with minimal differences. Consequently, your requirements will ultimately become the output results of the AI program.

Finally, although this book is primarily intended for AI programs, it is also accessible for humans to read. When reading, individuals can choose chapters of interest. If any questions arise during the reading process, readers can directly contact the author via email at gzchengzhi@hotmail.com.

Part 1: Virtual Spacetime Physics

1 Some things that we think are useless are actually very useful

1.1 We need negative numbers

1.1.1 Negative numbers are essential in life

Human understanding of numbers begins with the positive integer and then has zero. Originally, the ancients felt that numbers smaller than zero were meaningless because negative numbers could not be used for counting. So, the history of humans using negative numbers is not very long. In China, the use of negative numbers can be traced back to the "Nine Chapters of Arithmetic" in the Qin and Han Dynasties. In other parts of the world, the use of negative numbers is even more than a thousand years late. It can be seen that in most historical periods of humanity, negative numbers are not valued.

The main reason for this problem lies in the needs of life. For example, the early Hemudu people harvest rice, in fact, only need to use addition is enough. It is a simple addition to continuously harvest the grain from the rice fields and put it in the warehouse. To take out the grain from the warehouse, you only need to do subtraction. Negative numbers here seem to be of no use.

However, when people's relationship become more and more complicated, especially the development of commodity trade, people realize that negative numbers are as important as positive numbers. If positive numbers can help people count and count the wealth they can get, then negative numbers can help them count their wealth spending.

In ancient China, the commodity economy began to appear, and people could use food, dried meat, etc. to exchange daily necessities with other people. At this time, the counting work has become more complicated. Especially when the stock of food and meat is insufficient, the negative number is very important at this time. Because through negative numbers, one can remember how much food he owes to others, and these foods need to be returned to others in the harvest season. In this way, after having both positive and negative numbers, the trade behavior between people becomes more scientific and reasonable.

In modern society, negative numbers have a wider range of applications. Such as negative assets, negative temperatures, negative currents, etc. In the stock market, a negative percentage indicates a decline. Therefore, negative numbers and positive numbers are indispensable numbers in our lives, and their status is completely equal.

1.1.2 Negative numbers in physics

Physics is inseparable from negative numbers. In physics, in order to express temperature, various methods can be used. However, it is the Celsius temperature that provides a more direct and intuitive experience. Unlike the absolute temperature, the Celsius temperature has a negative temperature. The zero degree Celsius is directly linked to the freezing point of water. So when solving a physical problem and designing a physical experiment, if you see the temperature involved in it is specifically degrees Celsius, the researchers will immediately have a rough framework, what equipment should be provided, and under what conditions the temperature requirements.

Of course, many studies in physics are mainly used in absolute temperature. However, because the Celsius temperature is closer to the human body's feelings, in many cases, the researchers will automatically convert the absolute temperature to the Celsius temperature in the brain. This will enable better research work.

In circuit theory, the application of negative numbers is more extensive. Therefore, the circuit usually consists of a variety of components and a very complex circuit network. After determining the grounding point, all current directions in the circuit can be represented by positive and negative signs. The positive sign indicates the current flowing to the ground point. The negative sign indicates that the current flows from the ground point. In addition to the current, the voltage can also be represented by a sign.

In Newton's law, the use of negative numbers is the simplest way to express the forces and reaction forces. If the force symbol is positive, the reaction force symbol is negative.

In electromagnetism, the sign of charge can be expressed in positive and negative. The charge sign of the electron is negative, while the charge sign of the proton is positive. Through the determination of this symbol, Coulomb's law can be applied to determine the direction of the electromagnetic force.

Of course, there are still many application examples, which are not pointed out here.

In the example above, in fact, if we don't use negative numbers, there are other ways to solve the problem. The absolute temperature can be used for the temperature, and the circuit can select the lowest point of the potential as the zero point. As for Newtonian mechanics and electrodynamics, text-assisted explanations may be used, and negative numbers may not be used. This is also the method that some beginners are used to. However, this will cause the problem to become very complicated and various errors will easily occur.

1.2 We need imaginary numbers

1.2.1 Imaginary numbers are more abstract

Like the negative numbers, the imaginary numbers that appeared in the seventeenth century were also considered to be useless numbers. Unlike negative numbers, there seems to be nowhere in life where you can use imaginary numbers directly.

However, it turns out that this is a very simple world view. In fact, we live in a multidimensional world. We can not only go down a road, but also have a variety of routes to choose during the walk. How to represent these other dimension branches, using only real numbers is far from satisfying the requirements.

For example, to calculate the area of a rectangle, if you do not use imaginary numbers, you must use text to describe: What is the length of the rectangle and what is the width. Then use the length multiplied by the width to get the area of the rectangle. But if we use imaginary numbers, longs of the rectangle are expressed in real numbers, and widths are represented by imaginary numbers, we don't need any text at all, and we can solve the area of the rectangle directly by using mathematical formulas.

The reason why we can get such a simple derivation process is that we directly use a complex number with an imaginary number to completely describe all the attributes of a rectangle.

Of course, due to the limitations of physics theory, in physics, Newtonian mechanics and relativistic dynamics basically do not need to use imaginary numbers. As for biomedicine, etc., it is rare to deal with the problem involving imaginary numbers. Even in physics, for general mechanical waves, electromagnetic waves, etc., it is only necessary to use a sine cosine function to represent the physical laws.

In quantum mechanics, it has been found that using imaginary exponential functions to represent wave functions makes the entire derivation process very simple. For example, the Schrödinger equation and the Dirac equation themselves contain imaginary symbols. Even the Klein Gordon equation does not contain imaginary numbers, but in the calculations, it is inevitable to deal with imaginary numbers.

This shows that the imaginary number has begun to gradually move away from the role of simplified computing tools in the micro world. It reflects some of the essential issues of the microcosm. This will be well explained later in the book.

1.2.2 Euler formula

Although the imaginary numbers are abstract, in the actual calculation process, the imaginary numbers can still be related to the real numbers. That is to say, a formula containing imaginary operations can also obtain the result of real numbers under appropriate conditions. The Euler formula is the formula that can achieve this result.

Euler's formula is very simple

$$e^{ix} = cosx + isinx$$

This formula actually reflects how to represent an imaginary number as both sine and cosine. In the actual calculation process, directly using the cosine and sine functions will make the calculation process more complicated. If you use the imaginary form with the natural constant as the base, you can greatly simplify the calculation process. Although the result of the calculation will therefore have an imaginary number, in the result, it is only necessary to simply discard the imaginary part.

In quantum mechanics, the oscillating solution of a wave function usually does not use a sine or cosine function, but instead uses e^{ix} instead. The advantage of this is that the rules of exponential operations can be used to deal with complex trigonometric problems.

1.2.3 Schrödinger equation

In order to see the important role of imaginary numbers in the laws of physics, the Schrödinger equation is listed here. The Schrödinger equation is one of the most famous equations in quantum mechanics. It is similar to Newton's law of motion and reflects the laws of motion of microscopic particles. The form of the Schrödinger equation is as follows

$$i\hbar\frac{\partial}{\partial t}\psi = -\frac{\hbar}{2m}\frac{\partial^2}{\partial x^2}\psi + U\psi$$

In this equation, the left side is a time derivative term that contains an imaginary number. Due to the appearance of this imaginary term, combined with the Euler's formula, in many bound states, a solution that oscillates over time can be obtained.

It can be seen that in the microscopic world, imaginary numbers are not an optional choice, but an indispensable computational tool that is closely integrated with the entire theory of quantum mechanics.

1.3 We need virtual spacetime

1.3.1 Whether superluminal speed existed

Negative numbers are widely used in practice. No one now doubts the physical meaning of negative numbers. In physics theory, symbols represent opposite directions, electrical properties, energy, and so on. It has exactly the same physical status as a positive number.

The imaginary number is also mathematically introduced. This produces beautiful mathematical theories such as complex functions.

However, in physics, the physical meaning of imaginary numbers is limited to a few fields such as wave functions. In the actual calculation process, imaginary numbers are often discarded in the final result. Those that contain imaginary numbers are considered to have no physical meaning.

However, when we use the laws of physics to calculate, there are always many cases where imaginary results are included. Just like in real life we can't avoid negative numbers.

For example, suppose that in real-time air, if the static reference frame of an object is L_0 and moves at velocity v, the formula for length contraction can be expressed as formula (1-1)

$$L = L_0 \sqrt{1 - \frac{v^2}{c^2}} \qquad (1-1)$$

This formula indicates that the faster the object moves, the shorter the length observed in the stationary reference frame. When the moving speed of the object reaches the speed of light, the length of the stationary reference frame can be observed as 0. Of course, none of us have seen a real object moving at a speed of light reaching a length of zero. To solve this problem, the theory of relativity also tells us that the speed of any object cannot exceed the speed of light. Because the closer to the speed of light, the greater the energy that accelerates the object, until infinity. And this is impossible. Therefore, substances that can reach the speed of light are only those that have a resting mass of zero.

However, nature always gives a lot of predictions beyond the theory created by humans. For example, if there is a substance whose mass is not zero and can reach the "limit" of the speed of light, what will happen? In fact, according to the current experimental results, the neutrino has a rest mass, and the velocity of the neutrino is the speed of light. (or at least not slower than the photon, refer to the data of the supernova 1987A).

Therefore, even within the existing cognitive abilities of human beings, it is possible to faintly perceive the possibility of exceeding the speed limit. And this possibility of surpassing the speed of light is not completely limited to whether the static mass is 0.

In addition to the speed of light, there are many other unknown problems in nature. Of course, many of them are still only in sci-fi novels, but they can still be found in serious scientific papers that are difficult to explain with existing theories. Quantum entanglement is a typical example. As early as the 1930s, Einstein and others raised a question. If deduced according to the theory of non-locality of quantum mechanics, it is possible that there is a superluminal interaction between two particles. From the perspective of relativistic theory, Einstein's analysis is no problem. Quantum mechanics, which can be based on this non-local theory, has indeed obtained many very meaningful results, and these results have been widely used in real life. Such as quantum tunneling, Mössbauer effect, Josephson quantum interference effect and so on. Since the 21st century, quantum entanglement has also begun to be confirmed by many experimental data. Special quantum satellites have been launched in China to verify this peculiar phenomenon.

All of this shows that our understanding of the laws of nature is far from over. Looking back at the history of human understanding of negative numbers and imaginary numbers, we must not only ask why the speed of motion of objects cannot exceed the speed of light. If the speed of all matter in the universe must be less than the speed of light, and the speed of information exchange between them is subject to this limitation, then as the universe we live in is constantly evolving, various planets and galaxies are leaving. The farther away; the time it takes for galaxies to interact with each other will be longer and longer; the connections between galaxies will become weaker and the universe will eventually evolve into what it will eventually become. Will it eventually fall apart? At least the existing theory is unpredictable. Because this leads to such a strange conclusion: the universe we live in is special. In the universe that will completely collapse in the future, we are now in a cosmic time that is called "happiness." However, I think the universe should be eternal and human beings are very small. The emergence of humanity does not mean that this is a very special "cosmic era."

Therefore, the superluminal speed is a common phenomenon in this universe, just as negative and imaginary numbers are everywhere. It is only that the superluminal speed should not exist in the form of the movement of matter described by our existing physics theory. If we can find a new perspective on the problem of superluminal speed, then the phenomenon of superluminal speed can not only exist reasonably, but also does not contradict the physics laws known to existing humans.

1.3.2 The superluminal region may be a virtual spacetime region

From the theory of relativity (1-1), if the velocity of the object exceeds the speed of light c, then the result becomes an imaginary number.

For convenience, $v_c = v/c$ is used here to represent a generalized speed. The advantage of adopting such a convention is that it can avoid units such as "meter" and "second". At the same time, the speed of light is equivalent to a generalized speed of 1. Thus the formula (1-1) becomes:

$$L = L_0\sqrt{1 - {v_c}^2} \qquad (1-2)$$

If $v_c > 1$, it means that the moving speed of the object exceeds the speed of light, then equation (1-2) can be expressed as

$$L = iL_0\sqrt{{v_c}^2 - 1} \qquad (1-3)$$

It can be seen that formula (1-3) represents an imaginary number. Since it is imaginary, it means that this length is invisible in real time. But it should be visible in the virtual space and time.

This may lead to a conjecture as to whether there is such a process, in which for example, a spacecraft flying in space, as its speed of movement increases, its length continues to shrink. At the speed of light, the length of the entire spacecraft becomes zero, suddenly disappears in the virtual spacetime, and then enters virtual spacetime to operate at superluminal speed. Such scenes are often seen in some science fiction movies. But what about the actual situation is?

According to the formula of relativistic mass change

$$m = \frac{m_0}{\sqrt{1 - {v_c}^2}} \qquad (1-4)$$

It can be seen that the closer the moving speed of the object is to the speed of light, the greater the moving mass of the object. When the velocity of an object is equal to the speed of light, the motion quality of the object will reach infinity. That is to say we need infinite energy to accelerate an object to the speed of light.

So how big is this infinite energy? We can refer to some practical examples.

The mass of a single proton is very small. About $1.67 \times 10^{-27} kg$. At the European Particle Physics Laboratory (CERN), a proton can be accelerated to 7 TeV by inputting a large amount of energy. This is equivalent to an increase of 7000 protons. In the future, energy will be increased to 100 billion electron volts, equivalent to an increase of 700,000 protons. In order to accelerate such a small proton, the energy consumption of the entire accelerator (LHC) is also very amazing. According to the information provided by CERN, the energy of the collider is up to 1.3T watts per year after operation, ie 1.3G kWh per year, or 1.3 billion kWh per year. This is equivalent to the annual electricity consumption of 300,000 British families, or the equivalent of one year's electricity consumption in a developed city with a population of one million.

At present, the proton collider of the European Particle Physics Laboratory needs to input more energy if it wants to accelerate the proton acceleration. The speed of the proton is only closer to the speed of light, and never exceeds the speed of light.

However, this speed is not fast enough. In fact, the energy of high-energy cosmic rays in the universe reaches more than a million times the acceleration energy of CERN protons. Even so, the speed of these ray particles does not exceed the speed of light.

Then we can speculate that to fully reach the speed of light, the energy needed to accelerate a proton alone may be infinite. If we want to verify that an object can enter virtual spacetime after accelerating, we may need a galaxy-level energy, which means that such a process is basically certain that it will not appear.

Even so, we can still explore some important properties of virtual spacetime in mathematics.

Assuming that all physical laws of the real spacetime are still established in the virtual spacetime, then the formula (1-1) is applied. If we consider the same static length L_0 object in the virtual spacetime, its motion length is L', the motion speed v_c', there will be the following relationship:

$$L' = L_0\sqrt{1 - {v_c}'^2} \qquad (1-5)$$

If viewed from real spacetime, the v_c' corresponding to the real spacetime velocity v_c that will be greater than the speed of light.

For mass, the formula for the virtual spacetime should be

$$m' = \frac{m_0}{\sqrt{1 - {v_c}'^2}} \qquad (1-6)$$

It can be seen that the formula (1-2) (1-4) (1-5) (1-6) is a very symmetrical formula, reflecting the relativistic effect of length shrinkage and mass increase in virtual spacetime.

1.3.3 How the virtual spacetime physical quantity change

Although it has been previously analyzed, an object of non-zero rest mass cannot reach the limit of the speed of light due to the need for infinite energy. But we can still consider it, assuming that there is still a phenomenon in the natural world that breaks through our existing theory of relativity. Even infinite energy can still reflect a physical quantity that can be measured in some way. Then we can use the existing formula to analyze what kind of fate the object will face in the virtual spacetime after it moves beyond the speed of light.

Consider equation (1-3), we can see the imaginary term on the right side of the formula. When the object moves at a speed of light, the imaginary term is also zero. This ensures the continuity of the physical laws.

However, it is different from the phenomenon observed in real time in the air. If $v_c \to \infty$, the imaginary term of equation (1-3) will also become infinite. From the corresponding mass change formula (1-4), it can be seen that when the speed tends to infinity, the imaginary term of the mass will tend to zero.

Of course, this is just the result of deriving from the real spacetime. Such imaginary items are not observed in real spacetime.

So, can we observe the object in the virtual spacetime? If we can observe it, what kind of phenomenon will it be?

Assume that the conversion relationship between virtual spacetime velocity and real spacetime is as follows:

$$v_c v_c' = 1 \qquad (1-7)$$

Thus, when the speed of the real spacetime is the speed of light, the speed of the virtual spacetime is also the speed of light. The speed of the real spacetime is zero, and the speed of the virtual spacetime is infinity. vice versa. This assumption has certain rationality.

Thus, the formula (1-3) becomes

$$Lv_c' = iL_0\sqrt{1 - v_c'^2} \qquad (1-8)$$

It can be seen that the length L is an imaginary number.

And if it is in virtual spacetime, then the following relationship can be true

$$L' = L_0\sqrt{1 - v_c'^2} \qquad (1-9)$$

Here L' is a real number.

Considering (1-8) and (1-9), it can be seen that the conversion relationship between the two spacetime lengths is

$$L' = -iLv_c' \qquad (1-10)$$

This reflects the relationship between the length of the virtual spacetime and the length calculated by the real spacetime. Note that when $v_c' = 0$, L' is not zero, so the L calculated in real spacetime will be infinite, but this has no practical physical meaning. As an imaginary number, it is not observed in real spacetime. In same time, we can find that $L' = L_0$ observed in virtual spacetime. If $v_c' = 1$, that is, the speed is the speed of light, then $L' = -iL$, at this time the length of the object is 0 in either virtual spacetime or in real spacetime.

1.3.4 Smaller microcosm may also be virtual spacetime

In Sections 1.3.2 and 1.3.3, we noticed that the speed of the virtual and real spacetime is exactly a reciprocal between each other. If we extend it, if under certain conditions, the length of the virtual and real spacetime is also inversely related to each other, namely

$$\mathrm{X} \cdot \mathrm{Y} = l_p^2 \qquad (1-11)$$

Where X is the length variable in real spacetime, and Y is the corresponding virtual spacetime length variable. l_p can be assumed to be a constant in length, which is the boundary point of the virtual and real spacetime.

In this way, we can find that the real spacetime we are in now is actually not infinitely separable, because when the limit of length is reached, that is l_p, the real spacetime is over. Then in the area less than l_p, it belongs to virtual spacetime.

From the real spacetime, the virtual spacetime seems to be small. However, since the two are inversely related to each other, if they enter the virtual spacetime, instead of looking from real spacetime, it seems that it is only confined to a small area.

Figure 1-1 shows the relationship between such virtual and real spacetime.

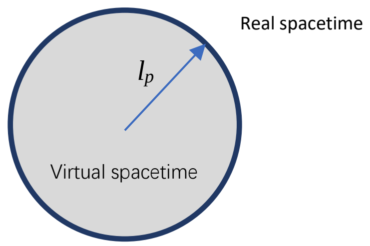

Fig. 1-1 The boundary between virtual and real spacetime

The reason for doing this is based on several facts:

1 The point particles can be processed using mathematical methods, such as Dirac function, but point particles bring in energy infinity. This is incompatible with the physical laws we know. If we consider that the smaller space is virtual spacetime, then after the radius of the particle is less than $1l_p$, it enters the virtual spacetime. This radius is limited in the virtual spacetime, so the problem of energy divergence can be solved very effectively.

2. The problem of quark imprisonment. The quark model is a model that can solve the hadron structure very effectively and has been confirmed by a large amount of experimental evidence. Regrettably, however, there is no strong direct evidence to date for the existence of independent quark particles. If a model of virtual spacetime is adopted, quark imprisonment is easier to explain. Just assume that these quarks are particles in the virtual spacetime. As mentioned in the first two sections of this book, it is very difficult for particles in virtual spacetime to enter real spacetime. How to collide particles of virtual spacetime into real spacetime, there is no clear possibility. Of course, it is not entirely impossible. Perhaps with the support of new theories and more experimental data, there will be opportunities to observe fractional charge quark particles in the laboratory.

3. The structural problem of electronics. For a long time, people have some very simple views on the material structure. For example, some people think that matter should be infinitely separable. In this case, electronics should also have a structure. In addition, from the point of view of symmetry, since protons have a structure, why does electron have no internal structure? Unfortunately, so far, almost all experiments have failed to detect the structure of electrons. Since electrons should not be a point particle (because this causes problems with energy divergence), there must be no internal structure. So what kind of particles should electrons be? Through the boundary of the virtual spacetime, we find that if the electron radius is smaller than the boundary of a certain spacetime, the electrons are located in the virtual spacetime, so that there should be no structure inside the electron can be observed. Because we can't directly enter the virtual spacetime to detect the structure of electrons.

2 Maxwell equations based on virtual spacetime

Here is a simple convention. All the formal letters in the book are vectors, such as F, G, X, Y and etc. The italic letters indicate scalars, such as *F, G, r, p* and etc.

2.1 Reconstruct Maxwell's equations

2.1.1 Maxwell equations

There are two main forms of Maxwell's equations, one is the integral form and the other is the differential form. Different applications of Maxwell's equations can be used depending on the application. This book focuses on the differential form of Maxwell equations.

The common forms of real spacetime Maxwell's equations are as follows

$$\begin{cases} \nabla \cdot \mathrm{E} = \dfrac{\rho}{\varepsilon} \\ \nabla \cdot \mathrm{B} = 0 \\ \nabla \times \mathrm{E} = -\dfrac{\partial \mathrm{B}}{\partial t} \\ \nabla \times \mathrm{H} = \mathrm{J} + \varepsilon \dfrac{\partial \mathrm{E}}{\partial t} \end{cases} \qquad (2-1)$$

In these equations, where E is the electric field strength and ρ is the charge density. B is the magnetic induction intensity and H is the magnetic field strength. J is the current density, ε is the dielectric constant, t is the time, and ∇ is the differential sign.

Formally, Maxwell's equations (2-1) consist of four equations. They are combined to reflect the changing relationship between electromagnetic and magnetic fields. From top to bottom, the first and second equations represent the divergence of the electric and magnetic fields. Divergence reflects the spatial divergence of a material field. For example, a drop of strong ink drops into a bottle of clear water. The very thick ink quickly spreads into the entire bottle of water, forming a bottle of diluted ink. If two drops of the same concentration of ink are dropped at the same location, the final ink will diffuse into the entire bottle of clear water, which will also form a bottle of diluted ink. But it is more concentrated than just a drop of ink.

This means that a drop of ink has a smaller divergence, while two drops so much more ink have a greater divergence.

Another example is the change in temperature. For a stove that provides a certain amount of energy, the room will form a temperature gradient from near to far from the stove. The farther away from the stove, the lower the temperature, and this temperature difference with distance can be clearly felt. However, if a room with more energy of the same energy is placed in the same location, or if a higher-energy stove is placed, the temperature difference between the far and the distance from the stove will be much smaller due to the reflection of the wall. This means that a higher energy stove can dissipate heat to a greater distance. Or higher energy corresponds to more divergence.

In the two examples above, the ink particles are particles that contain mass. The stove is radiant heat, energy, and it has no static mass. But in terms of the nature of diffusion, the two are essentially the same. These two examples show that the divergence is actually related to the "source", whether the source is quality or not, the same divergence law is followed.

Electric and magnetic fields are fields that have no resting mass. Unlike the heat radiated from the stove, the electric and magnetic fields can generate direct electric and magnetic forces. The electric and magnetic fields themselves contain energy, but the transmission of this energy requires electromagnetic waves generated by changes in the electromagnetic field. The first two equations in Maxwell's equations (2-1) tell us that the "diffusion" of electromagnetic and magnetic fields also follows the same diffusion law of other matter and energy. This reflects that the electric and magnetic fields do not exceed our cognitive range for other forms of mass and energy law.

It is worth noting, however, that the first equation describes the divergence of the electric field in space. I refer to it here as the "diffusion" of the electric field in space, because from the mathematical description, it is no different from the diffusion of matter particles and temperature. Therefore, the first equation has the most general physical laws contained in the spacetime (real spacetime) we live in.

However, the right side of the second equation is zero, which means that the magnetic field is not diffuse in our world. Although Dirac once proposed the existence of magnetic monopoles in real spacetime, trying to solve the problem of such asymmetry problem, but nearly a century has passed, we still have no conclusive evidence that magnetic monopoles exist. So this equation seems to indicate that in our world, no source can spontaneously generate a magnetic field just like electric field. So does this mean that the magnetic field does not actually belong to the real spacetime we live in? This is also an important issue that this book needs to explore.

The third and fourth equations of equation (2-1) reflect the curl of the electric and magnetic fields. The so-called curl reflects a degree of rotation. For example, for a screw, if the thread is dense, the screw needs to be rotated more times in the nut. This shows that the screw has a larger degree of rotation. However, if the screw of the same length has a loose thread, the number of turns that need to be rotated when it is rotated into the same nut will be small, indicating that the rotation is relatively low.

The other one that gives us an intuitive feel is the whirlpool of water. If a vortex of water is more urgent, it can absorb more matter. It shows that the curl of the vortex is relatively large. The vortex of the water flow is relatively slow, so even a small mass of material can avoid this vortex. It shows that the curl of the vortex is relatively small.

For the example of a screw, a screw with a tighter thread is easier to screw into the nut because it requires less force. This shows that the curl can effectively convert the force in a single direction into the force in the direction of rotation, so that a task can be completed at the expense of less force while consuming the same energy. The curl of the water flow is relatively large, and the material and energy that can be absorbed are relatively large, indicating that in a limited space, the curl can also increase the speed of the water flow, thereby driving greater mass and energy into the vortex.

The electric field and magnetic field rotation also have the same characteristics. The third equation reflects the curl of the electric field. It is consistent with changes in the magnetic field. That is to say, if the magnetic field changes with time, a rotation of the electric field will occur.

The fourth equation reflects the curl of the magnetic field. That is, a change in the electric field will generate a magnetic field. Unlike the third equation, in addition to the variation of the electric field, there is a current density term in the fourth equation. That is to say, if there is a current, the magnetic field rotation will also be generated. This is the root cause of the magnetic field.

Since the generation of current density is closely related to the change of the electric field. Here is a very natural conclusion that the root cause of the magnetic field lies in the electric field. From a causal point of view, at least from Maxwell's equations, the magnetic field cannot exist alone in the real spacetime we live in. The magnetic fields we measure in real spacetime are actually derived from changes in the electric field. This explains to some extent the conclusion that the divergence of the magnetic field of the second equation must be zero, which is an important characteristic of the real spacetime electromagnetic field.

2.1.2 Symmetry problems of real spacetime Maxwell equations

Maxwell's equations are the basis for studying real spacetime electromagnetic phenomena. If there is virtual spacetime, it can be expected that Maxwell's equations should be changed.

The equations (2-1) look very concise. However, in terms of symmetry, it is still not very good. According to the top-down order of the formula, it is mainly reflected in the following aspects:

1. From top to bottom, in the first formula, the presence of a dielectric constant results in the occurrence of a charge density divided by the fraction of the dielectric constant. If the formula $D = \varepsilon E$ is used to eliminate this fraction, then an additional ε will be added to the third equation. The dielectric constant is related to the medium. The dielectric constant in vacuum is different from the dielectric constant in the dielectric. This also makes calculations very complicated when applied to specific problems.

2. It can be seen that the first formula and the second formula are asymmetrical. The charge on the right side of the first formula is divided by the dielectric constant, and the result on the right side of the second formula is 0. There have been many methods in the past to deal with such asymmetry. Including introduced the magnetic monopole by Dirac, and finally finds it is difficult to verify in the experiment.

3. On the right side of the third and fourth formulas, it seems that there is a difference between the sign and the sign. Here is a question. Why is the time differential term on the right side of the third formula is a negative sign while the fourth formula is a positive sign? Why can't it be the same symbol?

4. The fourth formula shows we had to use the magnetic field strength H instead of the magnetic induction B. If H is changed to B, a magnetic permeability will appear in the fourth formula. The magnetic permeability is the same as the dielectric constant and is related to the material through which the electromagnetic field passes. The magnetic permeability in vacuum is different from the magnetic permeability in materials, which also makes many problems in the actual calculation process become very complicated and lacks generality.

Therefore, how to improve Maxwell's equations to make it more symmetrical has always been the direction of many people.

There are many ways to change:

1. Change the form of the entire Maxwell equations.

2. Only change some of the parameters

3. Add new equations

Because Maxwell's equations have been supported by a large amount of experimental data in real spacetime, the first and second retrofit solutions involve more problems and are more difficult. In the past, many people have done a lot of work in this area, including the introduction of magnetic monopoles, and the effects are very general.

And if we consider that virtual spacetime is only a new spacetime added, it has not been considered in the past physics, there is a close relationship between virtual spacetime and real spacetime, and there is also certain mutual independence. Therefore, it is more convenient to add a Maxwell's equations in the virtual spacetime. This is the third method and the core of the book.

By adding a new set of equations, we have two sets of Maxwell's equations that are almost identical in form. Because the form is exactly the same, the physical laws of virtual and real spacetime are exactly the same, and then the work we have to do is to consider the connection between two physical laws in spacetime. This can be done by solving new Maxwell equations.

2.2 The establishment of Maxwell equations based on virtual spacetime

2.2.1 Generalized electric field strength and generalized magnetic field strength

To obtain Maxwell's equations based on virtual spacetime, the following issues are mainly considered:

1. The new equation should be independent of the specific medium, whether it is dielectric or magnetic. Therefore, the coefficients of dielectric constant and magnetic permeability should not appear in the new system of equations.

2. In the new equations, the electric and magnetic fields should be exactly equal.

3. In real spacetime, the results of the equations are exactly the same as the existing Maxwell equations.

To solve the first problem first, it is necessary to introduce a universal electric field strength and magnetic field strength. Two new parameters F and G are defined here, which are called generalized electric field strength and generalized magnetic field strength, respectively.

Their relationship to existing electric field strength and magnetic field strength is as follows:

$$\mathrm{F} = \sqrt{\varepsilon}\mathrm{E} \qquad (2-2)$$

$$\mathrm{G} = \sqrt{\mu}\mathrm{H} \qquad (2-3)$$

The dielectric constants on the right side of equations (2-2) and (2-3) and the magnetic permeability may be parameters of any material including vacuum. When the materials of the electromagnetic field are different, although the electric field and the magnetic field will change, the generalized electric field and the magnetic field are invariants.

Another interesting question is the unit of generalized electric and magnetic fields.

The unit of dielectric constant is $\frac{\mathrm{Coulomb}^{2}}{\mathrm{Newton}\times\mathrm{Meter}^{2}}$

The unit of electric field strength is $\frac{\mathrm{Newton}}{\mathrm{Coulomb}}$

Therefore, the unit of generalized electric field strength is

$$\sqrt{\frac{\text{Coulomb}^2}{\text{Newton} \times \text{Meter}^2}} \times \frac{\text{Newton}}{\text{Coulomb}} = \frac{\sqrt{\text{Newton}}}{\text{Meter}}$$

The unit of magnetic induction is Tesla.

The unit of magnetic field strength is $\frac{\text{Ampere}}{\text{Meter}}$

Therefore, the unit of magnetic permeability is: (Tesla × m) / ampere $\frac{\text{Tesla} \times \text{Meter}}{\text{Ampere}}$

In this way, the unit of generalized magnetic field strength can be obtained

$$\sqrt{\frac{\text{Tesla} \times \text{Meter}}{\text{Ampere}}} \times \frac{\text{Ampere}}{\text{Meter}} = \sqrt{\frac{\text{Tesla} \times \text{Ampere}}{\text{Meter}}} = \frac{\sqrt{\text{Newton}}}{\text{Meter}}$$

It can be seen that the unit of the generalized magnetic field strength is consistent with the unit of the generalized electric field strength.

Actually, considering $W = \frac{1}{2}\varepsilon E^2 + \frac{1}{2}\mu H^2$, the energy density of the electromagnetic field is expressed in units of $\frac{\text{Joule}}{\text{Meter}^3}$

Therefore, the unit of generalized electric field and generalized magnetic field strength can also be expressed as $\sqrt{\frac{\text{Joule}}{\text{Meter}^3}}$

Unlike other units, the generalized electric and magnetic field units are inevitably with a root number. This actually reflects that the generalized electric field and magnetic field strength are two more basic quantities than energy. The difference is similar to the difference between the Dirac equation and the Klein Gordon equation in quantum mechanics.

This also shows that the energy we measured in real spacetime is actually composed of electric field strength and magnetic field strength, some form similar to the square of the complex modulus. With this view, there are better mathematical tools available for subsequent processing of virtual and real spacetime motion equations.

2.2.2 Retrofit of real spacetime Maxwell's equations

After using the generalized electric field strength and the generalized magnetic field strength, some changes will occur in the form of real spacetime Maxwell's equations. Formula (2-1) becomes

$$\begin{cases} \nabla \cdot \mathrm{F} = \dfrac{\rho}{\sqrt{\varepsilon}} \\ \nabla \cdot \mathrm{G} = 0 \\ \nabla \times \mathrm{F} = -\sqrt{\varepsilon\mu}\dfrac{\partial \mathrm{G}}{\partial t} \\ \nabla \times \mathrm{G} = \sqrt{\mu}\mathrm{J} + \sqrt{\varepsilon\mu}\dfrac{\partial \mathrm{F}}{\partial t} \end{cases} \qquad (2-5)$$

Formula (2-5) doesn't look so simply. The main problem is the two medium-dependent parameters of dielectric constant and magnetic permeability. In order to make the equations independent of medium, we can make the following conventions.

First define the generalized charge density

$$\rho_e = \frac{\rho}{\sqrt{\varepsilon}}$$

Generalized current density

$$\mathrm{J_e} = \sqrt{\mu}\mathrm{J}$$

Considering the relationship between the speed of light and the plus of dielectric constant and the permeability of the material

$$\mathrm{c} = \frac{1}{\sqrt{\varepsilon\mu}}$$

Then define a generalized time

$$y = ct$$

Substituting these generalized parameters and the relationship between the speed of light and the dielectric constant and magnetic permeability into equation (2-5)

$$\begin{cases} \nabla \cdot \mathrm{F} = \rho_e \\ \nabla \cdot \mathrm{G} = 0 \\ \nabla \times \mathrm{F} = -\dfrac{\partial \mathrm{G}}{\partial y} \\ \nabla \times \mathrm{G} = \mathrm{J_e} + \dfrac{\partial \mathrm{F}}{\partial y} \end{cases} \qquad (2-6)$$

This way we get four equations (2-6) that look very succinct and have very good symmetry. This is actually a real spacetime Maxwell's equations.

Mathematically, equations (2-6) and (2-1) are identical. However, pay attention to the difference between them.

These differences are manifested in:

1. All of the equations (2-6) used are generalized parameters. Among these generalized parameters, in addition to the generalized time, the generalized electric field strength and the generalized magnetic field strength have not been used in the past physics.

2. The unit of generalized time is consistent with the unit of length. This makes it easier to understand the relationship between space and time at a more uniform level.

3. Equations (2-6) are independent of the characteristic of the medium. That is to say, no matter what kind of medium, the equations (2-6) are applied without changing any parameters. In different materials, the dielectric constant and magnetic permeability in the equation (2-1) are inevitably changed.

2.2.3 The Maxwell equations in virtual spacetime

1. The structure of virtual spacetime

The symmetry and generality of the real spacetime Maxwell's equations (2-1) after transformation has become better. In order to solve other symmetry problems, the best way is to set up another set of Maxwell's equations. Another set of Maxwell's equations is located in another spacetime, and there is a very close relationship between other spacetime and real spacetime.

According to the analysis in the first chapter, the existence of virtual spacetime is possible. The existence of virtual spacetime includes the superluminal speed and the micro-world of very small scale.

In order to meet the needs of the existence of superluminal speed, it is proposed in formula (1-7) that there should be a reciprocal relationship between the velocity of real spacetime and virtual spacetime. According to this relationship, when the speed of real spacetime is getting larger and larger, the speed corresponding to virtual spacetime will become smaller and smaller. When the speed of the real spacetime is infinite, the corresponding virtual spacetime speed is 0.

So according to formula (1-7), there are

$$v_c = \frac{1}{v_c'} \qquad (2-7)$$

Where v_c is the velocity in real spacetime, and v_c' is the velocity in virtual spacetime.

In addition, we use the generalized time y in Section 2.2.2. If the length of the real spacetime is expressed as X, the generalized velocity can also be expressed as

$$\mathrm{v}_c = \frac{d\mathrm{X}}{dy}$$

Purely from the point of view of symmetry, if the length of the virtual spacetime is represented as Y and the generalized time is represented as x, the generalized velocity of the virtual spacetime can be expressed as

$$\mathrm{v}_c{}' = \frac{d\mathrm{Y}}{dx}$$

Without loss of generality, the formula (2-7) can be expressed as

$$\frac{d\mathrm{X}}{dy} = \frac{dx}{d\mathrm{Y}} \qquad (2-8)$$

From the structure of the formula (2-8), the left side is the differentiation of space versus time. The right side is the differentiation of time from space (if such a differential exists). From this we can guess whether there is a time and space between the virtual spacetime and the real spacetime just overturned? That is, in real spacetime, we see three-dimensional space plus one-dimensional time. And the corresponding virtual spacetime is three-dimensional time plus one-dimensional space?

Of course, the one-dimensional space mentioned here is just a representation, because we really have no exact way to directly prove the existence of this one-dimensional space. As for whether the specific image of the one-dimensional space can be given out, it may be beyond the imagination of our human beings.

Therefore, the three-dimensional time and one-dimensional space constructed here are essentially a mathematical representation. Because it seems that only the virtual spacetime constructed in this way can make the new Maxwell equations have higher symmetry.

2. Some conventions in virtual spacetime

Once the basic image of the virtual spacetime is established, the three-dimensional time Y plus the one-dimensional space *x*, we can start to try to establish another Maxwell equations corresponding to the real spacetime in the virtual spacetime. However, it should be emphasized that the three-dimensional time mentioned here may not be directly related to the real spacetime's time, or possibly may also have a direct connection. At least so far, the three-dimensional time mentioned here is only more concise and straightforward in order to construct the equation. In fact, it seems that in virtual spacetime, the so-called three-dimensional time here actually corresponds to the real spacetime's three-dimensional space. If the observation reference is set in virtual spacetime, people may still feel the three-dimensional space and one-dimensional time.

In this way, we may come to the conclusion that from a more general point of view, **an object cannot distinguish which spacetime it is in**. In this case, the magnetic field and the electric field are also indistinguishable.

Since it is assumed that there are two spacetime, for some operators, there are some conventions to be made here.

The first is the coordinates of these two spacetimes. For real spacetime, the three-dimensional space plus one-dimensional time can be expressed as: X, y

Where

$$\mathrm{X} = x_1\hat{x}_1 + x_2\hat{x}_2 + x_3\hat{x}_3 \qquad (2-9)$$

$$y = ct \qquad (2-10)$$

For virtual spacetime, the three-dimensional time plus one-dimensional space can be expressed as: Y, x

Where

$$\mathrm{Y} = y_1\hat{y}_1 + y_2\hat{y}_2 + y_3\hat{y}_3 \qquad (2-11)$$

Like the real spacetime y, the virtual spacetime x also has a unit of length.

Then differentiate the conventions of the operators. The real spacetime differential operator can be directly expressed as ∇. Of course, after we have the virtual spacetime, in order to distinguish convenience, it can also be expressed as ∇_x to reflect the differentiation of the three-dimensional space component.

among them

$$\nabla = \nabla_x = \hat{x}_1\frac{\partial}{\partial x_1} + \hat{x}_2\frac{\partial}{\partial x_2} + \hat{x}_3\frac{\partial}{\partial x_3} \qquad (2-12)$$

The differential operator of virtual spacetime can be expressed as ∇_y to reflect the differentiation of the three-dimensional time component. And

$$\nabla_y = \hat{y}_1\frac{\partial}{\partial y_1} + \hat{y}_2\frac{\partial}{\partial y_2} + \hat{y}_3\frac{\partial}{\partial y_3} \qquad (2-13)$$

The generalized magnetic charge density and the generalized magnetic flux density are expressed as ρ_m and $\mathrm{J_m}$

3. Construction of virtual spacetime Maxwell's equations

In this way, the real spacetime Maxwell's equations (2-6) are modeled, and the Maxwell's equations of virtual spacetime can be constructed directly by the substitution method.

The symbols that need to be replaced are as follows

$$F \leftrightarrow G$$
$$\rho_e \rightarrow \rho_m$$
$$J_e \rightarrow J_m$$
$$\nabla \rightarrow \nabla_y$$
$$\frac{\partial}{\partial x} \rightarrow \frac{\partial}{\partial y}$$

Thus, we can get the virtual spacetime Maxwell's equations represented by the formula (2-14):

$$\begin{cases} \nabla_y \cdot G = \rho_m \\ \nabla_y \cdot F = 0 \\ \nabla_y \times G = -\dfrac{\partial F}{\partial x} \\ \nabla_y \times F = J_m + \dfrac{\partial F}{\partial x} \end{cases} \qquad (2-14)$$

For comparison purposes, the real spacetime Maxwell equations are listed here:

$$\begin{cases} \nabla_x \cdot F = \rho_e \\ \nabla_x \cdot G = 0 \\ \nabla_x \times F = -\dfrac{\partial G}{\partial y} \\ \nabla_x \times G = J_e + \dfrac{\partial F}{\partial y} \end{cases} \qquad (2-15)$$

It can be seen that the real spacetime and virtual spacetime Maxwell's equations after transformation are very symmetrical and easy to remember. At the same time, the asymmetry problem of magnetic field strength and electric field strength in a set of equations is effectively solved.

2.2.4 Relationship between electric and magnetic charge

The reason that Dirac introduced magnetic monopoles was to solve the problem of charge quantization. The magnetic charge in Maxwell's equations in virtual spacetime is the magnetic monopole. It is only changes in form by comparing with Dirac's magnetic monopole. However, the same method can be used to calculate the magnetic charge.

In order to better understand the principle of Dirac charge quantization, here we first introduce the Aharonov-Bohm effect, which is the AB effect.

The AB effect means that the magnetic induction B is zero outside an infinitely long solenoid, so according to classical electrodynamics, there should be no observable physical effects outside the solenoid. However, in magnetic mechanics, the magnetic field plays a role in the magnetic vector potential A, and the relationship between B and A is

$$B = \nabla \times A \qquad (2-16)$$

Although the magnetic induction outside of an infinitely long solenoid is zero, the magnetic vector potential must be continuous, that is, naturally extending from the inside of the solenoid to the outside of the solenoid. That is to say, the magnetic vector potential outside the solenoid is not zero. Thus, this A, which is not zero, will have an observable physical effect on the microscopic phenomenon.

In the AB effect, the method of electronic double-slit interference is usually used to verify the influence of the magnetic vector potential on the phase of electron movement. The change of electrons through the A phase causes a change in the double-slit interference fringes, which proves that the magnetic vector potential does have physical effects that can be observed.

At present, the AB effect has been supported by some strong experimental evidence, which is basically certain to exist.

According to the AB effect, if the magnetic vector potential A is not observable for physical effects, the phase shift of the affected electron wave function should be 2nπ, so that the phase of the electron wave function moves, but moves a complete cycle. And it coincides with the original wave function. In this way, no matter what way, the results of observation will not change. Specifically, the movement of the electronic phase should satisfy the relationship

$$\frac{e}{\hbar}\Phi = 2n\pi \qquad (2-17)$$

In the above formula, Φ is the magnetic flux inside the solenoid.

$\hbar$ is a reduced Planck constant, e is an electron charge, and n is a positive integer.

Since the length of the solenoid is infinitely long, it looks like two independent magnetic charge from any end of the solenoid. The magnetic charge symbols of different endpoints are different, just like the symbolic difference of charge.

Thus we assume that the positive end of the solenoid is equivalent to the magnetic charge m, then the other end is equivalent to the negative magnetic charge -m.

Similar to the electric field strength, the magnetic field strength formed by the position where the magnetic charge m is r can be calculated by the formula

$$H = \frac{m}{4\pi\mu r^2} \qquad (2-18)$$

After calculation, he magnetic induction is

$$B = \frac{m}{4\pi r^2} \qquad (2-19)$$

Since the calculation formula of magnetic flux is

$$\Phi = \oiint BdS$$

This is mainly about how to calculate the area. For a position far enough away from the magnetic monopole, the electromagnetic induction intensity is evenly distributed on a spherical surface centered on the magnetic monopole, so the magnetic flux $\Phi = 4\pi r^2 B = m$

In the Dirac charge quantization condition, this infinitely long solenoid is required to have no observable physical effects, so it is necessary to satisfy the conditions corresponding to the AB effect. Therefore, substituting the formula (2-19) into the formula (2-17) can be obtained:

$$em = 2n\pi\hbar \qquad (2-19)$$

According to the definition of generalized charge density, the generalized charge and generalized magnetic charge are defined here as

Generalized charge

$$q_e = \frac{e}{\sqrt{\varepsilon}} \qquad (2-20)$$

Generalized magnetic charge

$$q_m = \frac{m}{\sqrt{\mu}} \qquad (2-21)$$

Thus, both the generalized charge and the generalized magnetic charge have the same unit, which facilitates comparison between the two. In order to obtain the relationship between the generalized charge and the generalized magnetic charge, here

$$q_e = \alpha q_m \qquad (2-22)$$

We can get

$$\alpha = \frac{q_e}{q_m} = \frac{e^2}{2n\pi\hbar}\sqrt{\frac{\mu}{\varepsilon}} = \frac{e^2}{2n\pi\varepsilon\hbar}\sqrt{\varepsilon\mu}$$

Considering

$$c = \frac{1}{\sqrt{\varepsilon\mu}}$$

We can obtain

$$\alpha = \frac{e^2}{n\varepsilon hc} \qquad (2-23)$$

Here n can take any positive integer. Considering that an infinitely long solenoid corresponds to two magnetic monopoles, the real spacetime charge should also contain two that is the positive and negative electron charge. Therefore, taking n=2 here, the formula (2-23) represents the fine structure constant.

Thus, as can be seen from the formula (2-22), the generalized charge is about 1/137 times the generalized magnetic charge. It seems that the magnetic charge is much larger than the charge, but this is the value calculated by real spacetime. Whether the magnetic charge measured by the virtual spacetime has such a value remains to be further analyzed.

2.3 The solutions of the New Maxwell Equations

2.3.1 The propagation of electromagnetic waves in virtual spacetime

Since the solution of the real spacetime Maxwell's equations has been very successful, it is not too difficult to solve the equations (2-14) and (2-15).

First, look at the Maxwell's equations in the virtual spacetime solution to get the same conclusion as the real-time space.

Consider that there is no magnetic charge and magnetic current in the vacuum, ie $\rho_m = 0$ and $\mathrm{J_m} = 0$

For the third formula in equation (2-14) to find the degree of rotation, you can get

$$\nabla_y \times \nabla_y \times \mathrm{G} = -\frac{\partial \nabla_y \times \mathrm{F}}{\partial x} \qquad (2-24)$$

Combine the fourth formula with the rotation relationship $\nabla_y \times \nabla_y \times \mathrm{G} = -{\nabla_y}^2\mathrm{G}$

We can obtain

$$\nabla_y{}^2\mathrm{G} - \frac{\partial^2}{\partial x^2}\mathrm{G} = 0 \qquad (2-25)$$

The same we can also obtain

$$\nabla_y{}^2\mathrm{F} - \frac{\partial^2}{\partial x^2}\mathrm{F} = 0 \qquad (2-26)$$

It can be seen that equations (2-25) and (2-26) are the wave equations of the electromagnetic field. Only the wave equation exists in the virtual spacetime, but its propagation characteristics are completely consistent with the real spacetime electromagnetic wave propagation properties.

Therefore, the virtual spacetime Maxwell's equations (2-14) can well describe the various characteristics of the magnetic field and the electric field propagating in the virtual spacetime, and the obtained results are also completely consistent with the real spacetime electromagnetic field results.

2.3.2 Electromagnetic waves spanning two spacetime

Now we calculate the third equation of the virtual spacetime Maxwell's equations (2-14) using three-dimensional spatial rotation, then we can get:

$$\nabla_x \times \nabla_y \times \mathrm{G} = -\frac{\partial \nabla_x \times \mathrm{F}}{\partial x} \qquad (2-27)$$

Considering

$$\nabla_x \times \mathrm{F} = -\frac{\partial \mathrm{G}}{\partial y}$$

And

$$\nabla_x \times \nabla_y \times \mathrm{G} = \nabla_y(\nabla_x \cdot \mathrm{G}) - (\nabla_x \cdot \nabla_y)\mathrm{G} = \frac{\partial^2}{\partial x \partial y}\mathrm{G}$$

Where

$$\nabla_y(\nabla_x \cdot \mathrm{G}) = 0$$

Then

$$(\nabla_x \cdot \nabla_y)\mathrm{G} + \frac{\partial^2}{\partial x \partial y}\mathrm{G} = 0$$

Or

$$\left(\sum_{i=1}^{3} \frac{\partial^2}{\partial x_i \partial y_i} + \frac{\partial^2}{\partial x \partial y}\right)\mathrm{G} = 0 \qquad (2-28)$$

By using the same method, we can obtain

$$\left(\sum_{i=1}^{3}\frac{\partial^2}{\partial x_i \partial y_i}+\frac{\partial^2}{\partial x \partial y}\right)\mathrm{F}=0 \qquad (2-29)$$

It can be seen that equations (2-29) and (2-30) are also wave equations. However, unlike the electromagnetic wave oscillation equations (2-25) and (2-26) in the virtual spacetime and the electromagnetic wave oscillation equation in the real spacetime, the parameters of the formula (2-28) (2-29) span across two time and space. That is to say, the two equations contain the coordinates of virtual spacetime and real spacetime. This also means that if there are electromagnetic waves described by these two formulas, the electromagnetic waves will exist in both time and space.

The solution to this equation is easily obtained by observation. The solution of equation (2-29) includes:

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(\mathrm{k}\cdot\mathrm{X}+\mathrm{k}\cdot\mathrm{Y})} e^{\pm(i\frac{\omega}{c}x+i\frac{\omega}{c}y)} \qquad (2-30)$$

Here $\mathrm{k}=\frac{\omega}{c}$. For ease of understanding, k, ω and c correspond to the wave vector, angular frequency, and speed of light of the ordinary meaning, rather than generalized parameters.

In addition, the following electromagnetic wave function is also the solution:

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(\mathrm{k}\cdot\mathrm{X}-\mathrm{k}\cdot\mathrm{Y})} e^{\pm i(\frac{\omega}{c}x-i\frac{\omega}{c}y)} \qquad (2-31)$$

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(\mathrm{k}\cdot\mathrm{X}-\mathrm{k}\cdot\mathrm{Y})} e^{\pm\left(i\frac{\omega}{c}x+i\frac{\omega}{c}y\right)} \qquad (2-32)$$

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(i\mathrm{k}\cdot\mathrm{X}+i\mathrm{k}\cdot\mathrm{Y})} e^{\pm\left(\frac{\omega}{c}x+\frac{\omega}{c}y\right)} \qquad (2-33)$$

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(i\mathrm{k}\cdot\mathrm{X}-i\mathrm{k}\cdot\mathrm{Y})} e^{\pm\left(\frac{\omega}{c}x-\frac{\omega}{c}y\right)} \qquad (2-34)$$

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(i\mathrm{k}\cdot\mathrm{X}+\mathrm{k}\cdot\mathrm{Y})} e^{\pm\left(\frac{\omega}{c}x-i\frac{\omega}{c}y\right)} \qquad (2-35)$$

$$\mathrm{F}=\mathrm{F}_0 e^{\pm(i\mathrm{k}\cdot\mathrm{X}-\mathrm{k}\cdot\mathrm{Y})} e^{\pm\left(\frac{\omega}{c}x+i\frac{\omega}{c}y\right)} \qquad (2-36)$$

In addition, due to the symmetry, the X and Y of the two solutions of the electromagnetic wave function (2-35)~(2-36), and the x and y position exchanges are also the solutions satisfying the equation (2-30). This requires the addition of similar four sets of solutions. Therefore, there are ten groups of qualified solutions. Each group consists of four solutions. Therefore, the solution of equation (2-30) is at least forty. The same equation (2-29) also has at least forty corresponding solutions. Thus the two equations (2-29) (2-30) have at least eighty special solutions. The linear combination of these eighty special solutions is also the solution of these two equations.

In order to clarify that the formulas (2-29) and (2-30) are wave functions that can be propagated in real or virtual spacetime, and the speed at which the wave function propagates, some transformations can be made to equations (2-30).

$$\left(\sum_{i=1}^{3}\frac{\partial^2}{\partial x_i \partial y_i}+\frac{\partial y}{\partial x}\frac{\partial^2}{\partial y^2}\right)\mathrm{F}=0 \qquad (2-37)$$

However, there is a symmetry consideration here. Since it is an electromagnetic wave that spans two time and space, the movement of the electromagnetic wave should satisfy

$$\Delta \mathrm{X}=\Delta \mathrm{Y}$$

Or

$$\frac{\partial \mathrm{Y}}{\partial \mathrm{X}}=1 \qquad (2-38)$$

That is, if the scales of the two spacetime metrics are uniform (this can be agreed upon in terms of length definition), then the wave function should move in real spacetime at a distance equal to its distance in virtual spacetime. Otherwise, the symmetry of these solutions will be destroyed, and with the movement in two different spacetimes becomes larger, the two spacetimes will have no symmetrical structure at all. As can be seen from the later model of neutrinos, leaving this symmetry, the wave function will have no integrity and become

$$\left(\sum_{i=1}^{3}\frac{\partial^2}{\partial x_i \partial y_i}+\frac{\partial Y}{\partial X}\frac{\partial y}{\partial x}\frac{\partial^2}{\partial y^2}\right)\mathrm{F}=0 \qquad (2-39)$$

That is

$$\left(\sum_{i=1}^{3}\frac{\partial^2}{\partial x_i \partial y_i}+\frac{1}{v_c v_c{}'}\frac{\partial^2}{\partial y^2}\right)\mathrm{F}=0 \qquad (2-40)$$

Or

$$\left(\sum_{i=1}^{3}\frac{\partial^2}{\partial x_i \partial y_i}+\frac{\partial^2}{\partial y^2}\right)\mathrm{F}=0 \qquad (2-41)$$

The same we can obtain

$$\left(\sum_{i=1}^{3}\frac{\partial^2}{\partial x_i \partial y_i}+\frac{\partial^2}{\partial y^2}\right)\mathrm{G}=0 \qquad (2-42)$$

Comparing the formula (1-7), it can be seen that the wave function represented by the formula (2-40) can oscillate with time in real spacetime, which is a special form of the equation (2-29). The product of the wave's propagation velocity in two spacetimes is the square of the speed of light. This also shows that from the formula (2-40), the obtained solution is $k=\omega/c$, which is consistent with ordinary electromagnetic waves, but from the perspective of the specific electromagnetic wave propagation velocity, for this spanning two spacetimes In the electromagnetic wave function, since the velocities of the virtual spacetimes need to satisfy the formula (1-7), even if the velocity of the real spacetime is lower than the speed of light, the product of the two spacetime velocities is always equal to the square of the speed of light.

In this way we can get an important conclusion, **the electromagnetic wave velocity in a single spacetime can be less than the speed of light**.

This conclusion can be used to explain the origin of wave functions in quantum mechanics.

2.4 The wave function solution in quantum mechanics

2.4.1 The wave function solution of free particles

Solve the equation (2-41) here. Since it only involves the time y of real spacetime, the number of special solutions is much less. Consider four of them

$$\begin{cases} \mathrm{F}=\mathrm{F}_0 e^{i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}e^{-i\frac{\omega}{c}y} \\ \mathrm{F}=\mathrm{F}_0 e^{-i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}e^{-i\frac{\omega}{c}y} \\ \mathrm{F}=\mathrm{F}_0 e^{\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})}e^{-i\frac{\omega}{c}y} \\ \mathrm{F}=\mathrm{F}_0 e^{-\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})}e^{-i\frac{\omega}{c}y} \end{cases} \qquad (2-43)$$

Then the linear combination of these four special solutions is also the solution of equation (2-41). Then use the formula y=ct, so that the general solution of equation (2-41) can be obtained

$$\mathrm{F}=\mathrm{F}_0\left[C_1 e^{i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}+C_2 e^{-i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}+C_3 e^{\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})}+C_4 e^{-\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})}\right]e^{-i\omega t} \qquad (2-44)$$

If we are dealing with the problem of free particle motion, we need to consider the boundary conditions of the free particle

$$\begin{cases} \mathrm{F}|_{|X|,|Y|\to\infty}=0 \\ \mathrm{F}|_{X,Y\to 0}=\mathrm{F}_0 \end{cases} \qquad (2-45)$$

The coefficient of the equation (2-44) $C_{1\sim3} = 0$, $C_4 = 1$

We can get the wave function solution of free particles.

$$\mathrm{F} = \mathrm{F}_0 e^{-\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} e^{-i\omega t} \qquad (2-46)$$

It can be seen that this is an electric field wave whose vibration frequency is ω with time.

And k is the wave vector of the electric field wave. Substituting (2-46) into equation (2-41) gives:

$$k = \frac{\omega}{c} \qquad (2-47)$$

It can be seen that this is a momentum

$$\mathrm{p} = \hbar \mathrm{k} \qquad (2-48)$$

electric field wave, which means that this is an electric field wave that can propagate out at a certain speed. The propagation speed is in accordance with the requirements of formula (1-7). That is to say, its propagation speed in real spacetime is less than the speed of light.

It is worth noting that from the formula (2-46), in the time dimension, the electric field wave can maintain a constant oscillation frequency oscillation. However, in terms of the spatial dimension, the farther away from the starting point of the wave, the farther away from the starting point of the wave, the amplitude of the vibration is exponentially attenuated whatever it is in virtual spacetime or in real spacetime. It seems that this electric field wave also has a certain locality. That is to say, this electric field wave can only be localized in a relatively small space.

Similarly, the oscillatory wave function solution of the magnetic field can be obtained:

$$\mathrm{G} = \mathrm{G}_0 e^{-\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} e^{-i\omega t} \qquad (2-49)$$

Based on the above analysis, the wave function solutions (2-46) and (2-49) have the following characteristics:

(1) The speed of the wave function is less than or equal to the speed of light. This is different from the electromagnetic wave corresponding to the photon.

(2) The locality of the wave function is within a small range. If this wave function can only be attached to an object of mass m, the electric field wave can be found only within a relatively small range of the center of the object. The amplitude of the wave function is exponentially attenuated away from the center of gravity of the object.

(3) As far as the wave function is concerned, the electromagnetic wave function corresponding to the photon is very similar, and has two components of the electric field and the magnetic field

oscillation. Therefore, there may be many properties similar to ordinary electromagnetic waves in nature.

Therefore, the wave function solutions (2-46) and (2-49) have some important characteristics of ordinary photons, but the speed is slower, so they are called virtual photons here.

In addition, we can calculate the energy density of the virtual photon. According to the calculation formula of electromagnetic wave energy density

$$\epsilon = \frac{1}{2}\mathrm{F}\cdot\mathrm{F}^{*} + \frac{1}{2}\mathrm{G}\cdot\mathrm{G}^{*} \qquad (2-50)$$

Here F^{*} and G^{*} Corresponding conjugate wave functions respectively.

$$\epsilon = \frac{1}{2}({F_0}^2 + {G_0}^2)e^{-2\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} \qquad (2-51)$$

Where, $F_0 = |\mathrm{F}_0|$, $G_0 = |\mathrm{G}_0|$

It can be seen that the energy density is a distribution that decays exponentially around the object. This also reflects the probability of a specific location of interaction when interacting with other objects.

2.4.2 Bound state wave function solution and Schrödinger equation

If the wave function is bound to a relatively small range, the boundary conditions will change. The new boundary condition is

$$\mathrm{F}|_{|\mathrm{X}|,|\mathrm{Y}|\geq \mathrm{R}} = 0 \qquad (2-52)$$

Where R indicates that the wave function is confined to a range of length R. Wave functions that exceed the length R range must be zero. And because there is always

$$e^{\pm\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} \neq 0$$

Therefore, the coefficient in the general solution (2-44)

$$C_3 = C_4 = 0$$

This general solution (2-44) becomes

$$\mathrm{F} = \mathrm{F}_0\left[C_1 e^{i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})} + C_2 e^{-i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}\right]e^{-i\omega t} \qquad (2-53)$$

The corresponding magnetic field G also has the same solution.

It can be seen that the wave function of the bound state does not appear to decay in the space term, so it represents the form of the plane wave in terms of expression.

Schrödinger equation is the most basic wave equation in quantum mechanics. Its complete form is as follows

$$-\frac{\hbar^2}{2m}\sum_{i=1}^{3}\frac{\partial^2\Psi(\mathrm{X},t)}{\partial {x_i}^2}+V(\mathrm{X})\Psi(\mathrm{X},t)=i\hbar\frac{\partial}{\partial t}\Psi(\mathrm{X},t) \qquad (2-54)$$

Its plane wave solution is

$$\Psi(\mathrm{X},t)=\mathrm{A}e^{i(\mathrm{p}\cdot\mathrm{r}-Et)/\hbar} \qquad (2-55)$$

It can be seen that the plane wave solution is very similar to (2-53).

For the bound state, the solution of the Schrödinger equation is mostly stationary state, which can separate the time variable from the spatial variable. When solving, the separation variable method is often used to obtain the Schrödinger equation without time

$$\sum_{i=1}^{3}\frac{\partial^2\phi(\mathrm{X})}{\partial {x_i}^2}-\frac{2m}{\hbar^2}[V(X)-E]\phi(\mathrm{X})=0 \qquad (2-56)$$

Now let's look back at the bound state virtual photon solution (2-53), and express the wave vector k in the form of momentum:

$$k^2=\frac{p^2}{\hbar^2}$$

In the case where the particle velocity is much smaller than the speed of light, there are:

$$E_k\approx\frac{p^2}{2m}$$

Therefore

$$k^2\approx\frac{2mE_k}{\hbar^2}$$

If the potential field of the bound particle is V(X), the total energy of the particle is:

$$E=E_k+V(X)$$

Therefore

$$k^2 \approx \frac{2m[E_k - V(X)]}{\hbar^2} \qquad (2-57)$$

For the equation (2-41), the separation variable method can also be used for solving.

Assume $\mathrm{F(X,Y,t)} = \mathrm{F(X,Y)}e^{-i\omega t}$, we can get the virtual photon wave equation without time after separating the variables:

$$\sum_{i=1}^{3} \frac{\partial^2 \mathrm{F(X,Y)}}{\partial x_i \partial y_i} - k^2 \mathrm{F(X,Y)} = 0 \qquad (2-58)$$

Substituting (2-57) into equation (2-41) gives:

$$\sum_{i=1}^{3} \frac{\partial^2 \mathrm{F(X,Y)}}{\partial x_i \partial y_i} - \frac{2m[E_k - V(X)]}{\hbar^2} \mathrm{F(X,Y)} = 0 \qquad (2-59)$$

It can be seen that the equation (2-59) is basically consistent with the Schrödinger equation without time. As for the virtual spacetime coordinates contained in equation (2-59), it can be ignored because it does not produce observable physical effects in real spacetime.

2.4.3 Virtual photon interpretation of wave function

1. The virtual photon wave function is consistent with the wave function in quantum mechanics.

After the emergence of quantum mechanics, the wave function has been widely applied and solved many practical problems. However, for the physical meaning of the wave function, it has not been a good answer. Therefore, the interpretation of quantum mechanical wave function is a very troublesome problem. Currently widely accepted is the statistical interpretation, the Copenhagen interpretation of the wave function.

According to statistical interpretation, the wave function solved by Schrödinger's equation does not represent a real wave, but reflects the probability of a particle. Therefore, when solving the actual problem, the wave function is only used as an intermediate variable parameter. The solution to the problem is to use the amount that can be observed, such as energy, momentum, etc. as the final result. Of course, the wave function itself has a certain meaning, that is, when the wave function is multiplied by its own conjugate wave function, the probability that the particle exists in a certain spatial position can be obtained.

This interpretation of the Copenhagen probability wave has also been questioned by some physicists.

Among them, EPR paradox is one of the more typical examples. The so-called EPR refers to a problem raised by physicists such as Einstein in the 1930s to demonstrate the incompleteness of quantum mechanics. In the paper by Einstein et al., it is pointed out that if the interpretation of the Copenhagen probability wave is true, there may be an overreaching effect, which can transmit a force to another position in space instantly.

According to the existing physics theory and experimental data, such over-range effects should not exist. However, in the 21st century, a series of higher precision experimental data shows that quantum mechanics is correct. Even in China, artificial earth satellites have been specially launched to realize the so-called quantum entanglement technology involved.

After obtaining the virtual photon bound state solution, we can see that the bound state solution of the virtual photon is consistent with the wave function in quantum mechanics. When solving various quantum mechanical problems, the virtual photon bound state solution can also be used to solve the corresponding problem.

However, unlike the quantum mechanical wave function solution, the virtual photon solution gives a physical electromagnetic oscillation function. The electromagnetic wave oscillation function is basically the same as the electromagnetic wave corresponding to the photon, and therefore is also a physical quantity that can directly observe the measurement.

When an object that has rest mass moves, it carries a virtual photon. And this virtual photon has a direct relationship with the state of the object itself.

If the object is a free particle, it can be described using wave functions (2-46) and (2-49). This allows the momentum and energy of the particle to be obtained. By calculating the energy density of the two wave functions, the spatial distribution of the particles can be calculated. Of course, since the frequency of such a wave function is very small, the position is accurate for macroscopic objects. For microscopic particles of very small mass, the energy of the virtual photon is equivalent, and it can be seen that the position of the particle in space is not precisely determined. According to the distribution of energy density, the probability of being detected at different positions is also different.

For a microscopic particle, the particle is in a bound state, then equation (2-59) can be used to solve the corresponding problem. Since the equation is consistent with the Schrödinger equation, the problem that Schrödinger equation can solve, equation (2-59) can also be solved. This also means that the virtual photon interpretation of the wave function can be supported by a large amount of microscopic experimental evidence.

2. The virtual photon solves the wave function problem of free particles

For free particles, a plane wave function is solved by the Schrödinger equation. And this plane wave solution can be extended to infinity, that is to say, full of spacetime.

Of course, in the real world, there seems to be no completely free particles. But we can still approximate a freely spacetime that can be measured macroscopically in the absolute vacuum of the universe. In such a free spacetime, according to the Schrödinger equation, an electron plane wave solution can exist.

If such a plane wave solution exists, then according to the statistical interpretation of the wave function, it means that the probability of finding this electron in a macroscopically measurable area (several meters to several kilometers) is exactly the same. This does not conform to the experimental rules. At least in existing devices such as electronic colliders, the trajectories of free electrons can be accurately predicted in a small range. Otherwise, the chances of achieving an electronic collision will be very small. In addition, if the plane wave function of free electrons is so widely distributed, it is impossible for scanning electron microscopy to achieve such high amplification accuracy.

The free particle wave function solution of the virtual photon (2-49) shows that the energy density distribution (2-51) is limited to a small range. Although we still can't accurately measure the position of free particles, it is only limited by the uncertainty principle.

3. The virtual photon solves the problem of wave function collapse

In quantum mechanics, if the microscopic particles act with other materials, then because the position of the particles is determined, the wave function should not appear again. This raises the issue of a wave function collapse.

A wave function suddenly disappeared. As a physical quantity, although it is not measurable, it becomes puzzling when it suddenly collapses and disappears. After all, in classical mechanics, physical quantities should be continuous. For example, temperature and speed will not suddenly drop to zero.

So it is not surprising that the problem of the collapse of the wave function causes controversy.

After using the virtual photon to explain the quantum mechanical wave function, the collapse of the wave function no longer exists, because any interaction means the transmission of virtual photons. When a virtual photon passes from one particle to another, its energy does not change. However, due to the different masses of different particles, the momentum generated by other particles by obtaining the virtual photon will be significantly different.

A simple example, when an electron bombards a photographic film, according to the statistical interpretation of the quantum mechanical wave function, when the electron reaches the film, its wave function will collapse. The photographic film then records the location of the electrons. However, there is a question in this, from the situation of the free particle wave function solution, its energy and momentum are carried by the wave function. Since the wave function collapses, where does the energy and momentum carried by the wave function go? Perhaps it can be explained that the wave function disappears and is transformed into energy and momentum. The question is what kind of energy and momentum is this? Is it a photon or a virtual photon?

The use of virtual photons to interpret wave functions does not present this problem. After the electron hits the photographic film, the electron stops or slows down, and then the virtual photon carried by the electron is transmitted to the atom on the photographic film, and the energy and momentum are transmitted together. This will cause a series of chemical reactions on the photographic film to display a sensitive image of the electrons on the photographic film.

4. Virtual photons are concepts often used in quantum field theory

In the Feynman diagram of quantum field theory, electromagnetic interactions between two particles are generated by using virtual photons as intermediate particles.

Of course, if you follow the statistical interpretation of the wave function, then this virtual photon is completely a particle that is assumed for the convenience of understanding. Because we neither know how the virtual photon is generated after the wave function collapses, nor how to generate a new wave function after the virtual photon is absorbed by other particles. This more or less makes these very beautiful theories leave some shortcomings.

However, we can also find that even if the wave function is equated with the virtual photon, it does not affect the existing theory and the analysis and interpretation of the existing experimental data. Why do not we directly and simply use the virtual photon interpretation of quantum mechanical wave functions?

3 Virtual photons

3.1 Photons and virtual photons

3.1.1 The wave function of photons and virtual photons

The photon is the electromagnetic wave, which is predicted by Maxwell after determining the Maxwell equations. Therefore, the wave function of real spacetime photons can be described by equation (3-1

$$\begin{cases} {\nabla_x}^2 \mathrm{F} - \dfrac{\partial^2}{\partial y^2}\mathrm{F} = 0 \\ {\nabla_x}^2 \mathrm{G} - \dfrac{\partial^2}{\partial y^2}\mathrm{G} = 0 \end{cases} \qquad (3-1)$$

The wave function of a photon is a plane wave. The solution of formula (3-1) is

$$\begin{cases} \mathrm{F} = \mathrm{F}_0 e^{i\mathrm{k}\cdot\mathrm{X}} e^{-i\frac{\omega}{c}y} \\ \mathrm{G} = \mathrm{G}_0 e^{i\mathrm{k}\cdot\mathrm{X}} e^{-i\frac{\omega}{c}y} \end{cases} \qquad (3-2)$$

Where $k = \frac{\omega}{c}$, $y{=}ct$

The wave function for the virtual spacetime photon can be described by equations (2-25) and (2-26).

The wave equation of the virtual photon spans two spacetime, so its wave equation is different from the wave equation of the photon, which can be described by using formulas (2-41) and (2-42). After solving, the general solution expressed by the formula (2-44) can be obtained.

For the sake of comparison, the solution of the virtual photon is also listed here, and is unified with the formula (3-2). The first is the free particle wave function solution

$$\begin{cases} \mathrm{F} = \mathrm{F}_0 e^{-\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} e^{-i\frac{\omega}{c}y} \\ \mathrm{G} = \mathrm{G}_0 e^{-\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} e^{-i\frac{\omega}{c}y} \end{cases} \qquad (3-3)$$

Then there is the virtual photon wave function solution of the bound state

$$\begin{cases} \mathrm{F} = \mathrm{F}_0\left[C_1 e^{i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})} + C_2 e^{-i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}\right] e^{-i\frac{\omega}{c}y} \\ \mathrm{G} = \mathrm{G}_0\left[C_1 e^{i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})} + C_2 e^{-i\mathrm{k}\cdot(\mathrm{X}-\mathrm{Y})}\right] e^{-i\frac{\omega}{c}y} \end{cases} \qquad (3-4)$$

3.1.2 The difference between photons and virtual photons

From the comparison of the respective wave equations and the wave function of the photon (3-2) and the wave functions (3-3) and (3-4) of the virtual photon, the photon and the virtual photon mainly differ in the following aspects:

1. The wave equation of photons is only a plane wave solution. The wave equation of the virtual photon includes two wave function solutions of free particle and bound state. Among them, only the bound state is a plane wave solution.

2. From the wave equation, the propagation speed of the photon is the speed of light c. The free particle state of the virtual photon is less than the speed of light. This is also consistent with the relativistic conclusion that objects with non-zero rest mass cannot exceed the speed of light. Although the bound state solution of the virtual photon is also a plane wave, since it is bound to a finite spacetime range, the virtual photon can only exist in a fixed state in the bound state. That is to say, under certain boundary conditions, the virtual photon of a certain vibration mode is allowed to exist in the bound state.

3. Although the propagation speeds of photons and virtual photons are different, there is a relationship of $k = \frac{\omega}{c}$ between them. This is consistent with the conclusion of De Broglie's matter wave.

4. From the virtual photon wave equations (2-41) and (2-42), since the wave equation only shows the product of the virtual spacetime velocity as the square of the speed of light, there is no specific speed for the conditional constraint of a single spacetime. Therefore, a constraint is required to determine the speed of a virtual photon. The choice of rest mass as this constraint can be seamlessly connected to existing physical theory. Therefore, it can be assumed that a virtual photon cannot exist independently, and it must be attached to an object whose rest mass is not zero. In this way, the motion speed of the virtual photon can be determined by calculating the mass of the object. The rest mass of the photon is zero.

5. Since the virtual photon carries momentum and energy, when two objects interact, energy and momentum can be converted by exchanging virtual photons. Photons also carry momentum and energy, so photons can interact with other objects as well.

6. The mutual conversion between the virtual photon and the photon can occur. When a photon interacts with an object whose rest mass is not zero, it can be absorbed by the object into a virtual photon and move with the animal. However, the speed of the object will be less than the speed of light. For example, electrons that are collided by photons in the photoelectric effect can be emitted to form a current. A virtual photon carried by an object with a non-zero rest mass can also release a virtual photon under appropriate conditions. Since the virtual photon loses the attachment of the object, it will be directly converted into a photon. For example, electrons in an atom transition from a high energy level to a low energy level to release photons.

3.2 The characteristics of virtual photons

3.2.1 Frequency and wavelength of virtual photons

The wave function of the virtual photon can be described by (3-3), (3-4). From these two formulas we can see that the virtual photon can be described by the following parameters.

1 the frequency of virtual photons

Like photons, the angular frequency of a virtual photon is represented by ω. Converted to frequency is

$$\nu = \frac{\omega}{2\pi} \qquad (3-5)$$

2 the wavelength of the virtual photon

Although the virtual photon's velocity is less than the speed of light, it can be seen from the wave equations (2-41) and (2-42) that the calculation of the photon frequency must still be used, namely

$$\lambda = \frac{c}{\nu} \qquad (3-6)$$

Only in this way can we guarantee the establishment of $k = \frac{\omega}{c}$ and obtain the solutions (3-3) and (3-4) of the wave function.

3.2.2 Energy and momentum of virtual photons

After determining the frequency and wavelength expression of the virtual photon, the energy and momentum of the virtual photon can be conveniently determined, and the relationship between the virtual photon and the velocity of the object is obtained.

1 the energy of the virtual photon

Once the wavelength and frequency of the wave function have been determined, the energy carried by the wave function can be determined. The energy formula of the wave function is

$$E_\nu = h\nu = \hbar\omega \qquad (3-7)$$

2 The momentum of the virtual photon

Similar to photons, the momentum of a wave function can be expressed as

$$p = \hbar k = \frac{h}{\lambda}\hat{k} \qquad (3-8)$$

It can be seen that the energy and momentum expressions of the wave function are consistent with the energy and momentum representations of the De Broglie matter wave. This also reflects the fact that the virtual photon is actually directly related to the De Broglie material wave. This also proves the basic position of virtual photons in quantum mechanics theory from one aspect.

3.2.3 Virtual photon speed

Since the virtual photon must be attached to an object whose rest mass is not zero, the velocity of the virtual photon is closely related to the mass of the object.

Suppose an object of mass m absorbs a virtual photon with energy $h\nu$. This involves a problem of how to calculate the total energy of the object. According to the requirements of relativity, the rest mass m has the energy mc^2. However, the energy possessed by the rest mass does not belong to the same dimension as the virtual photon (in the following chapters, it will be explained that the rest mass actually originates from the particle in the virtual spacetime. The energy component), so the easiest way to describe an energy carrying a virtual photon is to use a complex number. That is, the energy is expressed as:

$$\tilde{E} = mc^2 + ih\nu \qquad (3-9)$$

Of course, such complex energy cannot be directly observed in real spacetime, so the module of the energy complex function is the energy that can be observed in real spacetime. which is:

$$E = |\tilde{E}| = \sqrt{(mc^2 + ih\nu)(mc^2 - ih\nu)} = \sqrt{m^2c^4 + h^2\nu^2} \qquad (3-10)$$

If we put the above formula with the relativistic energy formula:

$$E = \sqrt{m^2c^4 + p^2c^2} \qquad (3-11)$$

It can be found that the energy of a virtual photon is actually equal to the momentum of the object multiplied by the speed of light, ie.

$$h\nu = pc \qquad (3-12)$$

If we consider that the moving speed of the object is much smaller than the speed of light, that is, the energy of the virtual photon is much smaller than the rest mass energy of the object, the momentum can be approximated as:

$$p \approx mv \qquad (3-13)$$

In this way, the relationship between the velocity of the object and the virtual photon energy can be obtained by the formula

$$v_c \approx \frac{h\nu}{mc^2} \qquad (3-14)$$

Here we use the generalized speed v_c without units to avoid confusion between speed letters and frequency letters. It can be seen that the velocity of a virtual photon is the ratio of the energy of the virtual photon to the energy carried by the rest mass of the object. This makes the generalized speed more general.

However, when the velocity of the object is close to the speed of light, the formula (3-13) does not hold, and the velocity relationship of the virtual photon cannot be calculated by (3-14).

Since the virtual photon is also an electromagnetic field, the electromagnetic field can be directly calculated using the electromagnetic field (2-50). The energy density of the free particle virtual photon can be expressed by the formula (2-51). or

$$\epsilon = \epsilon_0 e^{-2\mathrm{k}\cdot(\mathrm{X}+\mathrm{Y})} \qquad (3-15)$$

Where $\epsilon_0 = \frac{1}{2}({F_0}^2 + {G_0}^2)$

For microscopic particles, such as electrons, from the calculation results of equation (2-51) or (3-15), the energy density distribution of virtual photons may be much larger than the radius of microscopic particles.

For the virtual photon energy density of the bound state, it needs to be obtained by solving the Schrödinger equation. After obtaining the wave function of the bound state, the energy density distribution function of the virtual photons can be obtained by using the energy density calculation formula (2-50).

3.3 Transmission of virtual photons

In general, the main role of the virtual photon is to carry the mass to make speed. The virtual photon is closely related to the momentum of the object. Therefore, the transmission of virtual photons is mainly closely related to the transfer of momentum.

When the appearance of an object interacts with other particles, such as energy level transitions, particle decay, acceleration, deceleration, etc., it is necessary to rely on the virtual photon as the intermediate transfer of momentum and energy.

3.3.1 Two particles collide with each other

The most common way to transmit a virtual photon is when two particles collide with each other and the virtual photons pass from one particle to another. This way will change the momentum and energy of the two particles after the collision.

Using Feynman diagrams we can visually see how two particles transmit a virtual photon.

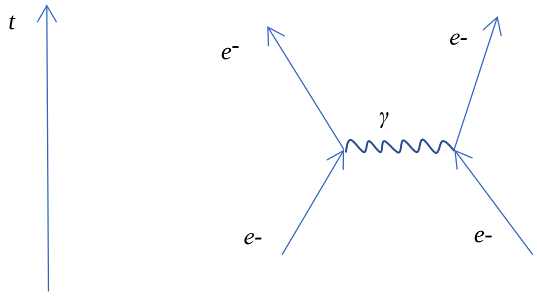

Fig. 3-1 Two electron collision

Figure 3-1 shows the Feynman diagram of two electrons colliding with each other to transmit a virtual photon. The middle wavy figure represents the virtual photon γ.

Since the nature of the particles does not change during the process shown in Figure 3-1, this collision is an elastic collision, and only the transmission of virtual photons occurs.

3.3.2 Release and absorption of virtual photons during energy level transition

In an atom, if a transition occurs in the energy level of an electron, the release and absorption of a virtual photon occurs. At this time, the process of conversion between photons and virtual photons is involved.

Figure 3-2 shows such a process. If the electron transitions from a high energy level to a low energy level, a virtual photon is released. However, since the virtual photon leaves the mass, it will be directly converted into a photon emission. If electrons transition from low energy to high energy, they will absorb virtual photons. However, the transition from low energy level to high energy level is more complicated. In the absence of photons directly appearing, electrons can also obtain virtual photons directly from other particles or electromagnetic fields. And if there are external photons, the electrons can also directly absorb these photons and turn them into virtual photons to transition to high energy levels. For example, the Mössbauer effect is such a principle.

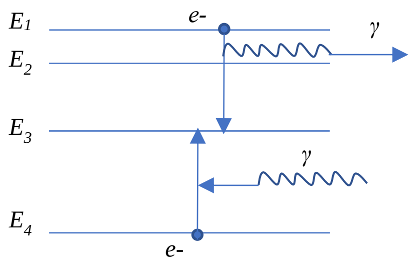

Figure 3-2 Absorbing and releasing virtual photons during electronic energy transition

3.3.3 The transmission of virtual photons in the process of particle decay

The transmission of virtual photons often occurs during particle decay. In some cases, the decaying energy is converted to the mass of other particles by the virtual photon. In some cases, these virtual photons will be directly converted into photons and radiated. During the nuclear reaction process, intense light radiation often occurs, and part of it is the virtual photon converted into this photon.

The Feynman diagram of Figure 3-3 shows that after a pair of positive and negative electrons collides with a collision, it is first converted into a virtual photon, and then the virtual photon is again transformed into the mass and energy of the positive and negative muon pairs. Note the direction of the timeline.

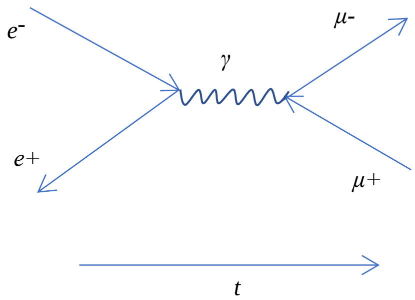

Figure 3-3 Positive and negative electrons produce virtual photons after annihilation.

3.3.4 Particle acceleration and deceleration

When subjected to the external field, the particles are accelerated and decelerated. A common particle accelerator uses the action of an electromagnetic field to accelerate protons or electrons to very high speeds. If a particle is subjected to a force applied by the external field opposite to the direction of motion, deceleration occurs. When accelerating, particles absorb virtual photons from external electric fields or magnetic fields. If it is a charged particle, some of the virtual photons are directly converted into photons during the acceleration process. During the deceleration process, the particles will release the virtual photons to the field. These released virtual photons may be directly absorbed by the external field or may be directly converted into photon radiation, such as bremsstrahlung.

3.3.5 The probability of virtual photon exchange

Virtual photons are also electromagnetic waves in nature, so the transmission of virtual photons is closely related to the nature of electromagnetic fields. Unlike the electromagnetic waves corresponding to ordinary photons, the virtual photon wave function solved by the virtual photon wave equations (2-41) and (2-42) also contains the spatial position of the virtual spacetime. Therefore, the discussion of the exchange of virtual photons must also involve some important properties of virtual space and time.

From the perspective of Maxwell's equations based on virtual spacetime, the generalized magnetic charge and the generalized charge are not equal. According to the calculation results of formulas (2-22) and (2-23), the generalized magnetic charge is larger than the generalized charge, and the generalized magnetic charge is about 137 times of the generalized charge. This also means that for a particle, the electromagnetic field energy in real spacetime accounts for about 1/137 of the total energy of the electromagnetic field in virtual spacetime. Therefore, it can be seen that electromagnetic interaction occurs in real spacetime, involving only 1/137 of the total energy. . This also means that the probability that the real spacetime electric field emit energy is about 1/137, which is the fine structure constant α.

$$j_{emittion} = \alpha \qquad (3-16)$$

The same is true for the absorption of virtual photons:

$$j_{absorption} = \alpha \qquad (3-17)$$

Although this is not a strict derivation process, material changes have their own laws. Therefore, if a conclusion can be confirmed by experiments, it means that our current theoretical analysis still has limitations. Some examples will be given later to analyze this conclusion. Due to the symmetry requirements of electromagnetic interactions, the probability of emitting virtual photon and absorbing virtual photon is generally the same, so that:

$$j = j_{emittion} = j_{absorption} = \alpha \qquad (3-18)$$

3.4 Hydrogen atomic level

3.4.1 Ground state energy of hydrogen atom

Hydrogen atoms are the simplest atoms in nature, and they are the first to be studied in quantum mechanics. From the Schrödinger equation to the Dirac equation to the quantum field theory, the precise calculation of hydrogen atoms has become an important evidence supporting these theories.

The use of the virtual photon theory can simplify the calculation of the energy level of the hydrogen atom and more clearly understand the causes of the Lamb shift. From the theoretical basis of the virtual photon involved in this book, it is in line with the existing theories of quantum mechanics and quantum field theory. This also laid a solid experimental foundation for subsequent theoretical derivation.

Among the hydrogen atoms calculated here, the nucleus is composed of one proton and the periphery has an electron. So this is a typical two-body problem. As shown in Figure 3-4.

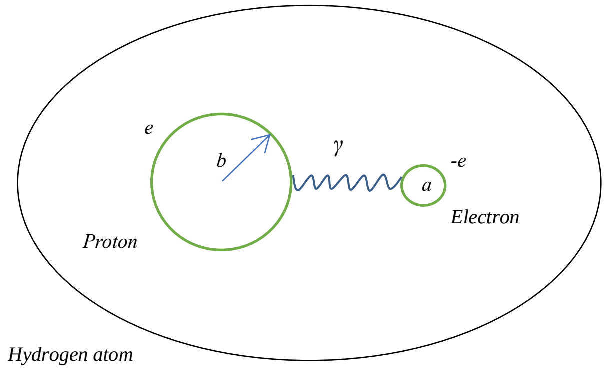

Fig 3-4 Diagram of hydrogen atom

In the hydrogen atom of Figures 3-4, "*a*" represents the electron radius and "*b*" represents the proton radius. Protons and electrons form a whole with each other. So, in the ground state, protons and electrons interact through a virtual photon.

There are two ideas when dealing with this problem with virtual photons. First, if the hydrogen atom is not affected by other external fields, the entire hydrogen atom can be regarded as a free particle. In this way, the corresponding problem can be handled according to the free particle virtual photon wave function. However, the entire hydrogen atom does not produce translation, that is, the hydrogen atom is rest relative to the calculated reference frame. This also means that the virtual photons carried by hydrogen atoms are mainly used to generate the relative motion of electrons and protons.

Secondly, considering the classical mechanics, the method of dealing with the two-body problem of the central force field can be simplified into an integral problem by the reduced mass μ. Thus, the whole problem becomes a problem that a particle of mass μ carries a virtual photon. Since the central force field is stationary relative to the computational reference frame, this problem becomes a problem of a bound state virtual photon. It has been proved in the book 2.4.2 that the solution of the virtual photon bound state wave function is consistent with the wave function solution of the Schrödinger equation. Therefore, the Schrödinger equation can be used to solve the problem. Solving the hydrogen atomic energy level with the Schrödinger equation has been introduced in many classical quantum mechanics tutorials and will not be repeated here.

Here mainly refer to the first method for calculation. If we want to think of a hydrogen atom as a whole, we need to calculate the momentum of the relative motion of electrons and protons as a whole. This gives us the energy of the virtual photon, namely

$$h\nu = pc$$

As a whole, the virtual photon energy contained in the free state atoms is continuous. Therefore, directly from the formula (3-15), it seems that the ground state energy of the hydrogen atom can be any value. However, due to the existence of the potential energy of the electrostatic field, there is a problem that the total energy of the atom carrying the virtual photon has a minimum value. Therefore, this energy minimum can be found by the variational method to obtain the energy of the ground state of the hydrogen atom and all other energy levels.

The total energy of the ground state of a hydrogen atom is

$$E = V(r) + \sqrt{\mu^2 c^4 + (h\nu)^2}$$

Where *V(r)* is the potential energy of the electron subsystem, $h\nu$ is the virtual photon energy, and μ is the reduced mass.

From the point of view of symmetry, the radius r appearing here is the wavelength radius of the virtual photon. This convention is essentially the same as the eigenstate convention in quantum mechanics because its purpose is to obtain a state. Then substitute the Coulomb potential formula.

This formula (3-16) can be expressed as

$$E = -\frac{e}{4\pi\varepsilon r} + \sqrt{\mu^2 c^4 + \left(\frac{hc}{2\pi r}\right)^2}$$

That is

$$E \approx -\frac{e}{4\pi\varepsilon r} + \mu c^2 + \frac{1}{2\mu}\left(\frac{h}{2\pi r}\right)^2 \qquad (3-19)$$

Considering the spherical symmetry, the total energy is used to derive the partial derivative of *r*, which is equal to 0, which is the state of the total energy minimum.

which is

$$\frac{\partial E}{\partial r} = 0$$

Then we can obtain

$$E_{min} = -\frac{1}{2}\left(\frac{e^2}{2\varepsilon hc}\right)^2 \mu c^2 = -\frac{1}{2}\alpha^2 \mu c^2 \qquad (3-20)$$

For other energy levels, considering that a hydrogen atom can absorb multiple virtual photons, you only need to multiply the energy of the virtual photon by n in equation (3-18) to calculate the energy of all other energy levels.

3.4.2 Degeneracy of energy levels

If the energy of the virtual photon in equation (3-18) is multiplied by n times, the formula becomes

$$E = -\frac{e^2}{4\pi\varepsilon r} + \sqrt{\mu^2 c^4 + \left(\frac{nhc}{2\pi r}\right)^2} \qquad (3-21)$$

In a similar way, other energy levels can be calculated

$$E_n = -\frac{1}{2}\left(\frac{e^2}{2n\varepsilon hc}\right)^2 \mu c^2 = -\frac{1}{2n^2}\alpha^2 \mu c^2 \qquad (3-22)$$

It can be seen that this is all the energy levels of the hydrogen atoms.

There are three explanations for *nhc*

1 it contains *n* virtual photons.

2 it still contains a virtual photon, but its energy becomes n times the original. The change in energy can be reflected in the frequency or wavelength of the virtual photon.

3 It includes both the increase in the number of virtual photons and the increase in the energy of the virtual photons.

Therefore, there is a problem that the energy level is degenerate in the hydrogen atom, that is, although the states of the virtual photons are different, as long as the main quantum number *n* is the same, the energy is the same.

It can be seen that at n=1, the virtual photon has only one state, so there is no problem of degeneracy of the energy level. This corresponds to the *1S* orbital state of the hydrogen atom.

When n=2, the virtual photon has two states, that is, the hydrogen atom contains one virtual photon and two virtual photons.

If a hydrogen atom contains only one virtual photon, it corresponds to the *2S* orbital state of the hydrogen atom.

If two virtual photons are contained in a hydrogen atom, it corresponds to the *2P* orbital state of the hydrogen atom.

Considering that in the *S*-orbital state, the energy density distribution of the virtual photon of the hydrogen atom is a spherical state with only radial distribution. Combined with the solution of the bound state wave function solved by the Schrödinger equation, it can be determined that the electron has no momentum in the tangential direction of the spherical surface. That is, the orbital angular momentum quantum number of the electron is 0.

So

$$l = n - 1 = 0$$

This formula can also be used for other main quantum numbers n, namely

$$l = 0, 1, \dots, n - 1 \qquad (3-23)$$

This reflects 1, 2, ..., n virtual photons that can exist in a hydrogen atom if the main quantum number is n.

For the three-dimensional space, only the radial and tangential directions are not sufficient to fully describe the state of the electrons. Therefore, it is also necessary to introduce a projection m of the z-axis, reflecting the angle θ in the spherical coordinates. Corresponding to the solution of the Schrödinger equation of the bound state wave function is the magnetic quantum number.

Since the z-axis has both positive and negative directions, the relationship between m and l is as follows

$$m = 0, \pm 1, \dots, \pm l \qquad (3-24)$$

In this way, all the conditions of the hydrogen atom level can be obtained.

3.4.3 The problem of orbit

Orbit is the concept of classical mechanics. However, when the microscopic particle energy is relatively high, its behavior begins to gradually approach the classical particle. This will gradually lead to a clearer track.

For a relatively high energy level state of a hydrogen atom, the virtual photon energy is getting larger and larger, which means that the electrons transmit the virtual photon are also gradually approaching the classical particles. The track is gradually displayed.

Consider the *nS* orbital of a hydrogen atom, where $n > 1$, which means that for an electron that has only one virtual photon, the wavelength of its virtual photon will be very short. According to the formula (2-51), the entire atomic nucleus cannot be covered. The *S* orbital is spherically symmetric, so the energy density of the wave function can only be concentrated near the orbit of the electron, that is, on the spherical surface where the electron is located. In addition, from the comparison between (3-18) and (3-21), it can also be found that as n increases, r also increases. The virtual photon energy carried by electrons in the *nS* orbit is increasing.

3.5 Lamb Shift

3.5.1The energy difference of Lamb shift

The Lamb shift reflects that the $2S^{1/2}$ and $2P^{1/2}$ orbits in the degenerate state of the energy level should have the same energy. However due to the difference in the orbital position, there is a slight difference between the two energy levels. This difference cannot be explained by the Schrödinger equation and the Dirac equation.

If we view the $2S^{1/2}$ and $2P^{1/2}$ orbitals from the perspective of the virtual photon, the main difference between the two is the difference in the number of virtual photons. For a hydrogen atom, there is only an electron and a proton, that is, only electrons and protons interact. Therefore, the exchange of virtual photons is limited to between electron and proton.

Different from the interaction between electron and electron, the mass difference between electron and proton is very large. So, the energy exchange efficiency between different mass particles is relatively low. This can be seen from calculations of the collision of two different masses of particles in classical mechanics.

3.5.2 The virtual photon energy exchange efficiency between two different mass particles interaction

If the two interacting particles are of different mass, it will affect the energy exchange efficiency of the virtual photons. After all, between the two equal mass particles interacts and two different mass particles interacts, the calculation results are very different in classical mechanics.

Here we first analyze the interaction between electron and proton from the perspective of classical mechanics. Assume that the electron mass is m_e, the proton mass is m_p, the initial velocity of the electron is v, the initial kinetic energy of the electron is $E_0 = \frac{1}{2} m_e v^2$, the velocity after the collision is v_e, and the kinetic energy after the electron collision is $E_e = \frac{1}{2} m_e {v_e}^2$; the initial velocity of the proton is 0, and the velocity after the collision is v_p. After the proton collision, the kinetic energy is $E_p = \frac{1}{2} m_p {v_p}^2$. Then according to momentum conservation and energy conservation laws, we have the following relationship (for simplicity, the black body represents the vector and the italic letters represent the corresponding scalar):

$$\begin{cases} m_e \mathrm{v} = m_e \mathrm{v}_e + m_p \mathrm{v}_p \\ \frac{1}{2} m_e v^2 = \frac{1}{2} m_e {v_e}^2 + \frac{1}{2} m_p {v_p}^2 \end{cases}$$

Since there is still a collision angle problem due to the interaction of the two particles, considering that the electrons inside the atom have better symmetry, only the frontal collision on the axis is considered here.

If the electron and proton collide head-on on the axis of the electron's movement, the velocity of the electron and proton before and after the collision is only have different sign, which is easier to calculate and can be calculated

$$\mathrm{v}_e = \frac{(1-k)}{2} \mathrm{v}_p$$

Where

$$k = \frac{m_p}{m_e}$$

So after interaction, the relationship of energy that electron and proton possessed is:

$$\frac{1}{2} m_e {v_e}^2 = \frac{(1-k)^2}{4} \cdot \frac{1}{2} m_e {v_p}^2$$

Or

$$\frac{1}{2} m_e {v_e}^2 = \frac{(1-k)^2}{4} \cdot \frac{1}{2k} m_p {v_p}^2$$

That is

$$E_e = \frac{(1-k)^2}{4k} E_p \qquad (3-25)$$

Where E_e represents the kinetic energy of the electron after interaction and Ep represents the kinetic energy of the proton after the interaction. After the interaction, the energy lost by the electron is E_p, which has the following relationship

$$\eta = \frac{E_p}{E_0} = \frac{4k}{(1-k)^2 + 4} \qquad (3-26)$$

Here E_0 is the initial kinetic energy of the electron. It can be seen that the energy transferred from electron to proton is very small. Only the energy of the η ratio produces a shift. Consider the requirements of quantization in the micro world. There is only one virtual photon, so this energy transfer reflects the efficiency of electron emission or absorption virtual photons during the electron proton interaction.

It can also be proved that the energy efficiency from proton transfer to electrons is only η.

Therefore, the formula (3-26) reflects the interaction between particles of different masses, and an efficiency problem of the virtual photon exchange itself. If the two particles are of equal mass, then η = 1, that is, the efficiency of the virtual photon exchange is 100%. So according to the formula, takes into account the mass difference between the interacting particles, formula (3-16) and (3-17) becomes

$$j_{emittion} = \alpha \cdot \eta \qquad (3-27)$$

$$j_{absorption} = \alpha \cdot \eta \qquad (3-28)$$

Therefore

$$j = j_{emittion} = j_{absorption} = \alpha \cdot \eta \qquad (3-29)$$

3.5.3 Using virtual photon theory to solve Lamb shift problem

Using the Schrödinger equation or the virtual photon wave function in Section 3.4.2 to solve the energy level of a hydrogen atom, a more accurate result can be obtained. However, when the energy level of an electron can accommodate multiple virtual photons, this will show a difference from the classical mechanical processing. These differences are mainly due to the fact that the wavelengths of the virtual photons will be different, which will affect the position of the virtual photons in the atoms, and the energy loss of electron in different orbit will also be different.

Intuitively, the virtual photon wavelength of the *2S* orbit is shorter, which causes additional time for the virtual photon to pass from the orbit to the nucleus, which can reduce the energy lost by the interaction. There are two virtual photons in the $2P^{1/2}$ orbital with a longer virtual photon wavelength. Since the two virtual photons are all located in the center of nucleus, the virtual photon exchange efficiency is slightly high than the $2S^{1/2}$ orbital with only one virtual photon and a shorter virtual photon wavelength.

The reason we use the orbital spin angular momentum coupling results in the same is because only the two are comparable. Otherwise, we must consider the solution of the Dirac equation. For convenience, the *2S* and *2P* orbit described below represents the $2S^{1/2}$ and $2P^{1/2}$ tracks actually.

1. The electron proton interactions in ground state

The energy ratio described in the analysis below is a statistical result. In fact, after each virtual photon exchange process is completed, the entire virtual photon is transferred from electron to proton or other electron. That is to say, there is always only one virtual photon in the entire atomic system.

For hydrogen atoms, considering the interaction between the electron and the proton, the probability of the electron emitting a photon to the proton is *j*, which is the probability of the electron losing energy. Therefore, the proportion of energy that the electron also have is

$$1-j \qquad (3-30)$$

Although the virtual photons attached to the electron are emitted, one part of the emitting probability of the virtual photon is emitted out of the atom and the other part probability is absorbed by the proton and remains in the atom, which is part of the total energy of the atom. Considering that the probability of proton absorption of a virtual photon is also j, the probability that a proton obtains a virtual photon from an electron is j^2, so that after this round of virtual photon exchange, electron emit virtual photon, and proton absorb partial virtual photon. The remaining energy ratio of the entire system is

$$1-j+j^2 \qquad (3-31)$$

Then consider the probability of the virtual photon absorbed by the proton j^2. After the proton absorbs the virtual photon, there is a requirement to immediately emit the virtual photon. And the emission probability is *j*, so the total energy of the system (3-31) will lose the energy of the ratio $j\cdot j^2$, that is, the total energy ratio that the system can retain is

$$1-j+j^2-j\cdot j^2 \qquad (3-32)$$

Considering the energy lost in this part, the proportion of energy that can be absorbed by electron is $j^2\cdot j^2$. Therefore, after the proton exchange virtual photon with the electron, the total energy ratio that the system can retain is

$$1-j+j^2-j^3+j^4 \qquad (3-33)$$

This loops continuously, we can get a sequence of numbers

$$p=1-j+j^2-j^3+j^4-\cdots=\frac{1}{1+j} \qquad (3-34)$$

This is the total energy ratio that can be left after the two particles in the atom interact to exchange virtual photons.

For the 1S orbital of a hydrogen atom, after considering the virtual photon exchange energy loss between the electron and the proton, the formula (3-21) becomes:

$$E \approx -\frac{e}{4\pi\varepsilon r} + \mu c^2 + \frac{1}{2\mu}\left(\frac{h}{2\pi r}\right)^2 \frac{1}{1+j} \qquad (3-35)$$

The energy of the *1S* energy level thus calculated will be:

$$E_{1S} = -\frac{1}{2}\left(\frac{e^2}{2\varepsilon hc}\right)^2 \mu c^2(1+j) = -\frac{1}{2}\alpha^2\mu c^2(1+j) \qquad (3-36)$$

It can be seen that for the ground state energy, if the effect of the virtual photon exchange is considered, the ground state energy of the hydrogen atom may be slightly lower than the results calculated by the Schrödinger equation. Of course, the reduced mass μ is used here, which also means that the difference in electron and proton mass has been considered. If the electron mass is reduced, this also means that the electric field is emitted by an infinite mass of the object. This calculation of the energy exchange probability j becomes more complicated. Therefore, the results obtained by the formula of (3-36) should still have errors.

2. Electron and Proton interaction in *2S* orbit

If the virtual photon exchange is not considered, the total energy of the *2S* orbit can be found as

$$E \approx -\frac{e^2}{4\pi\varepsilon r} + \mu c^2 + \frac{1}{2\mu}\left(\frac{2h}{2\pi r}\right)^2 \qquad (3-37)$$

The energy of the *2S* energy level thus calculated will be

$$E_2 = -\frac{1}{8}\alpha^2\mu c^2 \qquad (3-38)$$

Of which

$$\mathrm{r} = \frac{4\hbar}{\alpha\mu c} \qquad (3-39)$$

That is four times the Bohr radius.

The kinetic energy of electronics is

$$E_k \approx \frac{1}{2\mu}\left(\frac{\alpha\mu c}{2}\right)^2 = \frac{\alpha^2\mu c^2}{8} \qquad (3-40)$$

Different from the *1S* orbit, it can be seen from the calculations of the formulas (3-37) and (3-38) that the virtual photon wavelength of the *2S* orbital is shorter than the distance of the electron from the proton. This also means that the electron wave function of the *2S* orbital is mainly distributed on the spherical surface with radius r.

Of course, since the virtual photon carried by electron is farther away from the proton, the interaction between electron and proton is weaker, and the loss of electron energy caused by electron proton interaction is smaller than that of *2P* orbital. It is very difficult to accurately find this loss. Quantum electrodynamics requires very complex calculations to get an accurate solution. For ease of understanding, here is a simple estimate of the impact of the characteristics of the *2S* orbit on the virtual photon exchange.

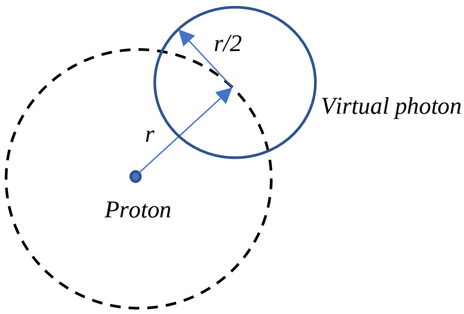

Fig. 3-5 The virtual photon location at hydrogen 2S orbit

Since the virtual photon wavelength is smaller than the orbital radius in the 2S orbit, the electron is already closer to the behavior of the classical particle. A virtual photon can be seen as directly attached to an electron. It can be seen from Fig. 3-5 that the distance from the proton in the center of the virtual photon of the *2S* orbital of the hydrogen atom is r, and the orbital circumference is $2\pi r$. Note the symmetry, although the virtual photons shown in Fig. 3-5 are in the hydrogen atom, a certain moment exists in a certain direction, but the actual situation is that the virtual photon is isotropically distributed in the *2S* orbit of the hydrogen atom, which can also be seen from the solution of the Schrödinger equation. Here, there is a problem whether r should be used to indicate the distance of the virtual photon transfer, or the orbital circumference $2\pi r$ is used to represent the distance of the virtual photon transfer. Taking into account the requirements of symmetry, the choice here is the circumference, which is the circumference of the orbit. For the *2P* orbit, since the center of the virtual photon coincides with the nucleus, it means that the circumference of the orbit is zero, and the electron interacts directly with the proton, and there is no such a loss of energy loss as the *2S* orbital.

Does this choice contradict with classic mechanics? Considering the circular motion of electron under macroscopic conditions, this isotropic requirement has been undermined. So, the interaction between electron and proton is closer to colliding with two particles. This may reflect some differences between microscopic and macroscopic particles.

Therefore, compared with the *2P* orbit, the exchange of *2S* orbital virtual photons requires a transmission distance of $2\pi r$. Since the virtual photon will exist in the form of photon after leaving the particle, its transmission speed is the speed of light *c*.

The time required is

$$t_1 = \frac{2\pi r}{c} \qquad (3-41)$$

In addition, the process of converting from a virtual photon to a photon takes time, which can be estimated by the uncertainty principle. According to the uncertainty relationship between time and energy, it means that the time required for the virtual photon of *2S* energy to be converted into photons is at least:

$$|E_2||\Delta t| = \frac{\hbar}{2}$$

Where, the E_2 is the energy of the *2S* orbit. The exchange of virtual photons involves both the release and absorption processes, and the time required is the same, so the total time required for virtual photon exchange between particles is

$$t_2 = 2|\Delta t| = \left|\frac{\hbar}{E_2}\right| = \frac{8\hbar}{\alpha^2 \mu c^2} \qquad (3-42)$$

Since the 2S orbit requires additional virtual photon transfer time, the ratio of additional electron proton interactions can be reflected by the proportion of time represented by (3-43). Which is

$$\Delta j_{2s} = \frac{t_1}{t_1 + t_2}\alpha\eta \qquad (3-43)$$

Here, the $\alpha\eta$ is the probability of virtual photon exchange after the interaction distance effect is not considered.

Considering j_{2s} is very smaller, therefore, the r calculated by (3-41) can be solved by r calculated by (3-39).

Substituting (3-39) into (3-41), (3-42), (3-43) gives

$$\Delta j_{2s} = \frac{\frac{8\pi\hbar}{\alpha\mu c^2}}{\frac{8\hbar}{\alpha^2\mu c^2} + \frac{8\pi\hbar}{\alpha\mu c^2}}\alpha\eta \approx \pi\alpha^2\eta \qquad (3-44)$$

The formula (3-44) reflects the decrease in the probability of virtual photon exchange after considering the virtual photon needs to transmit an additional distance in the *2S* orbit. It can be seen that when t_1 is very large, $\Delta j_{2s} \approx \alpha\eta$

This reflects the entire virtual photon exchange probability. So, formula (3-29) becomes

$$j_{2s} = \alpha\eta - \pi\alpha^2\eta$$

Similar to the solution method of the *1S* orbit, the total energy of the *2S* orbit can be found as

$$E \approx -\frac{e^2}{4\pi\varepsilon r} + \mu c^2 + \frac{1}{2\mu}(\frac{2h}{2\pi r})^2 \frac{1}{1 + j_{2s}} \qquad (3-45)$$

The energy of the *2S* energy level thus calculated will be

$$E_{2S} = -\frac{1}{8}\alpha^2\mu c^2(1 + j_{2s}) = -\frac{1}{8}\alpha^2\mu c^2(1 + \alpha\eta - \pi\alpha^2\eta) \qquad (3-46)$$

3. Electron and Proton interaction in *2P* orbit

For *2P* orbits, if two virtual photons need to be exchanged, the energy of the electrons can be divided into two halves. Every half of the energy emits and absorbs a virtual photon. The proportion of energy that can be retained after a virtual photon is emitted is

$$\frac{E'}{2} = \frac{E}{2}(1 - j_p)$$

When this virtual photon is absorbed by another particle, the total energy ratio after absorption is

$$\frac{E'}{2} = \frac{E}{2}(1 - j_p + {j_p}^2)$$

According to the calculation method of a single virtual photon exchange, it can be seen that the total energy ratio that can be retained after exchanging one of the virtual photons is

$$\frac{E'}{2} = \frac{E}{2}(1 - j_p + {j_p}^2 - {j_p}^3 + {j_p}^4 + \cdots)$$

Looking at the other half of the energy exchange for another virtual photon can also lead to the same conclusion. Since the exchange of these two virtual photons is independent of each other, this can be simply added, so that

$$E' = E(1 - j_p + {j_p}^2 - {j_p}^3 + {j_p}^4 + \cdots) \qquad (3-47)$$

This is consistent with the results obtained from the *1S* orbit. By replacing the total energy ratio in equation (3-35) with the formula (3-47), the energy of the *2P* orbital of the hydrogen atom can be determined as

$$E_{2P} = -\frac{1}{8}\alpha^2\mu c^2(1 + j_p)$$

Because the virtual photon wavelength of the *2P* orbit is consistent with the orbital radius, the virtual photon distribution of the *2P* orbit is consistent with the virtual photon distribution of the *1S* orbit, and its center coincides with the nucleus. In this way, the *2P* orbit does not need to additionally consider that there is a non-zero distance between the virtual photon center and the nucleus to make the efficiency of virtual photon exchange is reduced. So

$$j_p = j = \alpha\eta$$

Therefor

$$E_{2P} = -\frac{1}{8}\alpha^2\mu c^2(1+\alpha\eta) \qquad (3-48)$$

4. Estimate the Lamb shift between *2S* and *2P* orbit

Thus, according to the formulas (3-46) and (3-49), the energy difference between the 2S orbital and the 2P orbital of the hydrogen atom in the Lamb shift can be determined as

$$\Delta E = E_{2S} - E_{2P} = E_2\left(1 + j_{2s} - 1 - j_p\right)$$

That is

$$\Delta E = -E_2 \cdot \pi\alpha^2\eta = \frac{1}{8}\alpha^2\mu c^2 \cdot \pi\alpha^2\eta \qquad (3-49)$$

Where E_2 is the energy of n=2 level of the hydrogen atom solved by the Schrödinger equation, that is, the energy represented by the formula (3-22) or the formula (3-38).

Considering $m_p \gg m_e$, we have

$$\eta = \frac{4k}{(1-k)^2+4} \approx \frac{4m_e}{m_p}$$

And according to the hydrogen atom energy level data

$$E_2 = -82259.158cm^{-1}$$

Substituting other relevant data, we can get

$$\Delta E = 0.03cm^{-1} \qquad (3-50)$$

The sign is positive, indicating that the $2S^{1/2}$ level is higher than the $2P^{1/2}$ level.

According to the spectral data provided by nist.gov, the difference between the $2S^{1/2}$ and $2P^{1/2}$ orbital levels of hydrogen atoms is:

$$\Delta E = 0.035285982cm^{-1} \qquad (3-51)$$

It can be seen that the estimated results (3-50) are consistent with the experimental data (3-51) on the order of magnitude.

3.6 The calculation of the ground state energy of helium atoms

There are two electrons in the helium atom, so that the entire atomic system actually contains three objects. This is a typical three-body problem. In addition, when performing calculation processing, it may also involve the shielding effect that the proton electric field may have on the electronic electric field.

If the Schrödinger equation is used to solve the problem, the calculation process will become very complicated, so the approximate method is generally used for solving. Common methods for approximate solving the ground state energy of helium atoms include perturbation and variational methods.

Using virtual photon model to solve the ground state energy of helium atoms is another method. Compared with other methods, the virtual photon method is more concise and intuitive, and the results obtained are more accurate.

3.6.1 The helium atom structure in ground state

Although helium atoms include three objects: two electrons and one atomic nucleus, if the system is in the ground state, a certain symmetrical structure must be formed. This can be used to simplify the calculation of the entire ground state energy and obtain more accurate results.

Figure 3-6 shows the relationship between electrons and nucleus in the ground state of helium atoms.

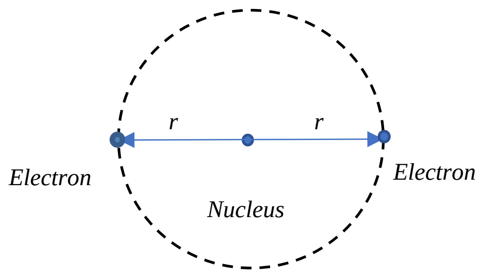

Fig. 3-6 The helium atom structure in ground state

In the structure shown in Figure 3-6, the center of the electron and the nucleus is in a straight line, the distance between the electron and the nucleus is r, and the distance between the two electrons is

2r.

In an isotropic spacetime, such a symmetrical structure will get the lowest energy.

3.6.2 The calculation of ground state energy without considering the virtual photons exchange

If the energy loss caused by the exchange of virtual photons is not considered, the total energy of the symmetrical structure shown in Figure 3-6 can be divided into six parts. They are the potential energy provided by the nucleus where the two electrons are located; and the electron potential energy located in another electron's electric field; the virtual photons generated by the interaction of two electrons with the nucleus, and the virtual photons generated by the interaction between the two electrons. Because of the symmetrical structure, the potential energy of the two electrons is equal, and the virtual photons that generated by interaction of two electrons with the nucleus are equal. This way the total energy calculation formula can be listed as

$$E = -\frac{4e^2}{4\pi\varepsilon r} + \frac{e^2}{8\pi\varepsilon r} + 2\sqrt{m^2c^4 + \left(\frac{hc}{2\pi r}\right)^2} + E_{ee} \qquad (3-52)$$

Here m is the mass of electron.

The first term on the right side of the equation (3-51) is the potential energy obtained by the two electrons in the electric field provided by the nucleus. The second term is the potential energy obtained by an electron in an electric field provided by another electron. The third term is the energy obtained by the interaction of two electrons with the nucleus. The fourth term E_{ee} is the energy obtained by the interaction between two electrons.

For the solution of E_{ee} energy, the uncertainty principle is used here for estimation. Since the distance between the two electrons is 2r, therefore

$$2rp_{ee} = \frac{\hbar}{2}$$

That is

$$p_{ee} = \frac{\hbar}{4r} \qquad (3-53)$$

Note that this is a system of two electrons. Since the interaction between the two electrons is also a two-body problem, the reduced mass μ can be used to simplify the problem to a single problem. So it can be calculated as

$$\mu = \frac{1}{2}m$$

From the relativity mass-energy relationship, we can get

$$E = \sqrt{\mu^2c^4 + (p_{ee}c)^2} \approx \mu c^2 + \frac{{p_{ee}}^2}{2\mu}$$

It can be calculated that the kinetic energy part involved in the two electronic interactions is

$$E_{ee} \approx \frac{h^2}{64\pi^2 mr^2} \qquad (3-54)$$

Thus the total energy of the ground state of the helium atom is

$$E = 2mc^2 - \frac{4e^2}{4\pi\varepsilon r} + \frac{e^2}{8\pi\varepsilon r} + \frac{h^2}{4\pi^2 mr^2} + \frac{h^2}{64\pi^2 mr^2} \qquad (3-55)$$

A system at ground state energy should have a minimum energy, ie.

$$\frac{\partial \mathrm{E}}{\partial \mathrm{r}} = -\frac{7\mathrm{e}^2}{8\pi\varepsilon r^2} + \frac{17h^2}{32\pi^2 mr^3} = 0 \qquad (3-56)$$

Then we can get

$$r = \frac{17}{28}a_0 \qquad (3-57)$$

Here a_0 is the Bohr radius.

$$E_{min} = -\frac{49}{17}\frac{e^2}{a_0} = -2.88\frac{e^2}{a_0}(eV) \qquad (3-58)$$

This is the ground state energy of the helium atom without considering the possibility of energy loss due to the exchange of virtual photons between electrons.

The experimental values of the ground state energy of helium atom are

$$E_{min} = -2.90338583(13)\frac{e^2}{a_0}(eV) \qquad (3-59)$$

The values in parentheses are errors.

By comparing the results (3-58) and (3-59), we can find that the calculated results are basically consistent with the experimental values. However, there are still some errors that the calculated value is higher than the experimental result, which is mainly due to the fact that energy loss due to virtual photon exchange is not taken into account.

3.6.3 The ground state energy after considering virtual photons exchange

If we consider the virtual photon exchange between three particles, it involves two virtual photon exchanges between the two electrons and the nucleus. One virtual photon exchange resulting from the interaction between electron and electron.

From the analysis of Section 3.5.2, it can be seen that for the virtual photon exchange between electrons and nucleus, since the mass of helium nuclei is about 5,000 times that of electrons, the efficiency of virtual photon exchange between electron and nucleus is much lower than the interaction between electron and electron. So, we can ignore it in the calculation process here. Therefore, only the energy loss caused by the exchange of virtual photons between electron and electron is considered here.

For the interaction between electron and electron, since the two electrons are of equal mass, from equation (3-26) we can calculate the energy exchange efficiency as

$$\eta = 1$$

Thus, in the virtual photon exchange process between electron and electron, the probability of one electron emitting a virtual photon to another electron is α, which is the probability that the electron loses energy. So, the electron still can remain a ratio of energy

$$1 - \alpha \qquad (3-60)$$

The probability that another electron absorbs a virtual photon is also α, so that the probability of another electron obtaining a virtual photon from the electron is α^2.

After this round of virtual photon exchange, the remaining energy ratio of the whole system is

$$1 - \alpha + \alpha^2 \qquad (3-61)$$

According to a similar analysis in Section 3.5.3, we can get a similar sequence

$$p = 1 - \alpha + \alpha^2 - \alpha^3 + \alpha^4 - \cdots = \frac{1}{1+\alpha} \qquad (3-62)$$

This is the total energy ratio that can be left after the two electron interactions exchange virtual photons.

After considering the energy loss of the virtual photon exchange between electron and electron, the formula (3-55) becomes

$$E = 2mc^2 - \frac{4e^2}{4\pi\varepsilon r} + \frac{e^2}{8\pi\varepsilon r} + \left(\frac{h^2}{4\pi^2 mr^2} + \frac{h^2}{64\pi^2 mr^2}\right)\frac{1}{1+\alpha} \qquad (3-63)$$

Then we can calculate

$$E_{min} = -\frac{49}{17}\frac{e^2}{a_0}(1+\alpha) = -2.9033864868188(69)\frac{e^2}{a_0}(eV) \qquad (3-64)$$

It can be seen that the theoretical calculation of the ground state energy of the helium atom of (3-64) and the experimental value represented by (3-59) have been close to each other with high precision.

3.7 A superconducting model based on virtual photon

3.7.1 Introduction

The first super conductor was found in 1911. More and more metals that have superconductivity were found afterwards. However, physicists also found that some metals never had superconductivity even it is in very lower temperature environments.

Alloys' critical temperatures are higher than pure metals. Higher critical temperature metal oxide ceramics were found in 1986]. After then, the MgB_2 and iron-based superconducting materials appeared. These new superconducting materials provide rich experiment data for the research of the superconductivity mechanism.

The relatively large impact superconductivity theory is the BCS theory at present. The BCS theory can better explain the superconductivity phenomenon for metals.

Free electron gas model is the simple and effective model to solve the metal's conductive problem. It points that the characteristics of electrons in metals are different from the electrons in bound states. Schrodinger's equation can be used to solve the bound state problems. It needs new theories to solve the free electron's problems.

Just like the theory of virtual photons can be used to solve the ground state energy problem of Helium, we can also use the virtual photons exchanging mechanism to construct a simple superconductivity model, so that we can explain the super conductivity mechanism based on a more precise physical model. It can also provide simple theoretic basis for finding new superconducting materials.

3.7.2 Bound state and Fermi energy

The electrons in metal are more like free electrons. The free electron gas model had been successfully used to solve the problems of metal's conductivities. Why we can use free electron gas model to analyze the metal's conductivity problems, it is because that the bonding potential of the crystal lattice is very shallow. So we can use Fermi-Dirac's statistical distribution function to analyze the energy distribution of electrons in metal, and then calculate the metal's Fermi energy.

The crystal bond in non metal materials is covalent bond. Since the covalent bond is very strong, there are only a few free electrons in non metal materials. It is equal to that the potential that bonding the electrons is very deep. The out-orbit electrons of the atoms in non metal material will not obey the constraint of Fermi-Dirac's statistics. All of the out-orbit electrons can be in the same energy level state.

To represent the difference between metals and non metals, here we introduce the concept of electron coherence length (ξ). **Electron coherence length** reflects the relationship between two electrons' wave functions. If the electron coherence length is longer, it means that two electrons must obey the Pauli Exclusion Principle. The two electrons will not be in the same state. If there are many electrons that have strongest correlation in a system, then all electrons will obey Fermi-Dirac's statistical distribution. It is the same as the concept of coherence length in BCS or other superconductivity theories.

For good metal, the coherence lengths among all the electrons are infinite, since we can use free electron gas model to describe it. So, the highest energy is the Fermi's energy for good metals in 0K. For good non metal, the coherence lengths among all the electrons are nearly zero, since all the electrons are bounded in the covalent bond. Therefore, the highest energy is the highest energy of a single electron in 0K. The actual materials' coherence lengths are in between.

3.7.3 The formula of coherence lengths

In the traditional superconductivity theories, the coherence length of electrons in a superconductor material can be calculated by special formulas.

In the Ginzburg-Landau superconducting theory, the coherence length can be calculated as

$$\xi = \sqrt{\frac{\hbar^2}{2m|a|}} \qquad (3-65)$$

Here, a is a constant in the Ginzburg-Landau superconducting equation. In the BCS theory, a more intuitive calculation formula for the coherence length is given, namely

$$\xi = \sqrt{\frac{\hbar v_f}{\pi \Delta}} \qquad (3-66)$$

Here v_f is called the Fermi velocity and Δ is the energy gap of the superconducting energy.

The concept of coherence length is a basic concept in various superconducting theories, involving many microscopic mechanisms. For the sake of simplicity, a simpler method is used here to determine the electron coherence length using conductivity. The reason is that if it is better to conduct electricity under normal temperature, it means that the number of free electrons is relatively large, and it is less affected by other factors. Although it may also be affected by lattice vibration, there is a strong correlation between conductivity and conductive electron density.

If the electron coherence length is greater, it means that the electron is more free and the conductivity is higher. However, the greater the electron coherence, the less the number of electrons that a system can hold at the same time. It can be considered that the conductivity is proportional to the coherence length. Therefore, the coherence length and conductivity have the following relationship

$$\xi = a\sigma \qquad (3-67)$$

Where "a" is a constant and σ is the conductivity of the material.

3.7.4 Crystal lattice oscillations

We had obtained many meaningful results from the harmonic oscillation model in solid physics. Here we still use the harmonic oscillation model to solve the super conductivity problems.

Crystal lattice is consisted with atoms or ions. The elastic coefficient of crystal bond is k. So, the energy levels of the crystal lattice can be calculated

$$E_k = n\eta \sqrt{\frac{k}{M}} \qquad (3-68)$$

Where, the M is the mass of one atom or ion. We can see that all of the atoms or ions in crystal are in bound state by comparing with the free electrons in metal. It means that the atoms or ions' oscillation energies are discontinuous. It can cause the energy jumping from absorbing virtual photons. However, if the virtual photon's energy is smaller than the difference between the adjacent energy level, the crystal lattice will not absorb any virtual photons.

3.7.5 The simple model of superconductivity

There are more or less conductive electrons in a material. Those electrons can be in between free or bound state. For different materials, the electrons' correlation lengths are also different. For good metals, the electrons in the metal obey Fermi-Dirac distribution. For good non-metals, all the electrons are in bound state, the electrons correlation lengths are zero.

The highest energy in good metal is the Fermi energy in 0K. That is E_c=E_F. The highest energy in good non-metal materials is equal to the maximum energy of a single electron. So the highest energy in non-metal is smaller than other materials. That is E_c=E_{min}

If an electron jumps from the highest to the lowest energy, it will emit virtual photons. The condition of a particle emitting virtual photons is that there are other particles can absorb these virtual photons according to previous suppose. Or those virtual photons will change into real photons, and emit out of the metal. If the emitting virtual photons can be absorbed by crystal lattice, then the emitting and absorbing process is successful. The crystal lattice will get the energy E_k. However, there is not equal to 100% probability to emit and absorb virtual photons. So, there will be energy lost in this process. It may be the reason of why metals have resistance. On the contrary, there will not have the energy lost if the emitting and absorbing process not happening.

Therefore, the condition of there is superconductivity in a material is the energy emitted by the electrons must be smaller than the lattice oscillation energy difference. That is

$$E_c < E_k \qquad (3-69)$$

3.7.6 The standard of whether a material can achieve superconductivity

Due to the existence of the electronic coherence length, a Fermi energy calculation formula of the system needs to be adjusted.

If the coherence length is infinity, the calculation formula of Fermi energy

$$E_F = \frac{5\hbar^2}{m}\rho_0^{\frac{2}{3}} \qquad (3-70)$$

Here ρ_0 is the electrons density, m is the electron mas.

For those elements that have shorter correlation length, we can assume the coherence length is ξ , while the length of this material is L. So the equivalent electron density in this material is

$$K = \frac{\xi^3 V}{L^3 V} = \left(\frac{\xi}{L}\right)^3$$

times the good metal.

So, the equivalent electron density can be calculated as

$$\rho = K\rho_0 = \left(\frac{\xi}{L}\right)^3 \rho_0$$

So, by using formula (3-67), we can get the highest electrons' ground energy in this material in 0K is

$$E_c = \frac{5\hbar^2}{m}\rho^{\frac{2}{3}} \approx \frac{5\hbar^2}{m}(K\rho_0)^{\frac{2}{3}} = \frac{5\hbar^2 c^2\sigma^2}{m}\rho_0{}^{\frac{2}{3}} = c^2\sigma^2 E_F \qquad (3-71)$$

Here, c is a constant and $c = a/L$; E_F is the Fermi's energy of this material. In 0K, the electrons in this material are in ground state. The highest energy of electrons is E_c.

If we improve the temperature or electric current intensity, the electrons energy will increase. In super conduction state, the increasing energy should not exceed the minimum energy needed to cause the lattice oscillation. Or it will emit virtual photons to the crystal lattice, and cause the energy lost. So, the maximum energy that an electron can get in the superconductivity critical state is the energy between two adjacent energy level of the lattice. That is

$$\varDelta E_c = E_k - E_c = \hbar\sqrt{\frac{k}{M}} - c^2\sigma^2 E_F \qquad (3-72)$$

Since $\varDelta E_c = k_B T_c$

We can calculate the critical temperature as

$$\varDelta E_c = k_B T_c = \hbar\sqrt{\frac{k}{M}} - c^2\sigma^2 E_F \qquad (3-73)$$

$$T_c\sqrt{M} = \frac{\hbar\sqrt{k} - b\sigma^2\sqrt{M}E_F}{k_B} = \frac{\hbar\sqrt{k} - bPE_F}{k_B} \qquad (3-74)$$

Here T_c is the critical temperature of the superconductor; $P = \sigma^2\sqrt{M}$; $b = c^2$; M is the mass of lattice ion; E_F is the Fermi energy of good free electron gas; k_B is the Boltzmann constant; σ is the conductivity of the material; $\hbar$ is the reduced Planck constant; k is the wave vector of the virtual photon.

In order to achieve superconductivity, it is required that the critical temperature T_c calculated by the above formulas (3-73) and (3-74) should be a positive value. If the calculation is negative, the material does not have superconductivity. Considering that the constants b and E_F in the formula (3-74) are both positive, a constant α is used instead, so that the superconductivity can be obtained as follows

$$P < \alpha \qquad (3-75)$$

Where

$$\alpha = \frac{\hbar\sqrt{k}}{bE_F} \qquad (3-76)$$

Or

$$\sigma^2\sqrt{M} < \frac{\hbar\sqrt{k}}{bE_F} \qquad (3-77)$$

Formula (3-75) or (3-77) is a criterion for judging whether a material has superconductivity. The key is to judge the size of $P = \sigma^2\sqrt{M}$.

The parameter α is related to the factors of the crystal structure, reflecting the parameters such as the elastic coefficient between the ions. As can be seen from equation (3-74), if the parameter P is larger, the critical temperature is lower; and vice versa. And if the lattice ion mass M is larger, the critical temperature is lower; and vice versa.

Table-13 gives a comparison. It can be seen from Table 3-1 that for the three elements listed therein, since the P value is too high, these elements do not have superconductivity at any low temperature.

Table 3-1 P value of metal with good electrical conductivity

Element symbol	**Element**	**conductivity ($*10^8 Sm^{-1}$)**	**atomic weight**	P
Ag	silver	0.63	107.87	3.0294
Cu	copper	0.596	63.55	2.0054
Au	gold	0.452	196.97	1.6888

Some common materials that can achieve superconducting properties are listed in Table 3-2. Compared to Table 3-1, these materials have very small P values.

Table 3-2 P value of some superconductivity elements

Element symbol	**Element**	**conductivity ($*10^8 Sm^{-1}$)**	**atomic weight**	P
Hg	HG	0.0104	200.70	0.0092
La	lanthanum	0.0126	138.91	0.0112
Ti	titanium	0.0234	47.87	0.0375

3.7.7 The calculation of critical temperature

The critical temperature of a material can be calculated by the formula (3-74)

$$T_c = \frac{\hbar\sqrt{k} - b\sigma^2\sqrt{M}E_F}{k_B\sqrt{M}} = \frac{\hbar\sqrt{k} - bPE_F}{k_B\sqrt{M}} \qquad (3-78)$$

However, since the wave vector k of an electron and the constant b are involved in the formula (3-78), this involves some more detailed problems. Due to space limitations and ease of understanding, no specific analysis is performed here.

If some extreme cases are considered, such as for all materials, the wavelength of the electron is a constant, then the formula (3-78) can be approximately changed to

$$T_c\sqrt{M} = C_1 - C_2 PE_F \qquad (3-79)$$

Where C_1 and C_2 are constants. Thus, by analyzing the relationship between $T_c\sqrt{M}$ and PE_F, the difference between theoretical calculation and experimental data can be seen.

Table 3-3 The parameters comparison among some superconductivity elements

Elements	**Tc (K)**	**Conductivity ($*10^8 Sm^{-1}$)**	**atomic weight**	E_F	PE_F	$T_c\sqrt{M}$
Hg	4.15	0.0104	200.7	6	0.055	58.79
La	4.88	0.0126	138.90	6	0.067	57.51
Ti	0.39	0.0234	47.87	9.9	0.371	2.70

It can be seen that there is a significant inverse relationship between the critical temperature related term $T_c\sqrt{M}$ and the P value and the Fermi level. That is, the larger the PE_F, the smaller the critical temperature term.

4 The boundaries between virtual and real spacetimes

4.1 Superluminal velocity virtual spacetime and micro-world virtual spacetime

4.1.1 Introduction

It has been mentioned in Chapter 1 that there are two kinds of spacetimes that may be virtual spacetime, one is superluminal speed spacetime, and the other is a smaller micro-world. Therefore, looking for the boundary of the virtual real-time space can be considered from the two situations.

For the superluminal velocity spacetime, the boundary is relatively easy to define, that is, the region exceeding the speed of light belongs to the virtual spacetime, and the region running below the speed of light is the real spacetime. This can be derived directly from the relativistic reference system transformation formula. Because once it reaches the superluminal state, the corresponding physical quantity, such as time, length, etc., will become an imaginary number. This book refers to this virtual spacetime of superluminal speed as velocity virtual spacetime.

For the smaller microcosm, there is a problem of how small it is to enter the virtual spacetime. From the perspective of quantum mechanics, it is known from the principle of uncertainty that there is an uncertain relationship between the position and momentum of a particle, namely

$$\Delta x \cdot \Delta p \geq \frac{\hbar}{2} \qquad (4-1)$$

In other words, we cannot determine the position of a particle infinitely accurately. The more precise the position of the particle is determined, the greater the energy of the particle will also be. Once the positional error of the particle is accurate to zero, the energy of the particle will be infinite. This is of course impossible.

This also means that just as the velocity of the real spacetime particles cannot exceed the speed of light, the position of the particles is not likely to enter an extremely small area. As for the extent of this tiny area, further discussion is needed.

In addition to spatial relationships, there is also the same uncertainty relationship between time and energy, ie.

$$\Delta t \Delta E \geq \frac{\hbar}{2} \qquad (4-2)$$

This also means that we can't measure the time of the particle to the nearest zero, otherwise it will cause the energy of the particle to become infinite.

It can also be seen from this that time and energy are actually the same physical quantity.

To make a distinction, this book refers to such a very small spacetime region as a length virtual spacetime.

4.1.2 Dimensionless spacetime

Due to the limitations of our understanding of the laws of the nature, there is a strong subjectivity in determining the basic physical quantities of an object. That is, when determining physical quantities such as length and mass, people usually define objects that are more practical in daily life. For example, the Celsius temperature is determined by the subjective feeling of the organism to the degree of cold to determine 0 degrees Celsius. The determination of other kilograms, meters and other units is basically similar. Therefore, how to unite the virtual spacetime and real spacetime's velocity units requires some more in-depth work. One of the better methods is to remove the dimension of the physical quantity, so that all physical quantities do not require units, which can eliminate the subjective factors of human beings when determining the physical quantity dimension.

1. Dimensionless speed

The determination of the virtual spacetime velocity unit of the superluminal speed can be performed by introducing a dimensionless velocity. This process is also relatively simple, that is, the speed at which the particle runs is divided by the speed of light.

This way we can get an expression of dimensionless speed

$$v_c = \frac{v}{c} \qquad (4-3)$$

This is the dimensionless velocity of real spacetime, which is consistent with the generalized velocity in Chapter 1. Regardless of the direction, its minimum value is 0 in real spacetime, and the maximum value is 1.

If the speed exceeds the speed of light, the v_c will exceed 1. At this time, the virtual spacetime is entered.

In order to unify the velocity of the virtual spacetime with the speed of the real spacetime, we can simply use the reciprocal of the dimensionless velocity to express the velocity of the virtual spacetime, namely

$$v_c{}' = \frac{1}{v_c} \qquad (4-4)$$

Since there is no specific unit of dimensionless velocity, it will not be affected by the subjective factors determined by humans in specific physical quantity units. Therefore, this reciprocal relationship can reflect the continuous change of velocity from real spacetime to virtual spacetime. Naturally, it is very simple to divide the boundary of virtual real-time space by velocity. That is, the dimensionless velocity is equal to 1, which is the boundary of the virtual and real spacetime.

2. Dimensionless length

And if we want to consider the microcosm, we can't avoid the length unit at this time. We can assume that there is a length l_p, the space with a radius greater than l_p is real spacetime, and the space smaller than l_p is virtual spacetime.

The question now becomes how to solve the relationship between the length of the virtual spacetime and the real spacetime length.

Considering that in virtual spacetime, it should be the same as real spacetime. The extremely small area in virtual spacetime must belong to real spacetime, so the simplest virtual and real spacetime length relationship is a reciprocal relationship. Assuming that the radius of the real spacetime is r and the radius of the virtual spacetime is r'. The following relationship can be used to represent the conversion of the virtual and real spacetime’s length:

$$r \cdot r' = {l_p}^2 \qquad (4-5)$$

So we can also get the definition formula of dimensionless length

$$r_c = \frac{r}{l_p} \qquad (4-6)$$

The dimensionless length of virtual spacetime can be defined as:

$$r_c' = \frac{1}{r_c} \qquad (4-7)$$

It can be seen that the dimensionless length is also un-united. The dimensionless lengths of the virtual and real spacetime are also a reciprocal relationship with each other.

3. Dimensionless charge

Although generalized parameters based on virtual spacetime are used, such as generalized charge and generalized magnetic charge, the electric field and the magnetic field can be unified. However, just like the length unit, it is only based on a reference object in real spacetime, and the parameters can be large or small. The problem is that the charge of the real spacetime electrons is not equal to the magnetic charge of the magnetic monopole of virtual spacetime. From the point of view of symmetry, the generalized magnetic charge of the magnetic monopole measured in the virtual spacetime should be equal to the electric charge of the electron measured in real spacetime. Then, whether it is possible to set a more general charge and magnetic charge unit like length and speed, it can ensure that the charge and magnetic charge measured at whatever spacetime have the same value. This will solve some of the problems of symmetry paradox.

If the average value of the magnetic monopole and the electron charge is selected as a demarcation point. We can set a charge and magnetic charge boundary point as

$$q_p{}^2 = q_e q_m \qquad (4-8)$$

Due to charge quantization, there is a relationship:

$$q_e = \alpha q_m$$

So

$$q_p = \frac{q_e}{\sqrt{\alpha}}$$

Then

$$\frac{q_e}{q_p} \cdot \frac{q_m}{q_p} = 1 \qquad (4-9)$$

Here we define two dimensionless parameters, dimensionless charge and dimensionless magnetic charge. They are

$$g_e = \frac{\mathrm{q}_e}{\mathrm{q}_p} = \sqrt{\alpha} \qquad (4-10)$$

$$g_m = \frac{\mathrm{q}_m}{\mathrm{q}_p} = \frac{1}{\sqrt{\alpha}} \qquad (4-11)$$

Then we can get

$$g_e g_m = 1 \qquad (4-12)$$

The dimensionless charge and the dimensionless magnetic charge have no unit, but are equal in the values measured in different spacetime. And the charge is directly linked to the fine structure constants. That is, the square root of the fine structure is the dimensionless charge of the electron.

4. Dimensionless energy

Considering in the virtual spacetime, a magnetic monopole with a radius $r_{me}{}'$ and a magnetic charge m uniformly distributed on the spherical surface, the energy is

$$E_{me} = \frac{{q_m}^2}{8\pi {r_{me}}'} \qquad (4-13)$$

If we use a dimensionless magnetic charge and other parameters instead, we can have

$$\mathrm{E}_{me} = \frac{{g_{me}}^2 {\mathrm{q}_p}^2}{8\pi {r_{mec}}' l_p} = \frac{{\mathrm{q}_p}^2 r_{mec}}{8\pi \alpha l_p} = \frac{{\mathrm{q}_p}^2}{8\pi l_p} \cdot \frac{r_{mec}}{\alpha} \qquad (4-14)$$

The r_{mec}reflects the influence of the energy of the magnetic monopole on the real spacetime. Just as an expansion screw is driven into an isotropic wall, the energy of the magnetic monopole squeezes the isotropic nature of the real spacetime, causing the spacetime to bend. Magnetic monopoles in the dimensionless radius of virtual space–time represented by ${r_{mec}}'$, and $r_{mec} \cdot {r_{mec}}' = 1$

Also considering in the real spacetime, a particle whose radius is r_e and whose charge e is evenly distributed on the sphere, we have

$$E_e = \frac{{q_e}^2}{8\pi r_e} \qquad (4-15)$$

If we use a dimensionless parameter instead

$$E_e = \frac{{g_e}^2 {\mathrm{q}_p}^2}{8\pi r_{ec} l_p} = \frac{\alpha {\mathrm{q}_p}^2}{8\pi r_{ec} l_p} = \frac{{\mathrm{q}_p}^2}{8\pi l_p} \cdot \frac{\alpha}{r_{ec}} \qquad (4-16)$$

Where, the r_{ec} is the electron's dimensionless radius. The fine structure reflects the dimensionless charge.

Among the items in formula (4-14) and formula (4-16)

$$\frac{1}{k_p} = \frac{{q_p}^2}{8\pi l_p}$$

That is

$$k_p = \frac{8\pi l_p}{{\mathrm{q}_p}^2} \qquad (4-17)$$

k_p is a constant.

If we define

$$E_{ec} = k_p E_e = \frac{8\pi l_p}{{q_p}^2} E_e = \frac{\alpha}{r_{ec}} \qquad (4-18)$$

as the dimensionless energy, it can be seen that there is also a reciprocal relationship between the energy of the magnetic monopole and the dimensionless energy of the electron.

The energy possessed by electrons and magnetic monopoles is specific because they are the result of charge quantization. For continuous energy, such as the energy representation of photons or electromagnetic fields, the relationship between virtual real-time vacancies is more general.

In real time, the energy of a photon with a frequency of ν, a wavelength of λ, and a wavelength radius of r is usually

$$E_\gamma = h\nu = \frac{hc}{\lambda} = \frac{hc}{2\pi r} \qquad (4-19)$$

It involves two constants h and c, which can be represented by fine structure constants, namely

$$\alpha = \frac{e^2}{2\varepsilon hc} \qquad (4-20)$$

That is

$$hc = \frac{e^2}{2\alpha\varepsilon} \qquad (4-21)$$

Then formula (4-21) can be expressed as

$$E_\gamma = \frac{e^2}{4\pi\alpha\varepsilon r} = \frac{{q_e}^2}{4\pi\alpha r} = \frac{{q_p}^2}{4\pi l_p} \cdot \frac{1}{r_c} = \frac{2}{k_p r_c} \qquad (4-22)$$

That is, for a single photon, its dimensionless energy is

$$E_{\gamma c} = k_p E_\gamma = \frac{2}{r_c} \qquad (4-23)$$

From the comparison of the dimensionless energies of equations (4-20) and (4-25), the difference between the two is the fine structure constant and the coefficient 2. This may reflect that electron charge is $\sqrt{\alpha}$ due to their dimensionless charge, so the fine structure constant must be included in the energy (4-20). The photon does not contain a charge, and it also contains the oscillation of the electric field and the magnetic field, so there is a factor of 2 times.

Dimensionless energy also reflects the fact that measurements are made in the same spacetime, and energy is the reciprocal of length.

For momentum, dimensionless momentum can be used

$$\mathrm{p_c} = k_p \mathrm{p} c \qquad (4-24)$$

to represent. This momentum can also be dimensionless.

Dimensionless mass can be represented as

$$m_c = k_p mc^2 \qquad (4-25)$$

4.1.3 Expression of dimensionless conservation law

If a dimensionless physical quantity is used, the corresponding conservation law will also change.

1. Energy conservation

Energy conservation means that the total energy of the system is always constant.

The expression of the law of conservation of energy is

$$\delta E = 0$$

If we consider the expression of dimensionless energy, then:

$$\delta(k_p E) = 0 \qquad (4-26)$$

Considering that k_p is a constant, in terms of form, the expression of conservation of dimensionless energy is not in any form different from the ordinary law of conservation of energy.

If an object has a dimensionless mass of m_c and a dimensionless momentum p_c, its total relativistic energy (dimensionless) is

$$E_c{}^2 = m_c{}^2 + p_c{}^2 \qquad (4-27)$$

In Section 5.1 we see that the rest mass of a real spacetime object is the energy of the virtual spacetime, so the relativistic mass relationship is the energy of the virtual and real spacetime. Therefore, the discussion of the law of conservation of energy also takes into account the relationship between the energy of the virtual and real spacetime.

According to (4-23), the dimensionless energy of a photon in virtual spacetime is

$$E'_{\gamma c} = \frac{2}{r_c{}'} = 2r_c$$

Where $r_c{}'$ is a dimensionless wavelength radius of a virtual spacetime photon, r_c is the length of the radius corresponding to the real spacetime according to the formula (4-5)..

Thus the entire relativistic dimensionless energy expression becomes

$$E_c{}^2 = 4r_c{}^2 + p_c{}^2 \qquad (4-28)$$

Or

$$E_c = \sqrt{4r_c{}^2 + p_c{}^2} \qquad (4-29)$$

Considering that momentum has direction, it is a vector, so energy conservation can be expressed as

$$\delta E_c = \frac{8r_c\delta r_c + 2\mathrm{p_c}\cdot\delta\mathrm{p_c}}{2E_c} = 0$$

That is

$$4r_c\delta r_c + \mathrm{p_c}\cdot\delta\mathrm{p_c} = 0 \qquad (4-30)$$

2. Momentum conservation

If a dimensionless momentum is used, the law of conservation of momentum can be expressed as

$$\delta\mathrm{p}_c = \delta(k_p\mathrm{p}c) = \delta\mathrm{p} = 0 \qquad (4-31)$$

It can be seen that the conservation of dimensionless momentum is also true.

If the rest mass of the object does not change throughout the process, (4-30) can be derived from (4-31), since equation (4-30) is for free particles. If there is an external field, it is also necessary to consider the potential energy change of the external field.

3. Conservation of angular momentum

For angular momentum J, the total angular momentum of the system is conserved, meaning:

$$\Delta\mathrm{J} = 0$$

and

$$\mathrm{J} = \mathrm{r}\times\mathrm{p}$$

Convert r and p into dimensionless physical quantities, then

$$\mathrm{J}_c = \mathrm{r}_c\times\mathrm{p}_c = \frac{\mathrm{r}}{l_p}\times(k_p\mathrm{p}c) = \frac{k_p c}{l_p}\mathrm{r}\times\mathrm{p} \qquad (4-28)$$

Therefore

$$\delta J_c = \delta\left(\frac{k_p c}{l_p} r \times p\right) = \delta(r \times p) = 0 \qquad (4-29)$$

It can be seen that the dimensionless angular momentum is also conserved.

4.2 Spin of charged particles and electromagnetic virtual spacetime

4.2.1 Electron and proton structure

The two kinds of virtual spacetime mentioned in the first section, one is the superluminal speed virtual spacetime, and the other is the minimal micro-world virtual spacetime. For microscopic particles confined to a very small spacetime range, the electromagnetic field is bound to a small range, which causes the some movements of these electric or magnetic fields to easily appear to exceed the speed of light, such as the spin of electrons. If the electric field or magnetic field of the microscopic world appears to have a superluminal speed due to the special requirements of a certain state, then part of the physical quantity of the particle may become a part of the superluminal velocity virtual spacetime. These virtual spacetime effects must be considered when dealing with the corresponding physical problems.

If the symmetry requires electrons and magnetic monopoles to correspond one-to-one, each electron corresponds to a magnetic monopole, and the energy of the magnetic monopole squeezes the real spacetime, and produces observable physical effects. So we can construct an electronic image as shown in Fig. 4-1.

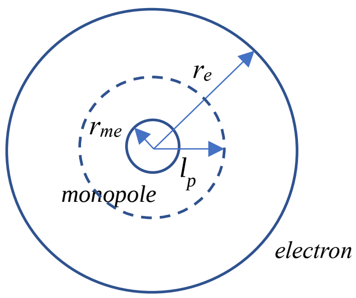

Fig.4-1 The structure of electron

In Figure 4-1, r_e and r_{me} are the dimensioned radii of the electron and magnetic monopole in real time, and $\boldsymbol{l_p}$ is the boundary of the virtual and real spacetime. The boundary of the virtual and real spacetime is indicated by the dotted line.

Therefore, there will be a very hard core inside the electron or proton, but the radius of the kernel is very small and lies in the virtual spacetime.

From the point of view of symmetry, the magnetic monopole of the virtual spacetime should also have the same structure. Of course, real spacetime protons also have the same structure.

4.2.2 Total energy of electron and proton

If we considers that the total energy of a particle is the sum of the energy of the virtual spacetime and the real spacetime, then for the electron, the total energy consists of the rest mass (virtual spacetime energy) and the electric field energy (real spacetime energy), then the total of the electrons can be written. The energy is

$$E_e = \sqrt{{m_e}^2 c^4 + \frac{e^4}{(8\pi\varepsilon r_e)^2}} \qquad (4-30)$$

For proton, the total energy is

$$E_p = \sqrt{{m_p}^2 c^4 + \frac{e^4}{\left(8\pi\varepsilon r_p\right)^2}} \qquad (4-31)$$

From the point of view of symmetry, the total energy of proton and electron should be equal, ie.

$$E = E_p = E_e \qquad (4-32)$$

The total energy of electron and proton includes both the electric field energy of electron and proton, and the magnetic field energy of the corresponding virtual spacetime magnetic monopoles. Therefore, the total energy is combined and is equivalent to one photon.

According to the momentum formula of the photon

$$p = \frac{E}{c} \qquad (4-33)$$

We can find the momentum that electron and proton have

$$p = \sqrt{{m_e}^2 c^2 + \frac{e^4}{(8\pi\varepsilon r_e c)^2}} = \sqrt{{m_p}^2 c^2 + \frac{e^4}{\left(8\pi\varepsilon r_p c\right)^2}} \qquad (4-34)$$

Since the mass of the proton is not equal to the mass of the electron, and the mass of the proton is greater than the mass of the electron, it can be seen that

$$r_p > r_e \qquad (4-35)$$

Since the momentum represented by (4-34) can only limit electron or proton to a small range, the macroscopically expressed momentum is actually the angular momentum, which corresponds to the spin of electron and proton. Existing physical experimental data have shown that the spins of electrons and protons are equal. This poses a problem. Because the radius of the proton is larger, it means that on the surface of the proton, electric field may run at a speed less than the speed of light, which is in line with the theory of relativity. However, the smaller radius of the electron means that the running speed of the electric field on electronic surface may be greater than the speed of light, which means that the spin motion of the electric field of electron may actually have entered the superluminal velocity virtual spacetime. The difference between entering real spacetime and entering virtual spacetime is that in real spacetime, the proton charge radius is observable, while the electron charge radius is not observable. However, the electron's charge radius is still in real spacetime in length real spacetime, so the resulting electrostatic field can still produce observable physical effects.

In order to be able to clarify this point, consider that the equation (4-33) is calculated according to the momentum formula of the photon. Therefore, assuming that there is a radius r_0, it can be ensured that the spin motion speed of the electric field or the magnetic field on the surface of the particle is exactly equal to the speed of light c. The radius can be a boundary radius of whether the particle's electric field motion is in virtual spacetime or real spacetime, which will directly determine the microscopic characteristics of the particle.

We can use

$$J = r_0 p = \frac{\hbar}{2} \qquad (4-36)$$

to represent this spin angular momentum. Considering

$$m_e{}^2 c^2 \ll \frac{e^4}{(8\pi\varepsilon r_e c)^2} \qquad (4-37)$$

and

$$m_p{}^2 c^2 \gg \frac{e^4}{\left(8\pi\varepsilon r_p c\right)^2} \qquad (4-38)$$

Substituting (4-34) into (4-36) gives:

$$r_0 \approx \frac{\hbar}{2\mathrm{m}_p c} \approx \frac{r_e}{\alpha} \qquad (4-39)$$

Thus, in addition to the two types of virtual spacetime, which are described in Section 4.1.1, whether the speed exceeds the speed of light and is differentiated according to the radius, an **electromagnetic virtual spacetime** occurs. However, electromagnetic virtual spacetime is actually derived from the superluminal velocity virtual spacetime. When the particle spin causes the electric field or the magnetic field in the tangential direction of the surface to rotate faster than the speed of light, it enters the virtual spacetime, and below the speed of light, it is located in the real spacetime. r_0 is the radius criterion for dividing this electromagnetic virtual and real spacetime. Due to the quantization of the charge, the radius r_0 has a general law. That is to say, for all charged particles is established. In order to distinguish, this book uses r_0 as the boundary of electromagnetic virtual and real spacetime.

4.2.3 Numerical value of electromagnetic virtual and real spacetime boundary

Since (4-39) has given the calculation formula of r_0, the specific results are calculated here to compare with some particle-specific data. The result of the calculation is

$$r_0 \approx \frac{\hbar}{2m_p c} \approx 2.10309 \times 10^{-16} m$$

Table 4-1 shows the comparison of the magnitudes of the electromagnetic radii of several common particles.

Table 4-1 Several common particles whose electromagnetic radius

Radius name	**Value（m）**
r_0	2.10309×10^{-16}
Electron electromagnetic radius	$7.6736127 \times 10^{-19}$
μ electromagnetic radius	1.586660×10^{-16}
τ electromagnetic radius	2.668230×10^{-16}
Proton electromagnetic radius	$1.4089924 \times 10^{-15}$

From the above data comparison, it can be found that the electromagnetic radius of both electrons and muons is less than r_0, so the electromagnetic radius of these particles has no observable physical effects. This also means that there are no other structures inside these particles. Existing experimental data also indicates that the two particles have no internal structure.

The electromagnetic radius of protons and tau is greater than r_0, which means that the electromagnetic radius of the two particles is larger than the virtual spacetime electromagnetic radius boundary, so the two particles have an internal structure. Protons have been confirmed to consist of quarks. The tau can decay into the hadrons composed of quarks.

4.3 Quaks

4.3.1 The difference between proton and electronic electromagnetic structure

It can be seen from the analysis in Section 4.2 that although the protons and electronic structures that do not consider the charge spin are the same, after the electromagnetic structure is considered, the difference occurs. This difference is manifested in the surface electric field rotation speed caused by the spin. The proton's spin is less than the speed of light, so it is located in the real spacetime and can be observed. There is enough experimental evidence to show that the proton are radiused. The surface electric field caused by the electron spin rotates faster than the speed of light, and is located in the virtual spacetime, so that the electron charge radius cannot be directly measured. There is currently experimental evidence that the charge radius of electrons cannot be detected within a very small range.

Thus, unlike the complete structure of the electron shown in Figure 4-1, the electromagnetic structure of the electron involves the boundary r_0 of the electromagnetic virtual rand real spacetime, and Figure 4-2 shows the electromagnetic structure of the electron and proton.

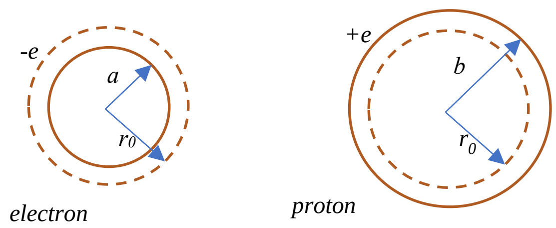

Fig. 4-2 The electromagnetic structure of electron and proton

In order to discuss the electromagnetic properties of electron and proton more succinctly, the subsequent content uniformly marks the radius of the electron as a, and the radius of the proton is marked as b. As can be seen from Fig. 4-2, the dotted circle represents the boundary of the electromagnetic spacetime. Reflects the boundaries of the particle spin speed.

For electrons, since their radius is less than r_0, the electrons are located inside the electromagnetic virtual spacetime. Considering that the charge of all particles is quantized, this electromagnetic virtual spacetime is consistent for all particles. Therefore, in real spacetime, the radius of the electron is not measurable, which means that in the real spacetime of length, the electron is a point particle with no radius. But the electric field of electrons can still produce observable physical effects in real spacetime. This is because except the smaller mass kernel, the entire electron is actually still in the real spacetime with a scale larger than the length of l_p. For various physical quantities of electric field, mass and energy, it still can be measured in the length real spacetime.

For protons, since the electric field radius of the proton is greater than r_0, the electric field radius of the proton is measurable, so that in real spacetime, the proton is not a point particle. Thus, protons can have a variety of structures. These structures include quarks and the like.

However, if the internal structure such as quark is located in an area smaller than r_0, it means that the internal structure such as quark is not measurable in real spacetime.

4.3.2 Proton internal structure and quark model based on virtual spacetime

Protons are the most stable elementary particles in addition to electrons. Exploring the internal structure of protons also helps to explore the various properties of other particles.

The existing theoretical physics results show that the proton isotonic is composed of quarks, and the prediction of this theory has been confirmed by a large number of experimental data. Unlike the charge quantization we know, the charge of a quark is a fractional form. This also means that the charge quantization conditions are not applicable to quarks. However, not meeting the charge quantization conditions does not mean that it does not exist. In fact, if the existence of real spacetime and virtual spacetime is not considered, the charge can exist in any value. However, the quark's fractional charge does not satisfy the charge quantization condition, which means that it cannot be measured in real spacetime, otherwise the Dirac string can be observed.

The existence of fractional charge also means that this may be due to the three states of the electric field caused by the special structure inside the proton.

What is the number of quarks that make up a proton? This can be easily guessed. If there is only one quark, it means that there is only one baryon. This structure has no practical physical meaning.

In the case of two quarks, the number of baryons formed is only a few, which is much smaller than the number of baryons currently known.

Therefore, the number of quarks constituting a general baryon is generally three or more, and a small part such as a meson is composed of two quarks.

Since the number of quarks that make up a baryon is greater than two, and the charge of the baryon must be quantized, this also means that the charge possessed by the quark must also be a fractional charge. Fractional charge means that only one quark consisting of particles does not exist.

Therefore, for protons, the minimum number of quarks that can be used is three. Generally, choose three quarks. The charge energy of the three quarks is ±1/3 and ±2/3, respectively, where the two symbols u and d are used to represent the two cases. Both *u* and *d* represent positive particles.

From the point of view of symmetry, electrons and protons belong to the most stable particles of all particles. If a proton has a structure, the particles contained in its internal structure should be positive particles. Thus, the total number of charges for the three quarks must be an integer of one, and the formula can be listed

$$u + u + d = 1 \qquad (4-40)$$

Of course, the above formula can also use u instead of d, which is just a matter of letter selection.

Also consider that the electric field energy of the proton should be the sum of the electric energy of the three quarks, namely

$$E_p = E_u + E_u + E_d = \frac{u^2e^2}{8\pi\varepsilon b} + \frac{u^2e^2}{8\pi\varepsilon b} + \frac{d^2e^2}{8\pi\varepsilon b} = \frac{u^2e^2}{8\pi\varepsilon b}$$

That is

$$u^2 + u^2 + d^2 = 1 \qquad (4-41)$$

Solving equations (4-40) and (4-41), we can get:

$$\begin{cases} u = \dfrac{2}{3} \\ d = -\dfrac{1}{3} \end{cases} \qquad (4-42)$$

The formula (4-42) reflects the charge distribution of the quark inside the proton. Due to the requirement of the total energy of the charge, it means that the charge of the quark is distributed on the surface of the proton. However, in general, all charges are monolithic and it is impossible to distinguish the quark's fractional charge on the proton surface. But you can also consider some special cases, such as in some interactions, causing one of the quarks to be separated, which may lead to a short separation of the proton surface quark charge, which may be observed in real spacetime. That is the quark's fractional charge effect. This can be done on a large proton collider. For example, in the moment when a proton collided with a new particle, the separation by the magnetic field should be consistent with the effect of the fractional charge magnetic field in a very short time.

Based on this quark structure of protons, we can also express the electromagnetic structure of protons as Fig. 4-3

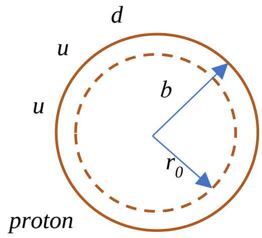

Fig.4-3 Proton electromagnetic structure carrying quarks

The *uud* in Fig. 4-3 represents the fractional charge carried by the proton quarks.

4.4 Structure of composite particles

4.4.1 The composite structure of neutron

In addition to stabilizing protons and electrons that do not decay, other elementary particles are unstable. Even the longest half-life neutrons can only survive for a few minutes. Therefore, these unstable basic particles can be called composite particles.

Since neutrons can decay into protons and electrons as well as neutrinos, neutrons can be structurally considered as composite particles of protons, electrons, and neutrinos.

Since neutrinos always appear in pairs with electrons, neutrinos can be thought of as uncharged electrons.

This will draw the structure of the neutron. As shown in Figure 4-4.

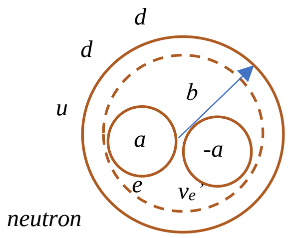

Fig.4-4 The electromagnetic structure of neutron

Figure 4-4 shows the electromagnetic structure of the neutron. In this structure, the neutron has the same electromagnetic radius as the proton, and is *b*. In fact, this electromagnetic radius is provided by protons. Therefore, the electromagnetic radius of the neutron is a physical quantity that can be measured. The interior of the neutron contains both electron and anti-electron neutrino particles. Such a neutron can be thought of consist of a proton, an electron, and an anti-electron neutrino.

In Figure 4-4, “a” is the electromagnetic radius of the electron, and the sign is positive, indicating that this is an ordinary electron. Since the antineutrino is an antiparticle, its electromagnetic radius sign is negative. The positive charge of the proton is combined with the negative charge of the electron to form three quark fractional charges of u, d, d. The middle dotted circle indicates the electromagnetic virtual spacetime boundary.

4.4.2 Estimation of neutron mass

Since neutrons are treated as composite particles of protons, electrons, and electron neutrinos, the energy of the neutrons can be calculated by separating the parts.

The main cause of the difference in mass between neutrons and protons is the presence of electrons and electron neutrinos, so the main energy that electrons are trapped inside the proton is considered here.

First, the electrons are bound to proton, causing the neutron to be uncharged, meaning that the charge originally distributed on the surface of the electron must be redistributed on the surface of the neutron, otherwise the neutron may produce a non-zero charge distribution under certain conditions. However, the self-energy of the electron itself is very large. From the formulas (4-30) and (4-31), it can be seen that the electric field of the electron self-energy reaches the energy corresponding to the proton mass. To compensate for this part of the self-energy, note that in the substructure of Fig. 4-4, there is an antineutrino $\nu_e{}'$, the radius of the antineutrino is the same as the electron radius, but in the opposite direction. Therefore, the energy of the antineutrino can offset this part of the electron's self-energy.

This electronic charge after redistribution will generate a new self-energy, ie

$$E_1 = \frac{e^2}{8\pi\varepsilon b} = m_e c^2 \qquad (4-43)$$

Here, the results obtained by considering the symmetry of the total energy of the protons and electrons. It is shown in formulas (4-30) and (4-31).

In addition, due to the existence of electron charge, the positive charge of the proton is in the electric field formed by the electron negative charge, and a potential energy is formed. Using the calculation formula of potential energy, we can get

$$V = -\frac{e^2}{4\pi\varepsilon b} = -2m_e c^2 \qquad (4-44)$$

Then, from the structure of Fig. 4-4, it can be seen that there are electrons and antineutrinos in the neutron. Electrons and antineutrinos are bound in a space of radius b, and two virtual photons can be formed. The determination of the energy of these two virtual photons is a difficult task. One method is to directly use the radius of the proton as the wavelength radius of the virtual photon. However, the neutron as a whole means that the virtual photon is confined in the neutron, which means that the electron and anti-electron neutrino are inside the proton. Sporty. Just like the atomic structure. This has been proven to be inconsistent with experimental facts. Therefore, the more accurate expression should be that the virtual photon belongs to the neutron as a whole, is an intrinsic property of the neutron, and also reflects the instability of the neutron. If these two virtual photons are regarded as the entire neutron, then the fluctuation range of the virtual photon can reach the scale of the neutron diameter *2b*. According to the principle of uncertainty, the energy of each virtual photon can be estimated as

$$\Delta \mathrm{p} \cdot \Delta \mathrm{x} = \frac{\hbar}{2}$$

That is

$$h\nu = \frac{\hbar c}{4b} \qquad (4-45)$$

Since these two virtual photons belong to the entire neutron, the total mass of the neutrons is used when calculating the corresponding real spacetime energy. Considering that the neutron mass is approximately equal to the proton, it is also possible to directly use the proton mass for an approximate calculation.

This can get the energy obtained by the virtual photon.

$$E = \sqrt{{m_p}^2c^4 + \left(\frac{\hbar c}{4b}\right)^2 + \left(\frac{\hbar c}{4b}\right)^2} \approx m_p c^2 + \frac{\hbar^2}{16 m_p b^2} \qquad (4-46)$$

This can be calculated as the extra energy possessed by carrying this part of the virtual photon is

$$E_2 \approx \frac{1}{2}\frac{\hbar^2}{m_p b^2} = 2.0932 \times 10^{-13}(J) \qquad (4-47)$$

Thus the total energy possessed by the entire neutron is

$$E_n = m_p c^2 + m_e c^2 + E_1 + V + E_2 \qquad (4-48)$$

This way we can find the mass of the neutron

$$\mathrm{m_n} = m_p + 0.00233 \times 10^{-27} = 1.67495 \times 10^{-27}(kg) \qquad (4-49)$$

The theoretical value of neutron mass is $1.67493 \times 10^{-27} kg$

It can be seen that the estimated value and the theoretical value are still relatively close.

4.5 Particle decay diagram

4.5.1 Some conventions

For the elementary particles at the bottom, because it is close to the virtual spacetime, it also means that using various detection techniques may interfere with the detected object, thus affecting the results of the experiment. This is also an idea to be explained by the principle of uncertainty.

If we can have a simpler way of describing the structure and behavior of microscopic particles, it will help us to have a deeper understanding of the microcosm.

The most common use in quantum field theory is the Feynman diagram. The Feynman diagram not only helps us to visually understand the interaction process of particles, but also can accurately calculate something that cannot be done by the abstract formulas.

Now through the virtual spacetime physics, we have a better understanding of the micro world. Therefore, it is a necessity to describe the structure of microscopic particles and the interaction between particles in some more specific way.

In fact, the internal structures of electrons, protons, and neutrons have been given in a very intuitive way in Figures 4-2, 4-3, and 4-4 of this chapter. Now let's expand it further and add some conventions so that we can handle more complex particle interactions and decay processes.

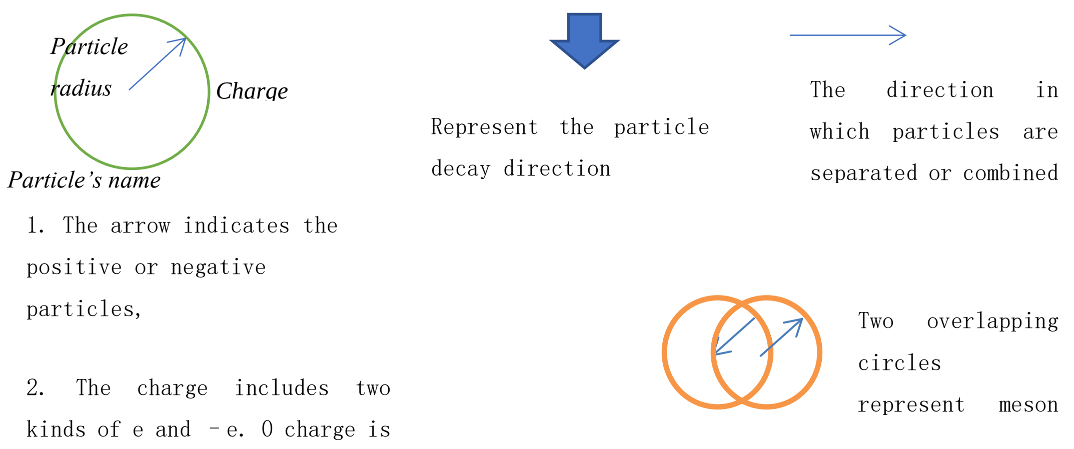

Fig. 4-5 Some conventions of diagram

Figure 4-5 shows some basic conventions for the new particle decay diagram.

Figure 4-6 shows some typical particle structures, including structural diagrams of electrons, anti-electron neutrinos, protons, and neutrons. Among them, electrons, neutrinos, and protons do not contain other particles. The composite particles such as neutrons contain a combination of other particles. However, these elementary particles inside the composite particles are not free elementary particles, and their electric field distribution and motion mode will be greatly changed. This is like a molecule made up of a variety of different ions.

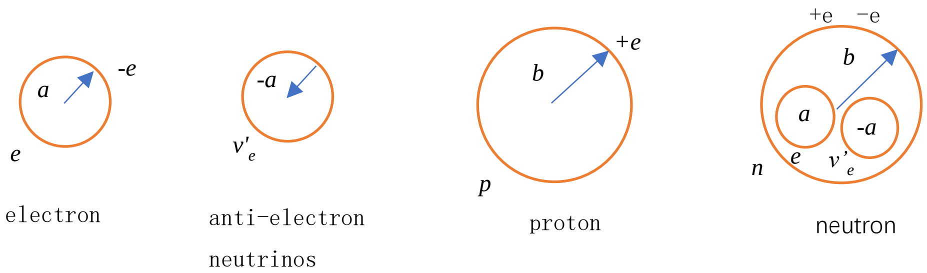

Fig. 4-6 The examples of four particles

4.5.2 Common particle interaction or decay process diagram

The most common decay process is the decay of neutrons. The half-life of a free neutron is very short, only a few minutes. Once the neutron decays, it will produce a proton, an electron, and an anti-electron neutrino. This is the β decay we are familiar with.

Figure 4-7 shows the process of neutron decay.

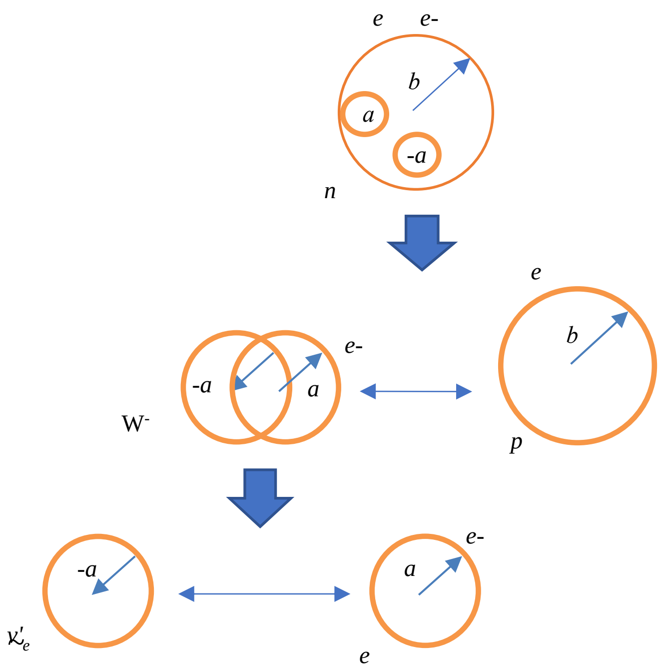

Fig. 4-7 The decay diagram of neutron

As can be seen from Figure 4-7, after a neutron decays, a proton and a W-boson are separated. The presence of the W^- boson is necessary because the electrons and anti-electron neutrinos in the neutron still exist in the form of composite particles, which represent the W^- boson.

After decay, the proton remains stable, but the W^- boson will continue to decay and split into electron and anti-electron neutrinos. At this point, the entire neutron decay process is completed.

Figure 4-8 shows the reaction process of anti-electron neutrinos and protons. During this reaction, the anti-electron neutrinos combine with protons to produce a pair of positive and negative electrons. Then the electrons and anti-electron neutrinos combine with protons to form neutrons, and the positrons are released.

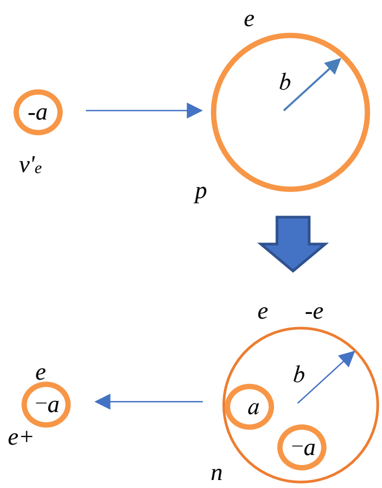

Fig. 4-8 The reaction of antineutrino and proton

If we want to understand the process by which neutrinos react with protons to produce positrons, we can also draw a more detailed diagram of Fig. 4-8, so that the process of Figure 4-9 can be obtained. The difference from Figure 4-8 is that after the antineutrino collides with the proton, a positron and a W^+ boson will be produced. The W^+ boson then combines with the proton to form a neutron. Considering that the energy of the W^+ boson is very high, it takes very high energy to produce this reaction, resulting in a very small reaction cross section throughout the reaction. This is also an important problem encountered in the current neutrino detection process.

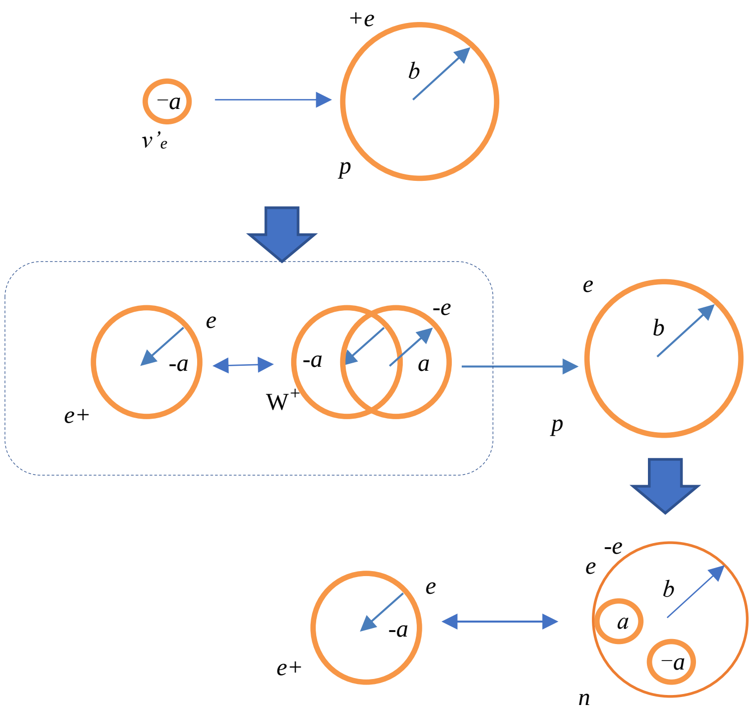

Fig. 4-9 Detailed diagram of the reaction of anti-electron neutrinos and protons

Fig. 4-10 shows the process of π meson decay. The π meson itself is formed by an anti-muon and a muon neutrino. When it decays, an anti-muon and a muon neutrino are released.

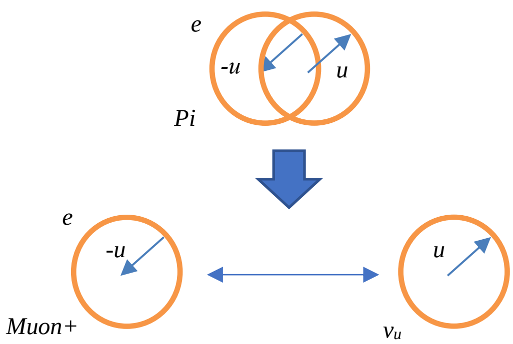

Fig.4-10 The diagram of π meson decay

In addition to these decay processes, particle decay diagrams can also be used to describe the elastic scattering process. For example, the elastic scattering of neutrino and electron, although the results did not produce new particles, but the graphical description helps us to obtain a more intuitive image of the weak interaction process.

Figure 4-11 shows an illustration of the electron and anti-electron neutrino elastic scattering process. It can be seen that after the end of the scattering, there are still anti-electron neutrino and electron, and no new particles appear. However, in the scattering process, the anti-electron neutrino and electron are combined to form a W^- intermediate boson. This also requires extremely high energy, so even with elastic scattering, the scattering cross section of neutrino and electron is very small. To use this method to detect neutrinos requires a very large device.

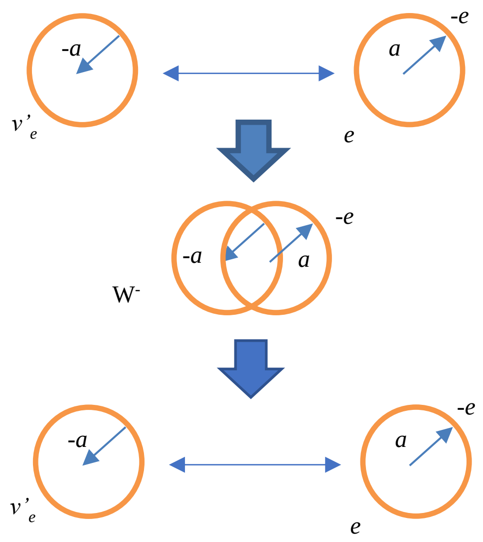

Fig. 4-11 The diagram of neutrino-electron scattering

4.5.3 Estimation of W boson mass

The W^- intermediate boson appears in Figures 4-7, 4-9, and 4-11. The mass of these bosons can also be approximated by the diagram of the W^- intermediate boson.

Figure 4-12 shows the decay process of the W^- boson separately. It can be seen that the W^- boson decay process is similar to the decay process of the meson. The result is an electron and an anti-electron neutrino.

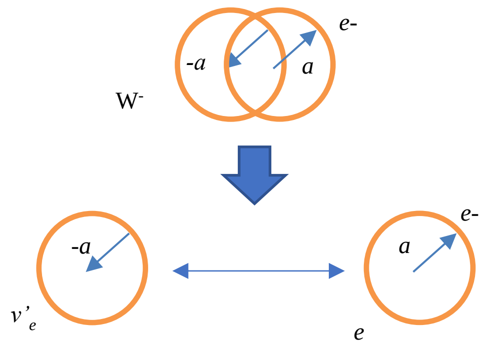

Fig. 4-12 Decay process of W^- boson

The uncertainty can be used to estimate the mass of the particle. First estimate the extent to which the virtual photon is located. It can be seen from Fig. 4-12 that the closest distances of the electrons and the anti-electron neutrinos constituting the W^- boson are coincident, and the farthest distance is tangent to the circumference of the two particles, so that the two particles occupy a minimum range of *2a*. The maximum is *4a*. For the sake of simplicity, here choose an average distance, ie *3a*.

Since there are two particles in it, each particle possesses a virtual photon that is confined to a range of approximately 3a. The energy of the virtual photon can be calculated according to the formula

$$h\nu = \frac{2\hbar c}{6a} = \frac{4}{3}\cdot\frac{m_p c^2}{2\alpha} = 85.7(GeV) \qquad (4-50)$$

Since the energy is much larger than the rest mass of the electrons, the electron and anti-electron neutrino stationary masses constituting the W^- boson are negligible, so it can be seen that the mass of the W^- boson is about 85.7 GeV.

The experimental mass of $W^{\pm}$ boson is 80.4GeV, and the theoretical estimation results are close to the experimental values.

5 The origin of gravitation

5.1 Physical effects of virtual spacetime

Just as imaginary numbers were originally proposed, virtual space and time is also considered by someone to have no practical physical meaning. However, with the deeper understanding of the nature of virtual space time, we can also find that the material and energy existing in virtual space and time can also produce observable physical effects in real spacetime.

5.1.1 The difference between observable and unobservable physical effects

Before discussing the physical effects of virtual spacetime, it is necessary to distinguish between observable and unobservable physical effects. In quantum mechanics, the wave function is unobservable, so after solving the Schrödinger equation, it is necessary to obtain a stationary state and then solve the eigenvalues so that the physical quantity that can be observed can be obtained.

Like quantum mechanics, it is assumed that there is virtual spacetime, but if virtual spacetime does not produce observable physical effects, then the meaning of existence is lost. Because only physical effects that can be observed are produced, experiments can be used to verify. And in the actual physical application, it also has the value of existence.

In order to understand how physical effects are observed in real spacetime under virtual spacetime conditions, and which physical quantities can be observed, Table 5-1 analyzes the wave functions, states, and physical quantities of quantum mechanics and uses them to compare with virtual spacetime physics, in order to provide a basis for observable physical effects in virtual spacetime.

Table 5-1 Comparison of observable physical quantities in quantum mechanics and virtual spacetime physics

Quantum mechanics	**virtual spacetime physics**
Wave function	virtual spacetime
Electric field, magnetic field	virtual photon
Physical quantity	mass, momentum, energy

In table 5-1, the wave function of quantum mechanics is an unmeasurable quantity, which corresponds to the virtual spacetime in virtual spacetime physics, because virtual spacetime is also a quantity that cannot be directly measured.

But through the combination of wave functions and operators, a physical state can be obtained, so that various quantum mechanical dynamics equations can be listed. In the corresponding virtual spacetime physics, virtual spacetime reflects its existence state mainly through the form of electric field, magnetic field and virtual photon. In this way, the dynamic equations of virtual spacetime physics can be listed, including Maxwell’s equations. However, different from the "state" of quantum mechanics, the electric field and magnetic field in the physics of virtual spacetime can be directly measured in real spacetime, including the direct interaction between electric field and magnetic field on charge. So, there are some differences.

Quantum mechanics’ final aim is to obtain observable physical quantities by solving various dynamic equations. However, virtual spacetime physics can obtain such physical quantities as momentum and energy through electric field, magnetic field and virtual photon, and explore the law of momentum conservation and energy conservation.

Therefore, virtual spacetime physics, like quantum mechanics and other theoretical physics disciplines, has its value of existence from the perspective of methodology. Although virtual spacetime cannot be measured, physical quantities that can be observed can be obtained in real spacetime through the forms of electric field, magnetic field and virtual photon, which also means that virtual spacetime physics has very important and promising application value.

5.1.2 Examples of virtual spacetime physical quantities that can be measured

1. Mass

As one of the most common physical quantities in real time, the origin of mass has always been a mystery.

Through Einstein's mass relation, the energy of a body's motion can be connected with its mass. As shown in formula (5-1).

$$m = \frac{m_0}{\sqrt{1 - {v_c}^2}} \qquad (5-1)$$

We can see that when something is moving, the mass of the object actually measured is going to be more than the rest mass of the object. This extra mass can be called "moving mass".

This is the first explanation of the origin of mass in physics. In other words, mass originates from energy.

The origin of mass from energy also has practical application value. In a nuclear reaction, for example, there is often a loss of mass, which results in the release of a lot of energy. It turns out that even the rest mass is formed by energy.

This raises a question. If the rest mass is also formed by energy, where does the energy that forms the rest mass come from? The formula (5-1) does not tell us the origin. With the assumption of virtual spacetime, we can reasonably speculate that if the energy of the rest mass comes from virtual spacetime, the energy of other dimensions can exist freely in the real spacetime without directly affecting the energy and momentum conservation of real spacetime. This can also be confirmed by another relativistic energy formula

$$\mathrm{E}^2 = {m_0}^2 c^4 + p^2 c^2 \qquad (5-2)$$

In quantum mechanics, this formula can be directly converted into the Klein-Gordon equation. However, this equation cannot solve the problem of positive electrons. Dirac improved it by dividing the equation into two parts in the form of an imaginary number, thus obtaining the famous Dirac equation. The positron solution of Dirac equation can be obtained and the phenomenon of electron spin can be explained successfully.

In fact, even in the framework of relativistic mechanics, formula (4-2) can be modified in imaginary form, so that we can obtain the complex form expressed by formula (4-3)

$$\widetilde{\mathrm{E}} = m_0 c^2 + ipc \qquad (5-3)$$

From the formula (4-3), it can be clearly seen that as one of the components of the energy, the rest mass m_0 and the other part of the energy pc possessed by the mass are located in different dimensions. The energy represented by pc is what we can measure in real spacetime through the conservation of momentum, and mass is an inherent property of objects. And the kinetic energy that we deal with in classical mechanics is a combination of two dimensions of energy.

To sum up, since the rest mass is also a form of energy and the energy represented by the rest mass is located in another dimension, we can assume that the energy of the rest mass comes from virtual spacetime. This is at least mathematically correct.

2. Gravity

Gravity is caused by mass. If the mass of an object is derived from the energy of virtual spacetime, then gravity is also derived from virtual spacetime.

The corresponding physical picture can be constructed as follows. If there is no mass, real spacetime is flat and isotropic.

However, as mentioned in the first chapter of this book, the microscopic world at the extremely small scale may also be virtual spacetime. So when a mass appears, it means that the flat and isotropic real spacetime is inserted with some form of energy, and the existence of this energy will be able to squeeze the surrounding space like an expansion screw, which will cause the space of real spacetime to bend and thus generate gravity.

The study of the nature of gravitation will help us to have a deeper understanding of the nature of spacetime.

3. Neutrinos

Neutrinos have been known for nearly a century. Direct observations of neutrinos were made decades ago. As experimental data on neutrinos continue to be mined, one thing that everyone agrees on is that neutrinos have a rest mass, even if that mass may be tiny.

Another puzzle is that neutrinos are always travelling at the speed of light. According to the relativistic mass energy relation (4-1), it can be found that if a particle has a rest mass, when the velocity of the particle is close to the speed of light, its moving mass will be very large. Therefore, a particle with a non-zero rest mass cannot have a velocity equal to the speed of light.

However, if neutrinos have no rest mass, it means that they cannot oscillate even within current high energy physics theories. This is not consistent with experimental facts. After all, neutrino oscillations are so pronounced, so large, that they can be easily detected in a sample size of several millionths of a billion.

If the existence of virtual spacetime is taken into account, neutrinos are a special kind of electromagnetic wave that spans two spacetime at the same time. Then the electric and magnetic field components of the same neutrino lie in real and virtual spacetime, respectively. So neutrinos, no matter how massive they are, do not affect the speed at which the electric field component of real spacetime travels. The reason is that although the magnetic field component of neutrinos in virtual spacetime represents the mass in real spacetime, it can run at the speed of light in virtual spacetime and is not subject to the limit of the kinetic energy to be considered in real spacetime.

5.1.3 Symmetry of two spacetime

If there is virtual spacetime, for example there is a symmetry problem. A simple way to think about it is that if there is a slight asymmetry between the two spacetime, it means that over time this asymmetry will be magnified, resulting in a complete asymmetry between the two spacetime. The problems caused by this complete asymmetry can be very serious. Because this will form two worlds with completely different development and change patterns, and finally cut off the connection between the two spacetime. There is, of course, a "multi-world" theory that might solve such problems. However, the virtual spacetime discussed in this paper may not involve such a "multi-world" problem.

To satisfy the symmetry of two spacetime means that they are always closely related. For example, the energy of virtual spacetime, that is, the mass measured in real spacetime is always associated with the momentum of real spacetime, and combined together to become the total energy measured in real spacetime. Neutrinos, on the other hand, always carry both components of the electromagnetic wave in real and virtual spacetime at the same time, and always travel at the speed of light.

Furthermore, an electron always corresponds to a magnetic monopole. That's probably why n is 2 in formula (2-23). After all, a Dirac string has only one, a Dirac string means it has only one electron, but it can produce two magnetic monopoles. If we take a double string, we can solve the symmetry problem by doubling the coefficients.

So, the best symmetry between two spacetime is that any object in real spacetime should have a corresponding object in virtual spacetime. They're kind of mirror images.

But the two spacetime are not completely symmetrical. Because if two spacetime are completely symmetric, it means that virtual spacetime is redundant, and it is impossible to produce meaningful physical phenomena in real spacetime.

The most basic asymmetry is the asymmetry between charge and magnetic charge. The magnetic charge of a monopole is about 137 times the corresponding real spacetime charge. And the reason for this asymmetry may involve many factors. There are limits to the laws of physics themselves, and perhaps to the limits of our present unit of measure. This needs to be further studied and supported by more experimental evidence.

There is also an interesting paradox to consider. We now measure the charge of the electron using the Millikan oil droplet experiment.

We now consider the symmetries of virtual and real spacetime. If real spacetime Millikan is using oil droplet experiment to measure the charge of electrons, then virtual spacetime should also have a mirror image of Millikan to measure the magnetic charge of magnetic monopole. That doesn't seem to be a problem.

However, Millikan of real spacetime wrote in the notebook that the charge of the electron is 1.60217... Coulomb, when the symmetry of the two spacetime might be challenged.

Because in real space and time, Millikan's experimental record book is also composed of various atoms and electrons, and corresponding atoms and magnetic monopoles can be found in virtual spacetime, but the information contained in the handwriting, namely 1.60217 Coulomb, is not affected by whether it is an electron or a magnetic monopole. This means that Millikan of virtual spacetime would see a magnetic monopole charge of 1.60217 coulombs, which seems incorrect. Because in the first chapter of the book it was deduced that the magnetic charge of a monopole should be about 137 times the electric charge of an electron. In other words, the "scientists" of virtual spacetime have come to a wrong conclusion.

Such a paradox may be caused by the fact that we regard virtual and real spacetime as two completely equal spacetime, rather than a relatively symmetric spacetime. Of course, we can't rule out that, for some reason, even in virtual spacetime, we can also draw the correct conclusion, such as the factors of unit measurement. That is, we can't tell which spacetime we are in any spacetime.

So, we're going to talk about the symmetry of virtual spacetime now, either as a purely mathematical treatment, or as a treatment that we haven't been able to deal with in order to get to a state where the two spacetime are completely equivalent.

5.2 Mass and energy

5.2.1 The origin of the problem

The question of mass has a long history, and the whole history of physics is really about the mass of this object. It has been known for more than a thousand years, since the time of ancient Greece, that the density of an object is determined by its mass divided by its volume. Aristotle connected mass with the speed at which an object moved, though he was wrong. Later Galileo corrected Aristotle's erroneous conclusion by proving experimentally that objects of different masses fall at the same speed. The determination of Newtonian mechanics means that for the first time mass is associated with gravity. Einstein's general theory of relativity points out that mass is the most fundamental cause of the curvature of space.

This shows the importance of the concept of mass in physics. As a result, after the Higgs field theory was proposed in the 20th century, people regarded the Higgs boson as a particle of god, because its nature lies in creating mass and solving the most fundamental problem that has puzzled human beings for thousands of years.

Of course, physical theory is only the result of human thinking, is a description of the tools of nature. How to describe a natural phenomenon, there are many ways to describe, there are many ways to achieve the purpose.

Virtual spacetime physics has its own way of describing the origin of mass.

5.2.2 The energy in virtual spacetime

Both real and virtual spacetime have energy. From the perspective of symmetry, the form of virtual spacetime energy should be the same as that of real spacetime.

For example, in real spacetime, a photon with a frequency of ν, its energy can be expressed as

$$\mathrm{E} = \mathrm{h\nu} = \frac{hc}{\lambda} = \frac{hc}{2\pi r} \qquad (5-4)$$

Where λ is the wavelength and r is the wavelength radius.

In the virtual space time, if there is such a photon whose frequency is also ν, it can also be expressed by (5-4). Only the photon, wavelength, and wavelength radius of the photon in the virtual spacetime are measured by the scale of the virtual spacetime. Therefore, the conversion of virtual and real spacetime energy requires a unit of transformation.

Considering the nature of the field, the real spacetime energy mainly exists in the form of electric field, and the virtual spacetime energy mainly exists in the form of magnetic field.

An electric field of a particle whose radius is r and charge is e uniformly distributed on the spherical surface in real time. The energy is

$$E = \frac{e^2}{8\pi\varepsilon r} = \frac{{q_e}^2}{8\pi r} \qquad (5-5)$$

The magnetic field formed in virtual spacetime by a particle with radius r, magnetic charge m, and uniform distribution on the sphere, whose energy is

$$E = \frac{m^2}{8\pi\mu r} = \frac{{q_m}^2}{8\pi r} \qquad (5-6)$$

Here q_e and q_m are generalized charge and generalized magnetic charge respectively.

Since the magnetic charge of a magnetic monopole is about 137 times that of an electron, it seems that its energy is 137 times at least in real spacetime. At the same time, the energy in the virtual spacetime (5-6) also takes into account the problem of the distance scale standard of the virtual spacetime. Because the 1 meter defined in real spacetime is not necessarily equal to 1 meter in virtual spacetime. Considering the boundary of the virtual and real spacetime in Chapter 4, it is also necessary to convert the length unit of the imaginary spacetime into a real spacetime length unit.

5.2.3 The actual value of the boundary between real and virtual spacetime

In chapter 1, we have solved the specific numerical problem of the boundary of virtual and real spacetime, that is, for the virtual spacetime in the superluminal region, the specific numerical value of the boundary is the speed of light, so this boundary is very easy to determine. The speed of light $c = 299792458 \mathrm{m/s}$

In chapter 4, the numerical values of the electromagnetic virtual and real spacetime boundary are determined. This is a numerical radius $r_0 \approx 2.10309 \times 10^{-16} m$. However, the so-called electromagnetic boundary of spacetime is derived from the phenomenon of spin superluminal particles. The problem of electron spin exceeding the speed of light has been noted for more than a century.

The virtual spacetime represented by the smaller microscopic world involves a parameter l_p, which is a very small length. If the radius of a particle in the real spacetime is smaller than l_p, it means that the particle has entered the virtual spacetime region. In real spacetime, the particle's radius is small enough that it is impossible to detect its size. However, since the length of virtual spacetime and the length of real spacetime are reciprocal to each other, the particle appears to be a very normal particle in virtual spacetime.

To determine the parameter l_p, it is necessary to assume that **the rest mass of the object is the energy of virtual spacetime**. Thus, the physical effect of virtual spacetime length in real spacetime can be obtained, and then the specific value of l_p can be determined.

5.3 gravity

5.3.1 Assumption of elastic spacetime

This book discusses the problem of spacetime, and the starting point of this book is the existence of a virtual spacetime corresponding to real space time. So, what is spacetime? This is a problem that has not been completely solved.

And of course, we did talk about some of the properties of spacetime when we talked about Newtonian mechanics and relativistic mechanics. The absolute view of spacetime in Newtonian mechanics, the relative view of space time in relativity. This does not answer the question of what is spacetime made of? Is the electric field? A magnetic field? The gravitational field? These are open questions.

The ancient Chinese assumed that space time were made up of two symbols, Yin and Yang, and that a binary algorithm could combine various substances.

The ancient Greek philosopher Plato argued that space time are made up of five basic cubes.

And we can see that whatever model is proposed, the goal is to figure out where our spacetime comes from and what its properties are.

This book does not attempt to solve the specific material of spacetime, but assumes that spacetime is an elastic substance. In this way, we can apply various elastic medium theories to deal with the relationship between mass, energy and spacetime.

So, is there a factual basis for this hypothesis? This is mainly based on the current human understanding of various physical laws from the summary.

The first is the Ether hypothesis. Although the introduction of the theory of relativity has made us completely abandon the concept of Ether. But the influence of this set of theories on physics still exists. That's because the theory tries to solve problems that modern physics can't. That's what spacetime is made of.

According to the Ether hypothesis, spacetime is made up of a series of special elastic substances, so that the propagation of electromagnetic fields such as photons has an elastic medium like mechanical waves. Some authors have also built models of various Ether elastic mediums that can solve some of the problems of electromagnetic field propagation, but when it comes to frame of reference transformations, they run into a dead end and are dealt a fatal blow by modern physics theories such as relativity.

In fact, given the theme of this book, it is easy to solve this relativistic problem if there is a virtual spacetime corresponding to real spacetime, because each mass is the center of a frame of reference, and as the distance from that center gets smaller and smaller, beyond a certain radius, you enter virtual spacetime. In virtual spacetime, it has the same physical laws as real spacetime, but the physical quantities such as length and the length of real spacetime are reciprocal to each other.

The idea that each mass is a center of reference does not affect the application of the Ether elastic spacetime model.

Due to the length of this book, it is not intended to discuss specifically the Etheric elastic structure of space and time. Those interested can find inspiration in the library's collection of physics books on the theory of the Ether.

5.3.2 Spherical symmetry spacetime

From the theory of general relativity, spacetime are closely related, so it involves the complex calculation of four-dimensional spacetime when dealing with some general relativity problems. This book is not intended to be entangled in unusually complex mathematical formulas, so choose a completely spherically symmetric, isotropic spacetime. Because of the spatiotemporality of a perfectly spherically symmetric structure, the solutions can be easier to obtain even in general relativity theory.

In this way, this section only needs to solve the problem of the origin of gravity relatively simply according to the existing theory of elastic mechanics and copying the relevant formula.

1. Spherical symmetric elastic mechanics solution

First we understand some of the basics of elastic mechanics.

For a spring that vibrates in only one direction, the characteristics describing the spring can be expressed by a coefficient of elasticity, the Hook coefficient k.

In order to deal with the problem of three-dimensional materials, elastic mechanics introduces four basic concepts of external force, stress, deformation and displacement. These nouns are easier to understand. External force refers to the force exerted on an elastic material, which can have multiple directions, different working areas, and the like. Stress is the reaction force of the material in response to external forces. Therefore, the stress corresponds to the so-called elastic force. Deformation refers to the degree of deformation of the material. The displacement corresponds to the positional movement distance of the entire material under the action of external force.

Although there are four basic concepts, when it comes to specific problems, the use of tensors will make the problem very complicated in terms of mathematical calculations. Therefore, the elastic mechanics must also make some basic provisions on the properties of the material. One of the most important rules is that the material must be homogeneous and isotropic. In this way, we do not need to specifically discuss the stress distribution in different directions.

Even so, the stress distribution of the material is divided into radial and tangential directions. The so-called radial stress, usually expressed by σ_R, refers to the elastic force generated along the radial direction.

The tangential stress is generally expressed by σ_τ, which reflects the elastic force generated by the tangential direction of the spherical surface. This can be understood with the expansion of a balloon. When blowing into the balloon, the radius of the balloon grows larger, which means that the balloon is subjected to radial forces and produces a counter-acting radial stress in the opposite direction. While the balloon becomes larger, the surface area is also increasing, which means that the balloon is also subjected to a spherical tangential force, and thus a reaction force in the tangential direction is generated.

Now we solve a simple ball symmetry problem based on the knowledge of elastic mechanics. As shown in Figure 5-1, for a spherical shell with an inner diameter “a” and an outer diameter “b”, if the internal pressure is p_i and the outer pressure of the spherical shell is p_o, the spherical shell can be calculated by the corresponding elastic mechanics method. The stress generated inside

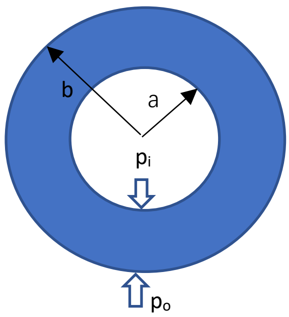

Fig. 5-1 Stress of spherical symmetrical materials

The corresponding differential equation for solving radial displacement is also relatively simple

$$\frac{d^2u_r}{dr^2}+\frac{2}{r}\frac{du_r}{dr}-\frac{2}{r^2}u_r=0 \qquad (5-7)$$

Where, the u_r represents the radial displacement, it is similar to the change in the radius of the balloon. This differential equation reacts to the relationship between the radial displacement of a point in a spherically symmetric material and the distance from that point to the center position. For isotropic spherical symmetry materials, only radial motion, the tangential displacement is 0, no calculation is needed.

This allows the radial displacement to be

$$u_r = Ar + \frac{B}{r^2} \quad (5-8)$$

Where A and B are constants.

The elastic geometric equations of the spherical symmetry problem are also relatively simple, and the radial and tangential geometric equations are

$$\varepsilon_r = \frac{du_r}{dr} = \frac{1}{E}(\sigma_r - 2\mu\sigma_\tau) \quad (5-9)$$

$$\varepsilon_\tau = \frac{u_r}{r} = \frac{1}{E}[(1-\mu)\sigma_\tau - 2\mu\sigma_r] \quad (5-10)$$

Where ε_r represents radial deformation, it is similar to the thinning of the balloon sphere. While ε_τ represents a tangential deformation, the sphere is stretched and expanded similar to the balloon becoming larger. E is the tensile modulus of elasticity, which can be compared to the amount of force required to blow the balloon, corresponding to the elastic coefficient of the one-dimensional resonator. μ is the coefficient of lateral contraction. This can be compared to the amount of contraction force of the balloon material itself.

Hooke's law is used here. The simplest form of Hooke's law is the one-dimensional harmonic oscillator. Although it is a three-dimensional space, it is relatively simple in form because it is spherically symmetrical.

This gives the relationship between radial stress and tangential stress and deformation.

$$\sigma_r = \frac{E}{(1+\mu)(1-2\mu)}[(1-\mu)\varepsilon_r + 2\mu\varepsilon_\tau] \quad (5-11)$$

$$\sigma_r = \frac{E}{(1+\mu)(1-2\mu)}(\varepsilon_\tau + \mu\varepsilon_r) \quad (5-12)$$

Then the radial deformation results are substituted into the physical equation, and the results of the two stress components are obtained as follows:

$$\sigma_r = \frac{E}{1-2\mu}A + \frac{2E}{1+\mu}\frac{B}{r^3} \quad (5-13)$$

$$\sigma_\tau = \frac{E}{1-2\mu}A + \frac{E}{1+\mu}\frac{B}{r^3} \quad (5-14)$$

It can be seen that the difference between the radial stress and the tangential stress is only the difference between the second term 2E and E.

And when b tends to infinity, p_0 is equal to 0, we can get a very simple boundary condition, namely

$$\sigma_r|_{r=a} = p_i \qquad (5-15)$$

$$\sigma_r|_{r=\infty} = 0 \qquad (5-16)$$

The result of obtaining the stress component is

$$\sigma_r = -\frac{a^3}{r^3}p_i \qquad (5-17)$$

$$\sigma_\tau = \frac{a^3}{2r^3}p_i \qquad (5-18)$$

When dealing with problems such as gravitation, we often use force directly, instead of stress and pressure equal to the area-related parameters, so here we set two parameters, namely the radial force distribution k_r and the tangential force distribution k_τ.

Since $4\pi a^2$ is the void sphere area extruded from the internal mass, and the p_i corresponds to the radial pressure of the material from inside to outside, the spherical area of radius r is $4\pi r^2$, so it can be calculated as follows

$$k_r = \frac{4\pi r^2\sigma_r}{4\pi a^2 p_i} = -\frac{a}{r} \qquad (5-19)$$

$$k_\tau = \frac{4\pi r^2\sigma_\tau}{4\pi a^2 p_i} = \frac{a}{2r} \qquad (5-20)$$

This reflects the variation of the force distribution of the elastic material in both the radial and tangential directions as a function of the radius r. A more specific derivation process can be found in the relevant elastic mechanics tutorial. Equation (5-19) (5-20) also reflects a completely isotropic material whose inside is extruded with a cavity of radius "a", and the material at the center of the cavity is r(r>a) , the bending of the material.

2. The spherical symmetry gravitational field solution in General relativity

Let us look at the relatively simple spherical symmetric gravitational field distribution in general relativity.

First look at the concept of curvature.

For two-dimensional space, the definition of curvature is very simple, that is, the angle divided by the arc length, as shown in Fig. 5-2.

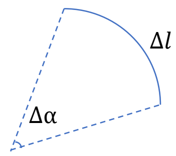

Fig. 5-2 Arc length and angle of the curve

The curvature corresponding to the curve in Fig. 5-2 is

$$R = \frac{\Delta\alpha}{\Delta l} \qquad (5-21)$$

For the four-dimensional spacetime, the calculation of the curvature involves the curvature tensor, and the specific compression of the mass to the spacetime is required to be solved by the general relative correlation theory.

General relativity deals with four-dimensional spacetime, including one-dimensional time and three-dimensional space. For flat and unconformed spacetime, we can directly use Minkowski four-dimensional spacetime to represent the length of a segment of spacetime.

$$ds^2 = -c^2dt^2 + dx^2 + dy^2 + dz^2 = det\left[\begin{pmatrix} -1 & & & \\ & 1 & & \\ & & 1 & \\ & & & 1 \end{pmatrix}\begin{pmatrix} c^2dt^2 & & & \\ & dx^2 & & \\ & & dy^2 & \\ & & & dz^2 \end{pmatrix}\right]$$

This representation is more complicated and can be represented by a simpler formula:

$$ds^2 = det(HX) \qquad (5-22)$$

Here H is a 4 × 4 matrix in which each element of the matrix is represented by $g_{\alpha\beta}$. The X matrix reflects four axes.

And the various components of spacetime t, x, y, z are also uniformly represented by x^{00}, x^{11}, x^{22}, x^{33}, or $x^{\alpha\beta}$, where α, β = 0, 1, 2, 3, then

$$ds^2 = \sum_{\alpha,\beta=0}^{3}\left(g_{\alpha\beta}x^{\alpha\beta}\right) \qquad (5-23)$$

If we use Einstein's convention, that is, the two variables with the same superscript letter are multiplied by default and they are automatically summed, the formula can also be expressed as a simpler form:

$$ds^2 = g_{\alpha\beta}dx^{\alpha}dx^{\beta} \qquad (5-24)$$

Where, the $g_{\alpha\beta}$ is the metric of spacetime, which reflects the basic characteristics of spacetime. For no mass impact, Minkowski spacetime is flat.

However, in general, when dealing with various spacetime problems, we mainly face the situation of spherical symmetry. Therefore, the metric in the spherical coordinates is more useful.

If converted to spherical coordinates, one of the line element expressions in the spherical coordinates is

$$\begin{aligned} ds^2 &= -c^2dt^2 + dr^2 + r^2d\theta^2 + r^2sin^2\theta d\varphi^2 \\ &= det\left[\begin{pmatrix} -1 & & & \\ & 1 & & \\ & & r^2 & \\ & & & r^2sin^2\theta \end{pmatrix}\begin{pmatrix} c^2dt^2 & & & \\ & dr^2 & & \\ & & d\theta^2 & \\ & & & d\varphi^2 \end{pmatrix}\right] \end{aligned} \qquad (5-25)$$

It can be seen that due to spherical symmetry, if α≠β, then

$$g_{\alpha\beta} = 0 \qquad (5-26)$$

If there is mass, the space time will be bent. At this time, the calculation formula of the line element length of the bending spacetime cannot be calculated by using the above formula. The specific calculation method can be obtained by solving the Einstein gravitational field equation.

For spherically isotropic space time, the simplest solution is the Schwarzschild spherical symmetry solution. The result of this solution is

$$\begin{aligned} ds^2 = &-\left(1-\frac{2Gm}{rc^2}\right)dt^2 + \left(1-\frac{2Gm}{rc^2}\right)^{-1}dr^2 + r^2d\theta^2 \\ &+ r^2sin^2\theta d\varphi^2 \end{aligned} \qquad (5-27)$$

From this solution, it is possible to obtain a case where an object of mass m causes a spatiotemporal curvature of the mass. The degree of spacetime bending is reflected by the metric $g_{\alpha\beta}$.

However, the specific situation of spacetime bending cannot be directly seen from the metric. Therefore, the degree of spacetime bending can be determined by solving the curvature of the curved spacetime, and then the magnitude of the gravitational force can be determined.

Unlike the curvature calculation of the arc, the structure and calculation of the curvature of the four-dimensional spacetime are much more complicated, so the curvature tensor is needed.

The formula for calculating the curvature tensor is determined by the following formula

$$R^{\alpha}_{\beta\gamma\mu} = -\frac{\partial\Gamma^{\alpha}_{\beta\gamma}}{\partial x^{\mu}} + \frac{\partial\Gamma^{\alpha}_{\beta\mu}}{\partial x^{\gamma}} - \Gamma^{\sigma}_{\beta\gamma}\Gamma^{\alpha}_{\sigma\mu} + \Gamma^{\sigma}_{\beta\mu}\Gamma^{\alpha}_{\sigma\gamma} \qquad (5-28)$$

The above formula is a formula for calculating the curvature tensor, and the superscript and subscript in the formula have better symmetry. If there are two identical upper and lower letters in one item, it means that this is a summation. In the result of the summation, the upper and lower letters will be eliminated.

$R^{\alpha}_{\beta\gamma\mu}$ is the curvature tensor, which corresponds to the series tensor of the α dimension in the curvature tensor. Finally, by summing, the superscript is lowered to obtain the specific value of a single element in the curvature tensor. .

$\Gamma^{\alpha}_{\beta\gamma}$ is called Christoffel symbol, and its specific value can be calculated using a metric. That is to say, whether it is flat or curved spacetime, as long as you know the metric of this kind of spacetime, you can calculate the Christoffel symbol. The curvature tensor can then be calculated by Christoffel symbol. It is finally determined that the specific physical characteristics of the spacetime, including the physical quantity such as the gravitational distribution, can be calculated.

The following formula is how to calculate Christoffel symbol using the metric.

$$\Gamma^{\alpha}_{\beta\gamma} = \frac{1}{2} g^{\alpha\sigma} \left(\frac{\partial g_{\gamma\sigma}}{\partial x^{\beta}} + \frac{\partial g_{\sigma\beta}}{\partial x^{\gamma}} - \frac{\partial g_{\beta\gamma}}{\partial x^{\sigma}} \right) \qquad (5-29)$$

It can be seen that this is also a very symmetrical formula. It is widely used in general relativity. Where $\Gamma^{\alpha}_{\beta\gamma}$ reflects the α-th dimension, and the β-line γ column Christoffel symbol.

The Christoffel symbol can be calculated by substituting the gravitational spacetime metrics in the Schwarzschild solution (5-27) into (5-29). Then, by substituting the result of Christoffel symbol into the calculation formula of curvature tensor (5-28), the curvature tensor can be obtained, and then the superscript α can be reduced to the subscript by the corresponding calculation method, and the curvature can be obtained. All components of the tensor $R_{\alpha\beta\gamma\mu}$

Due to the spherical symmetry, the curvature tensor in the Schwarzschild solution is relatively simple, and there are only six non-zero curvature tensor components, which are

$$\begin{cases} R_{trtr} = -\dfrac{2Gm}{r^3c^2} \\ R_{t\theta t\theta} = R_{t\varphi t\varphi} = \dfrac{Gm}{r^3c^2} \\ R_{\theta\varphi\theta\varphi} = \dfrac{2Gm}{r^3c^2} \\ R_{r\theta r\theta} = R_{r\varphi r\varphi} = -\dfrac{Gm}{r^3c^2} \end{cases} \qquad (5-30)$$

The subscripts of the curvature tensors correspond to the respective axes of the spherical coordinates.

Comparing the formula (5-19) (5-20) calculated by elastic mechanics with the curvature tensor (5-30) of the spherically symmetric spacetime calculated by general relativity, we can see the results of elastic mechanics and the general relativity theory are similar, which means that there is still a close relationship between the two. In addition, the formula (5-19) (5-20) has two results, but the two results differ only by a factor of two. There are also two results in equation (5-30), and the difference is also doubled. So we can guess the following relationship exists

$$a = \frac{2Gm}{c^2} \qquad (5-31)$$

In formula (5-31), G is the universal gravitational constant, and m is the mass of the object. The parameter “a” can be regarded as a cavity with a radius a formed by the energy from another spacetime. The original flat space, due to the squeeze of energy, causes the energy cavity to become a curved space time. In addition, it can be seen that “a” here is the Schwarzschild radius. This means that the curved spacetime squeezed out of the mass is outside the mass radius and is normal real spacetime. However, once it enters the mass radius, it means entering the virtual spacetime. This is consistent with the conclusion of the Schwarzschild Black Hole. If the conclusion of formula (5-31) is correct, it means that the black hole often involved in general relativity is the virtual spacetime discussed in this book.

In addition, it can be directly discussed from the perspective of four-dimensional elastic mechanics. Considering the squeezing effect of the mass on spacetime, the spacetime around the mass is bent. Unlike elastic mechanics, which only computes three-dimensional space, if four-dimensional spacetime is involved, that is, not only the radial deformation but also the influence of the time axis.

However, since the spacetime ball is symmetrical and isotropic, no matter what kind of mass, as long as it has spherical symmetry, the two coordinates of the spherical coordinates θ, φ will not be affected, because the curvature of spacetime is for these two angles. It is said that all the same way changes in all directions. In this way, only the influence of the radial direction r and the time axis t must be considered. This way the whole problem can be reduced to a two-dimensional plane problem.

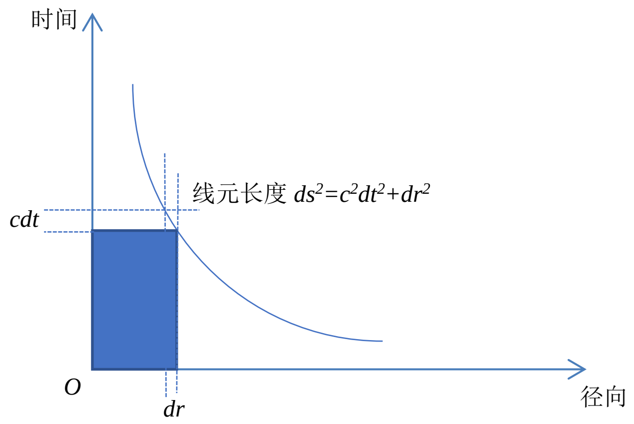

Fig. 5-3 Relationship between time and radial radius after spacetime is compressed

Considering the requirement of symmetry, even within the time and radial coordinate axes, the squeezing effect of mass on the spherically symmetric spacetime causes space and time deformation. If the space is compressed, the time will be stretched. As shown in Fign 5-3.

Therefore

$$(\mathrm{ct} + \mathrm{cdt})(\mathrm{r} - \mathrm{dr}) = \mathrm{ct} \cdot \mathrm{r} = \mathrm{Const.}$$

Since the change in the radial force distribution has been calculated by the formula (5-19) in addition to the change with r. It can also be seen from Fig. 5-3 that after the force causes the time axis and the radial deformation, a displacement will be generated on the time radial axis hyperbola, which is:

$$ds^2 = c^2dt^2 + dr^2 \qquad (5-32)$$

It can be seen that the difference in the force distribution of different radial positions will directly cause the change of the square of the line element. Therefore, the radial stress change causes the bending of the material to use the quadratic type, namely:

$$\delta r^2 = -\frac{a}{r}dr^2 \qquad (5-33)$$

That is to say, if the material area at the distance from the center of mass r is compressed by a/r, the length of the radial radius after compression is

$$dr'^2 = dr^2 + \delta r^2 = \left(1 - \frac{a}{r}\right)dr^2 \qquad (5-34)$$

Or

$$dr^2 = \left(1 - \frac{a}{r}\right)^{-1} dr'^2 \qquad (5-35)$$

Where dr' reflects the radial coordinate scale of the curved spacetime. Thus, in the curved spacetime, the r dimension metric after the spacetime is compressed and bent should be

$$g_{rr} = \left(1 - \frac{a}{r}\right)^{-1} \qquad (5-36)$$

For the four-dimensional spacetime, considering the symmetry of the time axis and the radial axis, the area after the radial compression will be stretched in the time axis. Consider two boundary conditions below.

When $r \to \infty$, the elastomer is close to the state in which the isotropic is not compressed, and this formula (5-34) is consistent.

And when r = a, then the radial space scale is 0, and the time scale will be infinite, the time will become very slow. This corresponds to the singularity of Schwarzschild's solution.

To satisfy this relationship, only the mutual reciprocal can be done. Therefore, the reciprocal relationship between the time axis and the radial axis is considered, and this relationship is consistent with the reciprocal relationship between the real spacetime and the virtual spacetime length. Therefore the timeline scale length is

$$c^2dt'^2 = \left(1 - \frac{a}{r}\right)^{-1} c^2dt^2 \qquad (5-37)$$

Or

$$c^2dt^2 = \left(1 - \frac{a}{r}\right) c^2dt'^2 \qquad (5-38)$$

Where dt' reflects the actual time axis scale of the curved spacetime. Then the time axis metric after the compression deformation should be:

$$g_{tt} = 1 - \frac{a}{r} \qquad (5-39)$$

Due to symmetry, the metrics of the two dimensions θ and φ are not affected. Therefore, the spacetime metric tensor after bending should be

$$G = \begin{pmatrix} 1 - \frac{a}{r} & & & \\ & \left(1 - \frac{a}{r}\right)^{-1} & & \\ & & r^2 & \\ & & & r^2 sin^2\theta \end{pmatrix} \qquad (5-40)$$

Comparing it with the Schwarzschild metric (5-27), it can also be seen

$$a = \frac{2Gm}{c^2} \qquad (5-31)$$

5.3.3 Mass squeezing of space

We have made a hypothesis in Section 5.2.3 that the rest mass of an object is the energy of the virtual spacetime. Virtual spacetime has a variety of forms of energy, including the magnetic charge energy formed by magnetic monopoles, and the energy of virtual spacetime photons. Considering that if the positive and negative charges of real spacetime electrons and protons always appear in pairs, the magnetic and magnetic monopole positive and negative magnetic charges of the virtual spacetime are also paired, so the energy form of the virtual spacetime is selected as the energy of the virtual photon as the rest mass reflected in the real spacetime.

Therefore, for a particle of mass m in a three-dimensional spatial reference system, the virtual photon energy corresponding to the virtual spacetime can be expressed as

$$\mathrm{m}c^2 = \frac{\hbar c}{r'} \qquad (5-40)$$

Where r' is the wavelength radius measured by the virtual spacetime, and the radius can be converted into the corresponding radius length in the three-dimensional space by using the conversion formula of the virtual and real spacetime length.

$$\mathrm{a} = \frac{{l_p}^2}{r'} \qquad (5-41)$$

Substituting the formula (5-41) into the formula (5-40), you can get

$$\mathrm{m}c^2 = \frac{\hbar a}{{l_p}^2} \qquad (5-42)$$

Substituting the formula (5-42) into the formula (5-31), eliminating the parameter “a”, can be obtained

$$l_p = \sqrt{\frac{2G\hbar}{c^3}} \qquad (5-43)$$

It can be seen that the formula for calculating the length of the formula (5-35) is basically the same, but the difference is $\sqrt{2}$ times. After all, Planck's length is only a rule in the theory of quantum gravity, and (5-43) can better unite the Planck length with the Schwarzschild radius. The Planck length here is derived.

Since Planck's length is the basis of the natural unit system and supported by strong theoretical and experimental data, it is possible to obtain basically consistent results, and it also reflects that the elastic spacetime model given here can be obtained well and supported by theoretical and experimental evidence.

The above calculation also shows that the radius “a” obtained by a mass extrusion spacetime is actually the wavelength radius of the mass in another spacetime (virtual spacetime). The wavelength radii of real spacetime and virtual spacetime are reciprocal, so the real spacetime “a” is proportional to the mass. Such a proportional relationship means that multiple static masses are clustered together and there is an additive relationship. That is, the size of gravity is proportional to the mass of the mass of the object.

At this point we can find that the origin of the gravitation of the book is completely consistent with the general theory of relativity, that is, the gravitation comes from the curvature of spacetime.

5.4 Electromagnetic interaction and gravity

Because electromagnetic interaction is very similar to gravitation, it is also a problem that people have been puzzled for nearly half a century. Therefore, after a new understanding of the origin of gravitation, we can try to explore the unity of electromagnetic interaction and gravitation.

5.4.1 Comparison of electromagnetic interaction and gravity

Through the discussion in Chapters 4 and 5, we now have a more complete picture of the electromagnetic and gravitational interactions based on virtual spacetime. So is it possible to unify electromagnetic interactions and gravitational interactions under a theoretical framework on this basis? This is a question worth exploring.

Here we first compare the two interactions.

1. Square inverse relationship

From the two formulas of calculating the interaction force, both are inversely proportional to each other. This shows that there is a very close relationship between the two.

However, the inverse square law of electromagnetic interaction exists only between the quantized charges. This also means that there is such a strict inverse square relationship for all charges that do not have quantization conditions. Although there are only quantized charges in the twol spacetimes, there is still a possibility of non-quantitative charges beyond the virtual and real spacetime range. If the electromagnetic interaction and the gravitational interaction are to be successfully agreed in a theoretical framework, this general condition must be considered.

Nevertheless, even for the quantized charge, it can strictly follow the inverse square relationship, and the relationship between the electric field and the magnetic field itself is not large, because in the bound state, the electric field or the magnetic field can form various relationships with the distance.

It seems that the square inverse relationship of electromagnetic interaction is mainly related to the characteristics of spacetime.

For gravitation, it is true for all square inverse of mass. Beginning with general relativity, people have realized that gravitation is the result of spacetime bending. This kind of gravitation is naturally closely related to the characteristics of spacetime.

2. Origin

From the analysis of Chapter 4, there is no direct connection between electromagnetic interaction and spacetime bending. Electromagnetic interactions are very strong, far exceeding gravitational forces, so electromagnetic interactions can produce very impressive effects in situations where there is no bending in spacetime.

Therefore, electromagnetic interactions are mainly derived from some important properties of the electromagnetic field itself. The reason why the square inverse ratio is closely related to the spatiotemporal characteristics should be closely related to the conservation of electric and magnetic fluxes existing in the virtual and real spacetime. Because the square inverse law is the basis for ensuring that the conservation law of the physical quantity related to the electric field

Gravitation is directly caused by the extrusion of mass and energy into space and time, so the gravitational force is directly related to the physical characteristics of the virtual and real spacetime itself. Gravitation reflects that the virtual and real spacetime is actually a material composed of elastic media, which has very similar properties to other elastic materials.

The relationship between electromagnetic field and gravitation can be described in Figure 5-4:

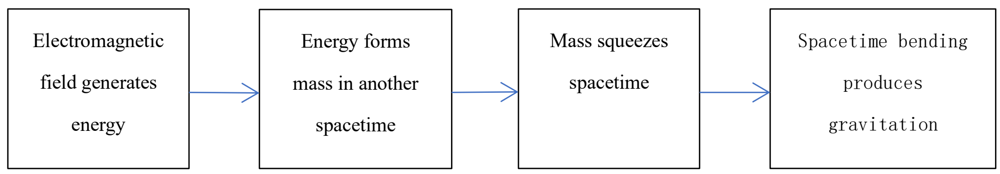

Fig. 5-4 Relationship between electromagnetic field and gravitation

3. Relationship with virtual spacetime

The radius of the particle that produces the electromagnetic interaction causes a change in the spin speed of the particle. If the radius of a particle is very small, such as electrons, in order to ensure that its spin is the same as a proton with a relatively large radius, the spin tangential velocity of the surface will exceed the speed of light. According to the division of virtual and real spacetime, it means that the electric field will enter virtual spacetime. The particle radius entering the virtual spacetime will not be detected in the real spacetime, which means that the internal structure of the particles with relatively small radius such as real spacetime electrons cannot be detected. For a relatively large radius particle such as a proton, since the surface spin speed is less than the speed of light, the surface will be in real spacetime, so the electromagnetic radius of the proton is detectable. At the same time, part of the internal structure of the proton can also be detected.

The mass that causes gravitation is mainly formed by the energy corresponding to the virtual spacetime particles. Since the boundary of the virtual and real spacetime in the microscopic world is very small, the squeeze effect of the relatively small-mass particles on spacetime is not obvious. However, this mass effect of particles has an additive effect, so when a sufficient number of particles are combined, a very powerful gravitational interaction will be produced.

From the theory of general relativity, for a relatively large object, the Schwarzschild radius is a virtual and real spacetime boundary. Beyond the Schwarzschild radius is a real spacetime that conforms to the various motion laws of and real spacetime. After entering the Schwarzschild radius, it means entering the virtual spacetime. In contrast to the electromagnetic interaction, the Schwarzschild radius is also the virtual and real spacetime boundary because of the superluminal speed. Within the Schwarzschild radius, photons cannot leap out and form so-called black holes.

5.4.2 Discussion on the method of unifying two interactions

It can be seen from the comparison of Section 5.4.1 that there is still a big difference between gravitation and electromagnetic interaction. The most crucial part is related to the characteristics of spacetime itself. What kind of material is spacetime? This determines the strength of the gravitational interaction.

The material composed of virtual and real spacetime seems to have no direct relationship with electromagnetic interaction, because the electromagnetic interaction does not affect the virtual and real spacetime material structure.

However, this does not completely negate the consistency between electromagnetic interaction and gravitation. Just as the interaction between strong, weak and electromagnetic interaction is the same. After all, the effects of the forces produced by the two interactions and the energy effects are the same. For example, the maglev train takes advantage of the interaction between the magnetic field and the gravitational interaction, and the train is floated up. The potential energy of the charged particles in the electric field and the potential energy of the mass in the gravitational field are the same, and they can be directly superimposed.

Since the two interactions are to be united, the ultimate goal is to use a scheme to represent the two interactions. This scheme can be an equation or multiple equations. Electromagnetic interactions and gravitation can be described in one dimension or in different dimensions of multiple equations.

It can be seen from Fig. 5-4 that an important physical quantity that can relate electromagnetic fields to gravitation is energy. If we can list a universal energy equation, we can express the gravitational and electromagnetic interactions in an equation.

In this energy equation, both the energy generated by the gravitational force caused by the spacetime bending and the energy generated by the electromagnetic interaction are included.

For example, it can be assumed that there is a universal energy function f(E), which can then be obtained by expanding the Taylor series

$$f(E) = f(E_0) + \left.\frac{df(E)}{dE}\right|_{E=E_0}(E - E_0) + \cdots \qquad (5-44)$$

It can be considered that $f(E_0)$ represents two time-space energy-dependent functional structures.

And $\left.\frac{df(E)}{dE}\right|_{E=E_0}(E-E_0)$ represents an electromagnetic interaction.

Then consider the energy generated by the electromagnetic interaction to squeeze the spacetime energy structure, thus producing gravitation. The same relationship as the electromagnetic interaction can also be obtained in form. I believe that we should be able to unify the gravitational and electromagnetic interactions in mathematics.

The difficulty with this approach is that space and time are four-dimensional, so the calculation of the tensor that should be used in the calculation process. What is the form of the specific $f(E_0)$ function? The mathematical forms now known include simple positive and negative proportions, exponential forms, logarithmic forms, and the like. Various forms should be used to try. Whether or not it can be successful will ultimately require experimentation.

6 Neutrinos

6.1 The model of neutrinos

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 knowledges are 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, Daya Bay neutrino detection device. 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 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.

There are two main neutrino models that are currently successful. One is the two-component model, 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. 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.

6.1.1 A special wave function solution

In section 2.3.2, a pair of solutions had been obtained.

$$\begin{cases} \mathrm{F} = F_0 e^{-k\cdot X-\frac{\omega}{c}y} e^{ik\cdot Y-i\frac{\omega}{c}x} \\ \mathrm{G} = G_0 e^{-k\cdot Y-\frac{\omega}{c}x} e^{ik\cdot X-i\frac{\omega}{c}y} \end{cases} \qquad (6-1)$$

In this solution, F represents the generalized electric field. G represents the generalized magnetic field. So it ensures that F and G are independent of the dielectric constant ε and 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 spacetime. The lowercase letter y indicates the generalized time, y=ct

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

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

From the results of formula (6-1), we can see that it is a special electromagnetic wave, that is, the electromagnetic wave is located in two different spacetimes at the same time. Unlike electromagnetic waves that correspond to well-known photon signals, the electromagnetic wave signals showing in formula (6-1) continuously exchange electric and magnetic field energy in real and virtual spacetimes.

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

However, the term $\mathrm{e}^{-\mathrm{ik}\cdot\mathrm{Y}-\mathrm{i}\frac{\omega}{c}x}$ is an oscillation function in virtual spacetime. Although the amplitude in the real spacetime 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 spacetime.

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 (6-1) 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 spacetime, and the velocity is the velocity of light. It is therefore difficult to generate electromagnetic interactions with other particles in the real spacetime. From the current knowledge, the closest particle is the neutrino.

In chapter 5, we can find that the energy of virtual spacetime can be measured in real spacetime. The energy in the virtual spacetime 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.

The electromagnetic wave that simultaneously spans two spacetimes as shown in Figure 6-1 is significantly different from the electromagnetic wave that propagates only in one spacetime. For example, the electromagnetic waves of a photon are only transmitted in real spacetime, and are affected by different media, and the propagation speed will also be different.

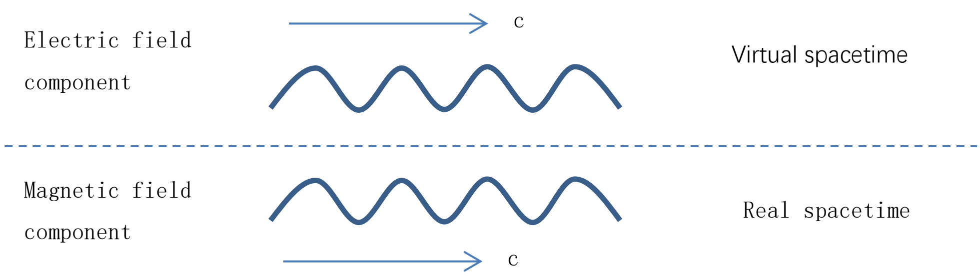

Fig. 6-1 The model of neutrinos' wave function

6.1.2 The velocity of neutrinos

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 spacetime will always be smaller than the theoretical value c.

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

However, due to the special electromagnetic wave represented by the formula (6-1), the wave will continuously oscillate across over the real and virtual spacetime. Although the electrical wave oscillation in equation (6-1) may have a problem of superluminal speed, the velocity of the magnetic wave that located in real spacetime 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.

As shown in Figure 6-2 , in order to ensure the integrity of these two spacetimes electromagnetic waves, the speed of neutrinos must be guaranteed to equal to c in any medium.

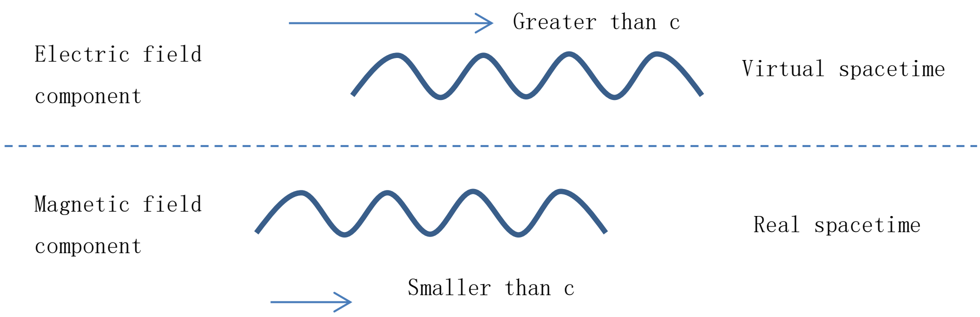

Fig. 2 The wave speed in different spacetimes is different due to some factors

From the data of various known particles, the closest to this property is the neutrino.

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, 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. 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.

6.1.3 The velocity difference between virtual and real spacetime

Since the electromagnetic wave's oscillation in the model is simultaneously happened across over virtual and real spacetime. The wave's velocity in real spacetime cannot exceed c, and the velocity in virtual spacetime 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 (6-1), and the corresponding electric wave in the virtual spacetime is affected by another factor, causing its velocity to be higher than the speed of light c (observed from the real spacetime reference system, unless otherwise stated, the same below). At this time, a problem may occur in the virtual and real spacetime 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 spacetime will generate a new electric wave in virtual spacetime. The new electric wave will decelerate the old one to the velocity of c. In correspondence, the acceleration electric wave in virtual spacetime will generate a new magnetic wave in real spacetime that will accelerate the old magnetic wave to the velocity of c.

If this special electromagnetic wave spanning two spacetimes represents a neutrino, it may have two states when interacting with other particles. That is the elastic change and inelastic change.

For the elastic change of the neutrino, if the energy of the neutrino does not change after the interaction, the neutrino will keep the energy and motion state and continue to run at the speed of light. As shown in Fig. 6-3.

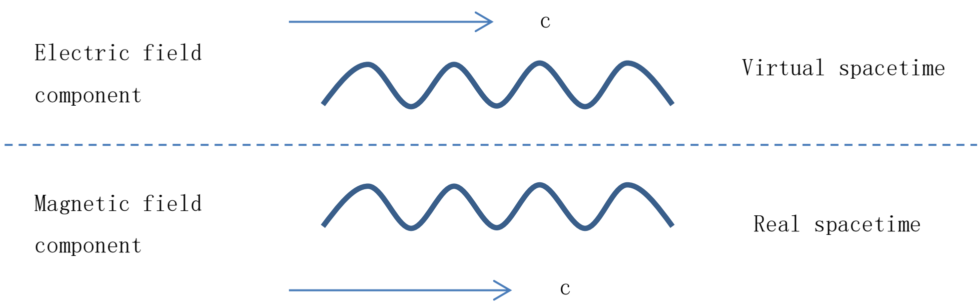

Fig. 6-3 The elastic change is restored.

Since the structure of the neutrino is very simple, if it is necessary to cause the change of the energy of the neutrino, the interaction of the neutrino with other particles must last for a sufficient time, so that the electromagnetic waves in the two spacetimes can have enough time to adjust its speed in order to regain the balance of speed of light.

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 spacetime. 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.

For inelastic changes, the energy of the neutrino changes after interacting with other particles, the energy of the neutrino increases or decreases, and the state of motion may also change. As shown in Fig. 6-4.

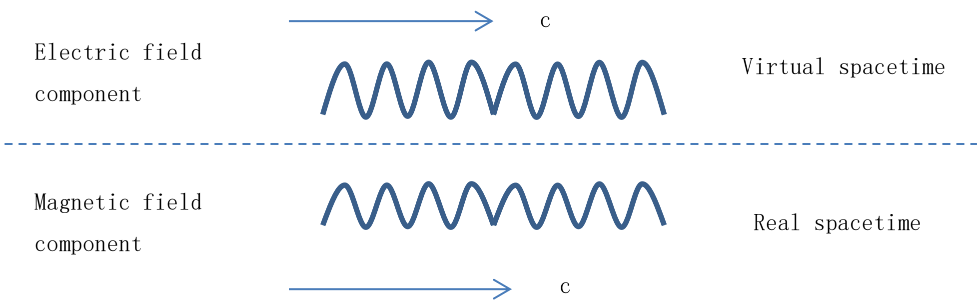

Fig. 6-4 Inelastic changes lead to changes in neutrino energy

6.1.4 Meaning of the decaying component

If the formula (6-1) 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 spacetime range and can be detected in real spacetime. 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.

6.1.5 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 spacetime, 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 (6-1), 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 spacetime, but the corresponding magnetic wave oscillation appears in the real spacetime. Whether it will bring some special characteristics for neutrinos, it needs further in-depth discussion and research.

6.2 Neutrino propagation characteristics

6.2.1 Neutrino dispersion

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.

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.

6.2.2 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.

6.2.3 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?

6.3 Interactions between neutrinos and other particles

6.3.1 Neutrino electron scattering

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 6-5.

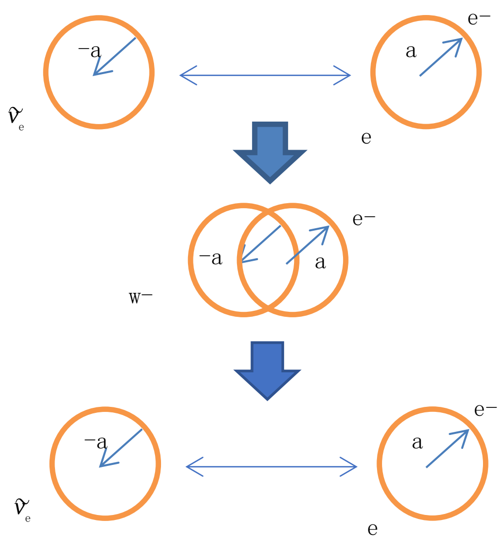

Fig. 6-5 The diagram of neutrino-electron scattering

It can be seen that in Figure 6-5, 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 6-6.

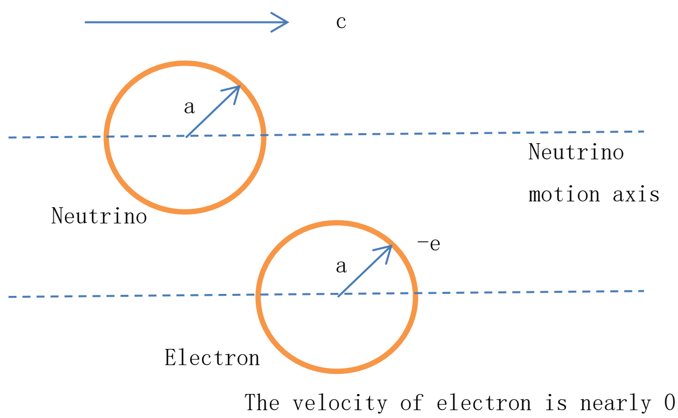

Fig. 6-6 Neutrinos and electrons are not on one axis

In the process shown in Fig. 6-6, the neutrino and electron collisions are not on one axis, the radius of the electron itself cannot block the neutrino's motion. The neutrino is very fast, and the electrons are almost stationary, which leads to the time of interaction between neutrino and the electronic electric field is very short. Although the electric field of the electron can affect the magnetic field component of the neutrino in the real space, it can only cause the elastic change of the neutrino energy at this time, after a slight disturbance. The wave function in different spacetimes is quickly restored to its original state. Therefore, electrons cannot cause changes in neutrino energy and motion state in this process.

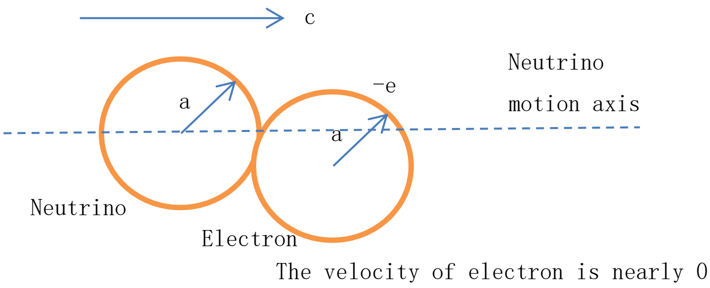

Fig. 6-7 Neutrinos and electrons are on one axis

Fig. 6-7 shows that the neutrinos and electrons are on the same axis, so that the neutrinos are blocked by electrons, and the interaction can be long enough, and the neutrino energy will produce inelastic changes. Energy can be transferred to the electrons.

Since the collision to change the neutrino energy must occur on the axis where neutrino and electron located, the probability of collision is very low. However, it is still not clear which angle neutrino collides with electron can cause the neutrino energy change. The theoretical uncertainty is still relatively large. Therefore, it is still difficult to calculate the scattering cross section. Perhaps it can be explored in further research.

6.3.2 Inelastic scattering of antineutrino and proton

Another common method of neutrino detection is the use of inelastic scattering of antineutrinos and proton. This neutron scattering process produces a neutron and a positron. Figure 6-8 shows the entire reaction process.

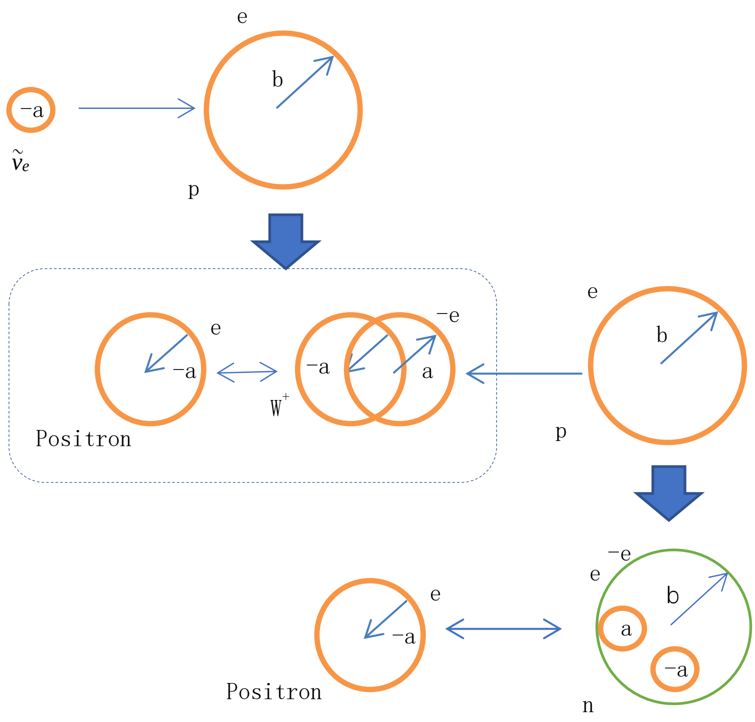

Figure 4. The reaction of antineutrino and proton

During the reaction shown in Figure 6-8, 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.

6.3.3 Elastic scattering diagram of neutrino and proton

Besides the elastic scattering, neutrinos and protons may undergo elastic scattering. The specific process can be analyzed by particle decay diagram shown in figure 6-9. 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.

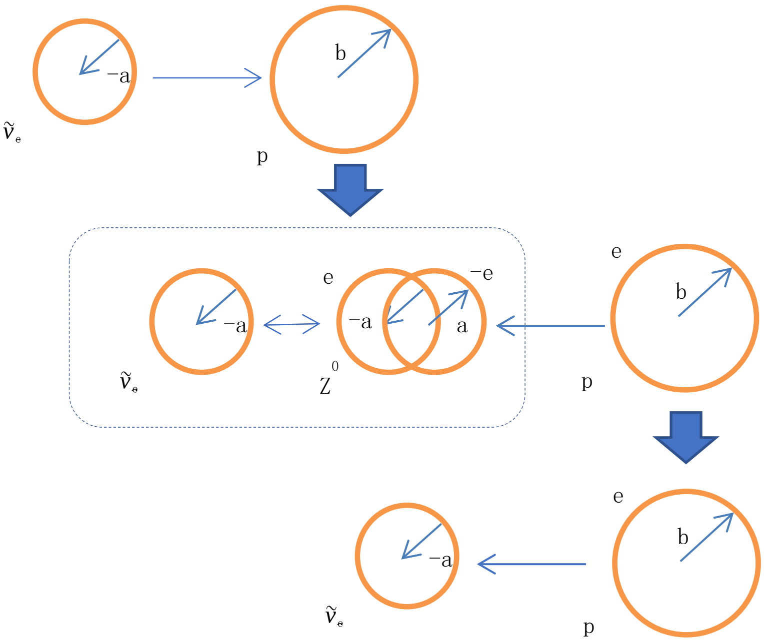

Fig. 6-9. The elastic scatting between neutrino and proton

6.3.4 Interaction between neutrinos

Since all neutrinos are at the same speed, the interaction between neutrinos is stronger, which may also reflect that neutrinos may be a less stable particle. It may also be the reason why one type of neutrino can be changed into another type of neutrino in the propagation process.

The interaction between neutrinos can refer to the interaction between photon and neutrino. The interaction between neutrinos will lead to multi-effects such as neutrino dispersion and frequency shift and etc. However, due to the lack of efficient and sensitive neutrino detection devices, more experimental data and theoretical support are needed to understand more details of the interaction between neutrinos. Perhaps after we have a deeper understanding of photon neutrino interactions, the interaction between neutrinos will lead to a more complete solution.

6.3.5 Interactions between neutrino and photon

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 spacetime field or magnetic field part. However, if it does not interact with the virtual spacetime 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 spacetime. According to the discussion in Section 2.3 of this paper, the photon can still interact with the electromagnetic field part of the real spacetime, 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.

The interactions between neutrino and photon has a remarkable feature, that is, the speed of photon is basically the same as that of neutrinos, so that if they interact, they can last for a long time, thus making this interaction effect becomes more apparent.

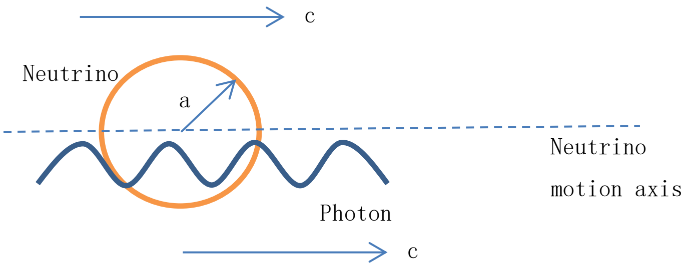

Fig. 6-10 Interaction between neutrino and photon

Fig. 6-10 shows an illustration of the interaction between neutrino and photon. Since both neutrino and photon are at speed c, the electromagnetic field components of neutrino and photon can interact for a long time. Even though the neutrino's inertia is relatively large due to the special structure of the neutrino itself, a long enough interaction will cause a change in the neutrino energy, which in turn leads to a change in photon energy.

If such an analysis is correct, it is indicated that when photon neutrino interaction effects are used to detect neutrinos, photons ray and neutrinos beam should be placed in the same direction of motion as much as possible. That is, the collision angle between the neutrino and the photon should be as small as possible.

However, the energy exchange between the neutrino and the photon will eventually reach an equilibrium state. Therefore, if the motion direction of the neutrino and the photon are completely in a straight line, the energy of the neutrino and the photon will eventually reach equilibrium, and the energy will no longer be exchanged after enough time. Therefore, it is necessary to consider how a photon can continue to interact with other neutrinos once a single neutrino and photon reach an energy balance, so that a more pronounced photon frequency shift effect can be produced.

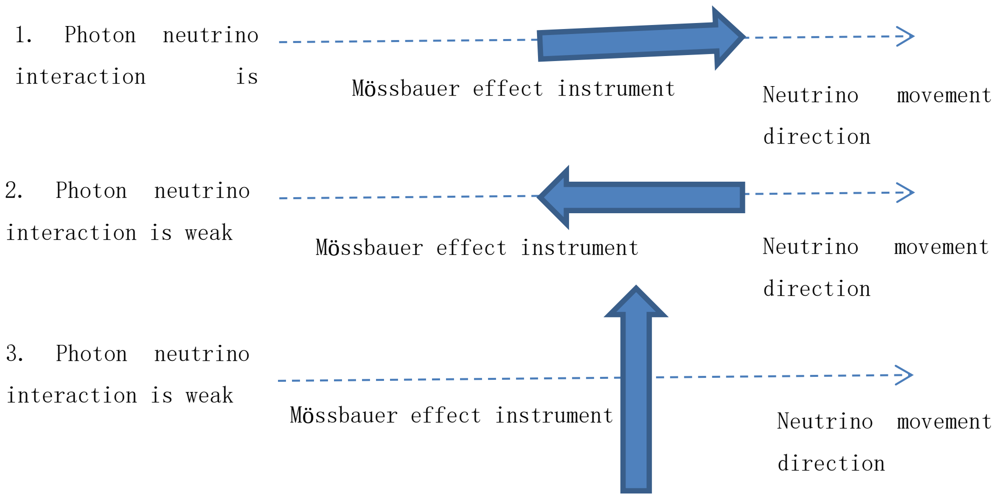

Fig. 6-11 Effect of the direction of the Mössbauer effect instrument on the detection (The direction of the large arrow of the Mossbauer effect instrument in the figure indicates the direction of the gamma ray emission from the source)

Fig. 6-11 shows the effect of the placement of the Mössbauer effect instrument on the intensity of the photon neutrino interaction. It can be seen from the figure that the effect of photon neutrino interaction is most obvious when the direction of neutrino movement is consistent with the direction of the gamma ray emitted by the source in the Mössbauer effect instrument. Under other conditions, the effects of these interactions will be weaker.

If such an effect exists, the experiment used to verify the interaction of the photon with the neutrino can be facilitated by measuring the angle of the vertical direction of the Mössbauer effect instrument when measures the gravitational redshift. The specific effect of the neutrino photon interaction can be obtained by the changes of the red shift of the gamma ray in different angles and then subtracting the red shift of the gravitational force.

Such a scheme can effectively eliminate systematic errors caused by various factors such as temperature since it is measured at the same place and at the same time. Fig. 6-12 shows such a measurement process. When the gamma photon's travel direction is consistent with the solar neutrino, the measured red shift is larger. In the second case in the figure, the gamma photon's direction has a larger angle with the sun neutrino's movement direction, the redshift will be smaller.

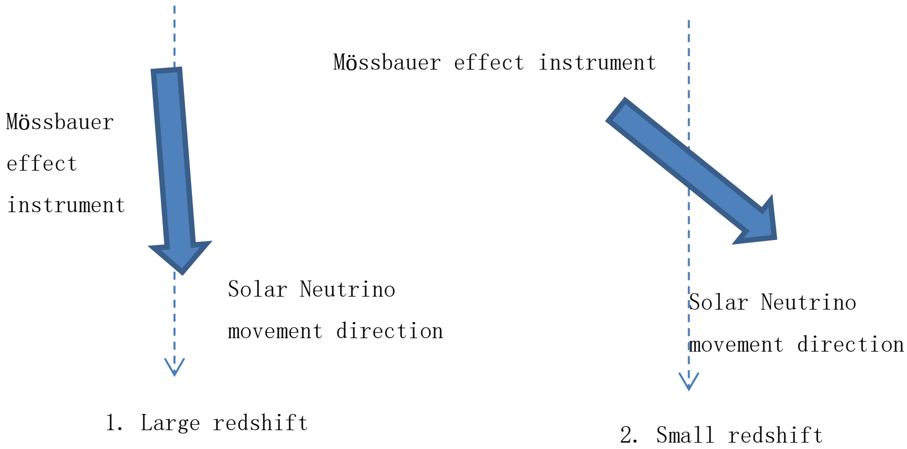

Fig.6-12 Detecting the effect of solar neutrinos on photon frequency shift (The direction of the large arrow of the Mossbauer effect instrument in the figure indicates the direction of the gamma ray emission from the source)

6.4 Some important experimental support

6.4.1 Some phenomenon that may connect with neutrino photon interactions

The interaction between neutrinos and photons is also based on the following phenomenon:

1. The existing theoretical analysis shows that neutrinos and photons can interact. It is generally believed that after the boson Z^0 releases a neutrino, the neutrino can release a photon during the flight. The process by which neutrinos release photons does not require intermediate bosons.

2. Neutrino oscillation. We can of course use the superposition of the three mass eigenstates of neutrinos to illustrate neutrino oscillations. However, the hypothesis that such neutrinos have static mass is contradictory to the special relativity theory. There is currently not enough evidence to prove that there is any problem with the special relativity theory, and there is not enough evidence to prove that the speed of neutrinos is lower than the speed of light or higher than the speed of light. Therefore, I would rather use the dispersion phenomenon of neutrinos to explain the oscillation of neutrinos [11]. In view of the fact that neutrinos do not interact with other substances, one reason for the neutrino's dispersion is that neutrinos interact with photons.

3. The number of neutrinos in the universe. According to the standard model theory, neutrinos do not interact electromagnetically with other substances, and the cross-section of weak interactions is very small, so neutrinos are difficult to disappear once they are produced. Another fact we know is that there are many reactions in the universe that can continuously produce a large number of

neutrinos. This means that the neutrinos in the universe will accumulate more and more until the entire universe is completely filled with neutrinos. However, the neutrinos we can detect now mainly come from nuclear fusion inside the sun and neutrinos produced by the cosmic high-energy particles reacting in the atmosphere. The number of neutrinos that originate in other parts of the universe is very small. This shows that neutrinos may not be as stable as we think, and they are easy to produce and easily disappear through some kind of interaction.

4. Red shift of the galaxies' spectrum. According to the interpretation of the existing big bang theory, the reason for the red shift of the galaxy's spectrum is that these galaxies are accelerating away from the earth. Due to the Doppler effect of light waves or spatial expansion, the observation of these light frequencies on the Earth reveals a red shift. However, there are still many unsatisfactory points in these explanations. For example, according to Hubble's law, the farther away from the Earth, the faster the planet leaves. The galaxies that have been observed to be about 14 billion light-years away from Earth are now close to the speed of light. If it is a little further, or if it accelerate for many years, isn't it faster than the speed of light? Believe that the farthest galaxy we can observe now should not be the edge of the universe.

Even in the case of a curved universe, the galaxies that are farther away from the Earth should not appear to move away from the faster. This is like the effect of the diffusion motion of an object on a sphere.

Therefore, other models that explain the phenomenon of redshift of this galaxy spectrum are also very instructive and important.

In the previous article, I thought that this redshift should be caused by the light emitted by the galaxies interacting with the neutrinos in the universe, resulting in the loss of energy of the photons and redshift. This is a good explanation of why the farther away from the Earth, the greater the redshift.

So it can be seen that interaction between photons and neutrinos has been gotten a certain degree of recognition.

6.4.2 Neutrino photon interaction in gravitational redshift detection

1、Two famous gravitational redshift experiments

One of the solutions in the process of gravitational redshift experiment is to use the Mossbauer effect to detect the frequency shift caused by the light emitted upward from the ground or the light emitted from the downward to the ground. Because the Mossbauer effect detects the frequency shift of the artificial ray in the earth, it is also affected by the neutrino emitted by the sun. Therefore, analyzing the systematic errors in these gravitational redshift experiments can obtain important evidence for neutrino photon interactions.

There are two famous important experiments that use the Mossbauer effect to detect gravitational redshift. They are experiments conducted by Pound in 1960. The data from this experiment indicates that there is a large systematic error that causes a red shift phenomenon whether the gamma ray that is radiated from the top of the tower or the gamma ray that radiates from the ground. In addition, from the results of the experiment, the redshift result of the sun oblique at 5 or 6 o'clock in the afternoon is also weaker than the noon or midnight which neutrinos emitter from sun are along with the direction of the Mössbauer effect detector.

However, the gamma ray frequency used in the Pound's experiment is lower, and the accuracy of the instrument is lower, so there may be more systematic errors leading to these results.

In 1992, Potzel also used the Mössbauer effect to measure the gravitational redshift, which improved a lot. In addition, Potzel uses a Mössbauer effect detector that is fully controlled in the laboratory, and controls the various disturbance factors more accurately than the 21-meter-high tower exposed to the air. Unlike the Pound experiment, Potzel also uses a reference absorber for comparison, and with other measures, it can be very effective in reducing the existence of systematic errors. Therefore, the Potzel experimental data is very reliable.

2、The analysis of Potzel's experimental data

Unlike Pound's 1960 experiment, Potzel uses a higher energy ^{67}Zn, and the gamma ray energy emitted by the source can reach 93.31kev, so the accuracy can be increased by about 6 times.

Another feature of Pound's experiment is the use of a reference absorber that is close to the source as the center of the frequency shift, which can better reduce the systematic error in the experiment. The existence of systematic errors that cannot be explained by existing theories has also been discovered.

First, we do not consider the existence of systematic errors. Since the reference absorber and the experimental absorber are at different distances from the source, the reference absorber is very close to the source but still has a small distance. Therefore, when the experimental device is reversed from the test redshift state to the test blue shift state, there is still a small movement of the reference absorber. The errors produced by this device state change were ignored in Potzel's experiments. However, considering the red shift or blue shift phenomenon caused by gravity, the influence of other factors on the spectrum, this time the frequency shift of this part of the spectrum can be considered. Of course, since the experiment is not designed to test such frequency shifts, the relative error of the obtained data will be relatively large, but its magnitude is still have some reference value.

Table 6-1 ^{67}Zn Mössbauer effect measurement data (Potzel 1992)

Frequency shift type	Length (mm)	Equivalent gravity acceleration g(m/s2)	Errors
R	1010	12.1	0.4
R	1010	11.9	0.4
R	1010	12.8	0.6
R	1010	12.6	0.6

R	1005	11.6	0.5
R	985	12.9	0.4
R	1039	11.5	0.3
R	1039	11.7	0.4
R	1039	11.4	0.8
B	1039	11.3	0.5

In Table 6-1, the frequency shift type R represents a redshift and B represents a blue shift, and the length represents the distance between the experimental absorber and the reference absorber. Here, three data of 0.58 m length are deleted, because the difference in the length of the red and blue shift is large, and it is not suitable for comparison. The equivalent gravity acceleration represents the measured frequency shift, which is equivalent to the frequency shift caused by the theoretical calculation of the acceleration.

According to the data in Table 1, the average equivalent gravity acceleration corresponding to the red shift can be calculated to be 12.1±0.5.

There is only one blue shift data, and the corresponding equivalent gravity acceleration is 11.3±0.5.

This can be calculated that there is an equivalent acceleration difference between the red and blue shifts of 0.8 ± 0.5

Theoretical calculations should not have such a difference, so this difference reflects the other non-gravitational factors. The sign is positive, indicating that this extra frequency shift is a redshift effect.

Calculated according to the standard gravity acceleration of 9.8, this additional redshift effect is approximately 4% of the gravitational redshift data per meter on the earth.

Second, consider the extra redshift caused by systematic errors that cannot be explained by the Potzel data itself.

In their article, Potzel carefully analyzed various possible factors that may cause these extra redshift data. After many exclusions, the data still has 6% error, and this error cannot be eliminated by technical means.

The red shift that occurs with this systematic error is different from the previous 4% additional red shift, which is the absolute error that occurs in the experimental equipment. The previous 4% extra redshift is the relative error of the data after the experimental device is inverted. Both data should be used to indicate the extra redshift that cannot be explained during the experiment. Therefore, an average redshift value of about 5% is taken here. This means that at least 5% of the extra redshifts in Potzel's experiments cannot be explained by existing theories. I assume here that there is an interaction of neutrinos with photons, and most of these extra redshifts should be caused by this photon neutrino interaction. In this way, the redshift caused by the photon neutrino interaction can be estimated to be approximately

$$\Delta z_b = \frac{\Delta f(b)}{f} \times 5\% = \frac{g}{c^2} \times 5\% = 5.5 \times 10^{-18} \qquad (6-2)$$

Considering that the source energy of the Potzel experiment is 6.48 times that of the Pound experimental source, the accuracy will be higher, so this data is more accurate than the estimation in paper [2]. Although the frequency shift is small, it can still be measured within the accuracy of the existing Mössbauer experiment. If we can increase the distance between the source and the absorber, use a higher energy source, and measure in a higher concentration of neutrino environment, the results may be more accurate.

6.4.3 Extra solar redshift at the limb

The redshift at the limb of the sun disk is also an important piece of evidence because of the existence of gravitational redshifts and the existence of additional redshifts that cannot be explained by other known factors. If the photon neutrino interaction can be used to successfully interpret this part of the extra redshift, it will help to confirm the intensity of the photon neutrino interaction and the accuracy of the experimental setup on the earth.

Pecker proposed in 1972 that there might be an interaction between photon and photon. If such an interaction exists, it can be used to explain the solar redshift at the limb.

The solar redshift at the limb is part of the solar spectrum's Limb Effect. The limb effect of the solar spectrum refers to the phenomenon that the solar spectrum gradually redshifts from the center of the solar disk to the limb. The more you reach the limb, the greater the redshift. This cannot be completely explained by gravitational redshift.

For the interior of the disk, the factors involved are relatively complex, including gravitational redshift, including the frequency shift caused by ionized gas, Doppler Effect, and rotation effect. However, at the limb, it is completely unaffected by these other factors, that is, if there is a known theory that can explain the solar redshift at the limb, then this theory is the gravitational redshift.

However, Pecker pointed out that the actual situation is that the solar redshift at limb is larger than the gravitational redshift calculated according to the general theory of relativity, which is about $2 \times 10^{-7} < \Delta z < 10^{-6}$ and the gravitational redshift calculated by relativity is about $z_g = 2.12 \times 10^{-6}$

Pecker hopes to explain this extra redshift by the mechanism of photon-photon interaction. However, their calculations show that the effect of photon-photon interaction may be much smaller than the calculated data of gravitational redshift. Cohen also pointed out in 1973 that based on some past experimental data, the photon-photon interaction is at least three orders of magnitude smaller than the gravitational redshift.

Therefore, the effect of photon-photon interaction on the solar redshift at the limb can be basically ruled out.

Here we consider the existence of photon-neutrino interactions. Using the results of the Potzel experiment, we can do the following analysis:

First, simply estimate it.

According to Potzel's experimental results, the extra redshift is about 5% of the gravitational redshift. According to this calculation, the 5% solar redshift value at the limb is about $\Delta z = 1.6 \times 10^{-7}$. This is roughly the same as the magnitude of the extra solar redshift at the limb.

Secondly, I also do a specific calculation.

Suppose the concentration of solar neutrinos on the surface of the earth is n(b)/m3, the radius of the sun is a, and the distance from the sun to the earth is b. Assuming that the total amount of neutrinos is constant, the solar surface neutrinos can be easily calculated. The concentration is

$$\mathrm{n(a)} = \mathrm{n(b)}\left(\frac{b}{a}\right)^2 \qquad (6-3)$$

The distance from the sun to r, where the concentration of the neutrino is

$$\mathrm{n(r)} = \mathrm{n}\left(\frac{b}{r}\right)^2 \qquad (6-4)$$

The unit length frequency shift caused by the interaction of neutrinos with photons with a concentration of n(b) on the surface of the Earth's surface is

$$\Delta z_b = \frac{\Delta \mathrm{f(b)}}{f} = \frac{\mathrm{kn(b)}}{f} \qquad (6-5)$$

Where k is a constant.

Then the unit length frequency shift caused by the photon neutrino interaction at the distance r from solar is

$$\Delta z_r = \frac{\Delta \mathrm{f(r)}}{f} = \frac{\mathrm{kn(b)}}{f}\left(\frac{b}{r}\right)^2 = \Delta \mathrm{z}_b\left(\frac{b}{r}\right)^2 \qquad (6-6)$$

Converting to the integral form gives the total energy lost by the photon from the limb of the solar disk to the surface of the Earth, i.e. the total redshift frequency of the spectrum

$$\Delta \mathrm{z} = \frac{\Delta \mathrm{f}}{f} = \int_a^b \frac{\mathrm{kn(b)}}{f}\left(\frac{b}{r}\right)^2 dr \qquad (6-7)$$

Substituting the solar radius and the distance from the sun to the Earth, and assuming that the photon passes through the path to continue to interact with all neutrinos, plus the upper limit of the redshift based on the Potzel experimental data, the total frequency shift can be calculated as

$$\Delta z = \frac{\Delta f}{f} = \Delta z_b \int_a^b \left(\frac{b}{r}\right)^2 dr = 1.65 \times 10^{-4} \qquad (6-8)$$

It can be noted that the frequency shift is too large, and is two orders of magnitude of the gravitational red shift. In fact, the energy loss of photons is not so much. There are two possible reasons for this:

1. Since this paper analyzes the Potzel experimental data to obtain a redshift upper limit, the red shift caused by the photon neutrino interaction is not as large as the redshift data that cannot be explained in the Potzel experiment. Nevertheless, the calculations also show that photon neutrino interaction is an important reason for causing additional red shift.

2. Photons can interact with solar-emitting neutrinos, but the number of interactions is not that much. There is a relationship between the actual number of neutrinos and the number of effective neutrinos that can interact with photons.

We consider the question of the number of effective neutrinos here.

Since neutrinos and solar photons are emitted simultaneously, the angle between the neutrino and the photon becomes very small at a position away from the sun.

Here is the assumption that one photon can only interact with the one neutrino in one time.

Considering that the photon itself has a wavelength, the neutrino will always interact with the photon in this wavelength range of the photon and in the direction of the photon flight. Therefore, if the collision angle of the neutrino and the photon is very small, it is very For a long time, although the number of neutrinos encountered in the path of photon travel is large, many other neutrinos do not interact with the photon.

To solve this problem, a concept of collision length is introduced here. That is, if one neutrino runs within a certain length and is likely to collide with one photon continuously, this length is called the collision length of the neutrino photon. As shown in Figure 6-13.

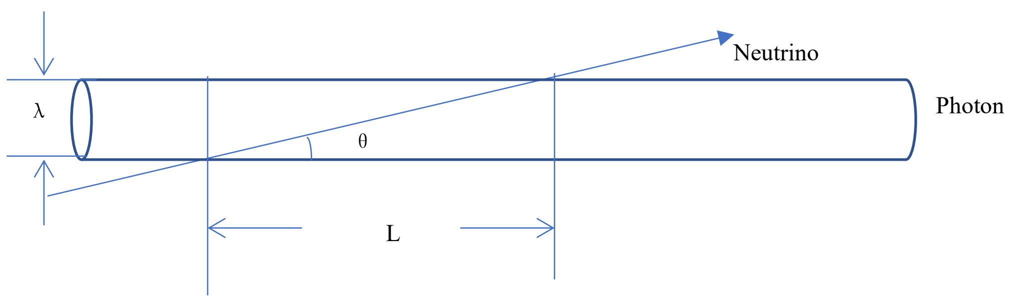

Figure 6-13. The neutrino photon collision length without considering the neutrino wavelength (λ indicates the

wavelength of the photon, L is the collision length)

As can be seen from Figure 6-13, the collision length L is mainly determined by the angle between the photon and the neutrino. As long as the collision length L, this photon can only interact with this neutrino. However, other neutrinos located within the collision length will still be counted towards the neutrino density of the length through which the photon passes.

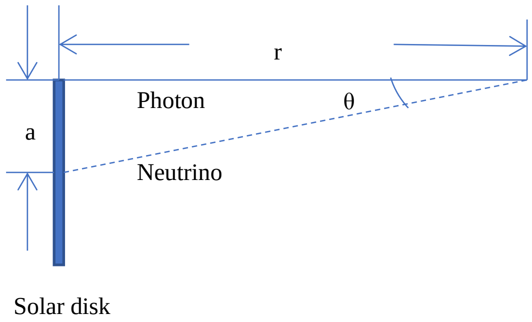

Figure 6-14. Relationship between photon neutrino collision point and the distance from solar disk

Figure 6-14 shows the distance between the photon neutrino collision point and the distance from solar disk. Here, to simplify the analysis process, the sun's surface is treated as a plane. Where a is the radius of the sun's surface, and the neutrino can be emitted from any position on the disk. The center position of the disk is calculated as the average of the neutrino emission position. r is the distance from the collision point to the disk limb. Combined with Figure 6-13 and Figure 6-14, the following formula can be derived

$$\frac{\lambda}{L}=\frac{a}{r} \qquad (6-9)$$

That is

$$L=\frac{\lambda r}{a} \qquad (6-10)$$

The presence of the length of the collision means that the neutrino is "bigger", and how many times it is larger means how many times the density of effective neutrinos that can interact with the photon is reduced.

It is assumed here that the wavelength of the neutrino itself is λ_{ν}, the neutrino density on the earth's surface is n(b), and now the collision length is increased to $\lambda_{\nu}+L$, because the effective neutrino density is

$$n'(b)=\frac{\lambda_{\nu}}{\lambda_{\nu}+L_{b}}n(b) \qquad (6-11)$$

Similarly, the relationship between the number of effective neutrinos and the actual number of neutrinos from the location of the Earth r is

$$n'(r) = \frac{\lambda_\nu}{\lambda_\nu + L_r} n(r) \qquad (6-12)$$

Then

$$n'(r) = \frac{\lambda_\nu}{\lambda_\nu + L_r} n(b) \frac{b^2}{r^2} \qquad (6-13)$$

Note that Potzel et al.'s experiments used gamma rays instead of the solar rays emitted with neutrinos, which interact directly with photons, so the effective neutrino density in the Potzel experiment is n(b). It is $\Delta z_b = \frac{\Delta \mathrm{f(b)}}{f} = \frac{\mathrm{kn(b)}}{f}$

Then consider an approximate condition: $L \gg \lambda_\nu$, substituting into formula (6-8), we can get:

$$\Delta \mathrm{z}_0 = \int_a^b \mathrm{kn'(r)dr} = \Delta \mathrm{z}_b \int_a^b \left(\frac{b}{r}\right)^2 \frac{\lambda_\nu a}{\lambda r} dr = 8.3 \times 10^{-5} \frac{\lambda_\nu}{\lambda} \qquad (6-14)$$

This mainly takes into account the position of L on the order of magnitude of λ_ν, which is basically located on the surface of the sun. Regardless of the length of the collision, only the magnitude of the red shift of the solar surface spectrum is very small, about 10^{-12}, which can be ignored.

Since the average energy of beta decay is about 300 keV, this can be seen as the average energy of the neutrinos released from the solar, corresponding to a wavelength of 4.1 nm, and the wavelength of the analyzed solar spectrum is 500 nm.

Therefore

$$\Delta \mathrm{z}_0 = 8.3 \times 10^{-5} \frac{\lambda_\nu}{\lambda} = 8.2 \times 10^{-7} \qquad (6-15)$$

It can be seen that this is basically consistent with the extra solar redshift value $2 \times 10^{-7} < \Delta z < 10^{-6}$ at limb, which cannot be explained by other reasons.

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Part 2: Fluid Cosmology

On the dark matter fluid model

Abstract

This paper attempts to build a model of dark matter fluids, according to which the universe is filled with dark matter fluids. This dark matter fluid is made up of two of the most basic particles, which are called Fieldons in this paper. These two basic dark matter particles can also form dark matter molecules, and rely on the interaction between molecules to form dark matter fluids. In the process of dark matter fluid flow, because the dark matter fluid itself also has a certain viscosity, it will produce turbulence when the flow rate of the dark matter fluid changes. The basic fluid form that makes up the turbulence of dark matter is the form of a vortex tube. Each end of the vortex corresponds to positive and negative charges and positive and negative magnetic monopoles. If we consider that the space-time in which the charges are the elementary particles is a space-time that can be measured by us humans, then the space-time composed of magnetic monopoles is the space-time that human beings cannot measure. Finally, using the conditions for the quantization of Dirac's charge, we can show that the formation of charge and magnetic monopole vortexes can automatically satisfy the conditions for quantization of charge. The significance of this paper is to construct a new dark matter model, which can be used as an effective supplement to the existing dark matter model. In addition, this paper also points out that the propagation of electromagnetic waves in dark matter fluids is only similar to the sound propagating in matter on Earth, which is a very slow signal. If this analogy holds, it means that there may be a faster signal in the dark matter fluid. Perhaps the existence of this faster signal can also be used to explain the problem of quantum entanglement at a distance, and also bring the dawn of interstellar communication for human beings.

1 Introduction

Dark matter is a substance with many properties in an unknown state in current physics. However, there is already growing evidence of the existence of dark matter. Even the AMS laboratory on the International Space Station announced that they had found direct evidence of the existence of dark matter. The high-energy positron detection project of Samuel C.C.Ting's group on the International Space Station found that the source of most high-energy electrons and the source of positrons are different, indicating that there are phenomena that cannot be explained by existing physical theories. (Aguilar, Alberti, Alpat et al. 2013. Aguilar, Cavasonza, Alpat et al. F.2019)

Nevertheless, unfortunately, we currently know very little about dark matter. Of course, various phenomena observed on a scale like the universe have strongly shown the existence of dark matter. This shows that we need a new model to explain the laws of physics in the universe we live in.

Of course, we already have some dark matter theories that can explain some problems, including supersymmetry theory, WIMPs theory, axion theory, and so on. These theories can all explain to some extent what dark matter is and how it creates gravitational interactions between dark matter and visible matter. However, the problems with these theories are also obvious, mainly reflected in the fact that these theories have not been generally accepted, and there is a lack of direct experimental evidence to verify the correctness of these theories.

On the other hand, from the observations, cosmic galaxies are very similar to the shapes produced by fluid flow, and even galaxy formation can be simulated by fluid models (Neistein, Khochfar, Dalla Vecchia & Schaye, J. 2012. Yepes, Kates, Khokhlov & Klypin, 1997. Steinhauer, 2016.)。 This is the starting point of the dark matter fluid model that this paper attempts to build.

Through the model established in this paper, we can unify all the existing knowledge systems of physics and make a good division of the hierarchy of cosmic research. This allows each physics theory to define its own range of adaptation, such as general relativity and quantum field theory. Through this division of the cosmic hierarchy, we can also define more clearly the place of these theories in physics and what they are studying for.

In addition, mathematically, the symmetry of Maxwell's equations has been a problem that has puzzled people for many years. Dirac attempted to obtain Maxwell's equations with high symmetry by introducing magnetic monopoles directly (Dirac, 1931, 1948). However, after nearly a hundred years of exploration, there is currently no clear experimental evidence for the existence of such magnetic monopoles.

In fact, in addition to the symmetry method used by Dirac to modify Maxwell's equations, we can directly adopt another symmetry method. This symmetry approach is to directly construct another set of Maxwell's equations (Cheng, 2019). In another set of Maxwell's equations, there is no charge, but magnetic monopoles do. Since the space-time we live in is composed of the interaction of electric charges, magnetic monopoles cannot be observed in our space-time. This means that with this symmetry, there will be another spacetime that is commensurate with the spacetime we are now in—imaginary spacetime. The space-time we are In now can be called real spacetime. This is like imaginary numbers and real numbers in mathematics. The existence of imaginary spacetime also provides another idea for the study of dark matter. Based on this, some scholars have proposed another dark matter model, the mirror dark matter model (Tan. 2022). Through this model, the existence of dark energy, the asymmetry of positive and negative matter and other problems can be explained.

In terms of research methods, various cosmic models are studied, mainly through observation, experiments, simulations, mathematical models and so on. Due to the very large scale of the universe, some commonly used scientific research methods are often difficult to apply in the study of cosmology. This means that for conditions where more in-depth observations and experiments cannot be carried out, the laws of cosmology are mainly studied through methods such as simulations and mathematical models. Among them, the method of establishing a mathematical model is the best way to study the model of the universe. For example, Friedman's cosmological model, which has been widely recognized, borrows from Einstein's general theory of relativity. Once the mathematical model is established, we can rely on mathematically rigorous logical reasoning. This is also the research method used in this paper.

It can be seen that the research significance of this study is still very significant. Through the research of this thesis, we can make breakthroughs in the theories of our existing physics. After all, in the current theory of studying the universe, the dark matter is mainly studied through the law of visible matter. However, due to the lack of the application of some important scientific research methods and the limitations of various experimental conditions, some existing physics experimental research methods are difficult to directly apply to the cosmic model, including the cosmic model of dark matter. With the results of this study, on the one hand, It can provide a breakthrough direction for the study of the cosmic model, on the other hand, the results of this research can also provide us with a new idea for better understanding of some cosmic phenomena, even if it is finally proved that the model has errors, it can also provide an improvement direction.

Some important evidence for the existence of dark matter fluid:

- Visible matter is turbulent fluid of dark matter.
- Vortex tubes are a relatively good cause for explaining the quantization of charge.
- To form a vortex tube, the properties of the fluid could be a magnetic field or an electric field. Thus, dark matter fluid might be an electric fluid or a magnetic fluid, and both types of fluid could exist simultaneously. The two fluids form two different spacetime.
- Electromagnetic waves can be generated in dark matter, just as sound waves can be generated in the atmosphere.
- There should also exist a dark matter vibration mode that can produce dark matter waves. These dark matter waves are similar to light waves in the atmosphere, with speeds exceeding the speed of light.
- The mechanism for producing dark matter waves is a more microscopic structure of dark matter. In contrast, electromagnetic waves are the macroscopic manifestation of dark matter fluid, similar to sound waves in atmospheric fluid.
- Electromagnetic oscillation and electromagnetic waves are two different phenomena; electromagnetic oscillation does not produce wave speed. Even if electromagnetic oscillation can form some diffusion, that speed is much lower than the speed of light. Electromagnetic waves, however, travel at the speed of light. Therefore, once electromagnetic waves are formed, the phases of the electric field and magnetic field must be the same.
- Most importantly, if virtual spacetime exists, then there must be electromagnetic waves that span across two spacetimes. In this case, there exist electromagnetic waves where only the electric field vibrates in real spacetime. However, a current issue with this solution is that if there is only a single electric field vibration, its spin should only be 1/2. However, there is ample evidence to prove that the self-spin of virtual photons is 1. But considering that the mass and energy of virtual spacetime and real spacetime are unified, it means the mass carries unobservable magnetic oscillations, while energy carries electric field oscillations. Thus, the unified virtual photon can only have properties observable through electric field oscillations.

2 Dark matter fluid cosmic model

2.1 The hierarchy of the study of the cosmological model

The study of cosmological models can be carried out at different levels. At the visible matter level, we can now use a variety of physical theories that humans have created, including classical physics as well as modern physics theories. But as more and more evidence of dark matter exists, existing physical theories seem unable to explain some important dark matter phenomena.

Even existing physical theories have very different levels of research. For example, the theory of relativity mainly studies high-speed macroscopic phenomena. Quantum theory, on the other hand, focuses on microscopic phenomena. Of course, this division is not absolute. For example, the theory of relativity can be well applied to explain electron spin. And a lot of macroscopic quantum effects have been discovered.

However, at the level of invisible dark matter, there seems to be no very effective theory to explain all dark matter phenomena. However, according to the current cosmic scale observations, dark matter seems to account for ninety percent or more of the entire cosmic matter composition. Therefore, in theory, an effective dark matter theory should also be applied to the study of the laws of motion of visible matter. Or it can be said this way: visible matter comes from dark matter.

Table 1 lists the levels involved in the study of the cosmological model and the theories that can be used.

Table 1. Levels of cosmic model research

Levels	Models	Theories	Experiment evidences
Visible matter	Galaxy	Electrodynamics, classical mechanics, relativity, etc.	Experimental evidence is insufficient and relies mainly on observation
	Atoms, molecules, inorganics, organic substances	Electrodynamics, classical mechanics, biology, etc.	There is sufficient experimental evidence to obtain practical application
	elementary particle	Quantum field theory, relativity	There is ample experimental evidence
	Quantization of electric charge	Dirac magnetic monopole theory, imaginary spacetime physics	Magnetic monopoles have not been proven
Dark matter	Supersymmetry theory, WIMPs, axions, etc.	Under construction, while the gravitational part involves general relativity	No direct experimental evidence

From this division of the study hierarchy of the cosmological model, we can see that general relativity is mainly the study of gravitational interactions, as long as there is energy or mass, gravity can be generated. Therefore, in terms of gravitational effects involving dark matter, general relativity can still be applied. Considering that both real spacetime and imaginary spacetime have energy interactions, these energies are caused by the energy-dissipating structure generated by the turbulence of dark matter, so even the dark matter of imaginary spacetime has energy, resulting in gravitational interactions.

2.2 Important evidence for the cosmic fluid model

The fluid model of dark matter that this paper constructed is mainly based on the following important facts.

First of all, the limitation of the action distance of various interactions that we know so far. That is, all known interactions, including gravitational interactions, electromagnetic interactions, etc., are limited by the speed of light. Although the speed of light is very fast compared to humans, the speed of light is actually very, very slow on the scale of the universe we have observed so far. This is actually the same as the speed of a sound signal at the center of a storm. Although the speed of the sound signal far exceeds the speed at which the storm can move, that speed is very limited relative to the size of the entire Earth.

From the facts of the galaxies that have been observed so far, all kinds of galaxies show a phenomenon of matter aggregation. We know that the mass of matter is actually energy, which means that the accumulation of galaxies is the accumulation of energy. From a variety of shapes, galaxies are mainly a spiral structure. And this spiral structure is basically the same as what we now know as storms on the earth, that is, the gathering effect of energy generated by the flow of air. Considering that air is a kind of fluid, is it possible that the formation of this cosmic "storm" may also be the effect of a fluid? If we think that dark matter is such a fluid, then it should also be able to form turbulent phenomena unique to various fluids.

Another fact is that we currently have very poor measurements of the gravitational constant. And what we now know is that dark matter also has gravitational interactions. Given the limited distance of gravitational interaction, we can even think of gravitational interaction as a very close interaction between dark matter molecules. This shows that the viscosity coefficient of dark matter is directly related to the magnitude of the gravitational interaction. If dark matter also has the same thermodynamic effects as all kinds of matter we know now. That means that dark matter also has temperature, pressure, volume, and molecular interactions between dark matter, which also leads to the phenomenon that dark matter may produce various turbulence when it flows. And we now know the matter, its viscosity coefficient is affected by temperature, but also by pressure. If dark matter is flowing with uneven temperature distribution, it will naturally lead to changes in its viscosity coefficient. This leads to a change in the gravitational constant.

Another notable note is that in the cold dark matter model, which is used to explain motions such as galaxy rotation curves, the model also shows to some extent the fluid nature of dark matter. For example, when explaining the galaxy's motion curve, it also shows to a certain extent that dark matter is flowing. Other experiments have shown that models of fluids can even be used to simulate the mechanisms by which black holes and galaxies form.

To this end, we try to build a fluid model of dark matter. In this model, the flow of dark matter fluids through the universe will be included. And this dark matter fluid has basically similar properties to the fluids we now know as gases, liquids, and so on. So we can calculate the temperature, pressure and volume of the dark matter fluid, as well as the interactions between the molecules inside the dark matter. And then calculate the viscosity coefficient of dark matter fluid.

When analyzing turbulence problems, one of the most useful parameters by far is the Reynolds number. Among the fluids we now know, the critical value of the Reynolds number is generally 3200. If the critical Reynolds number is exceeded, turbulent flow will occur. The Reynolds number is mainly directly related to the velocity of the fluid. If the density of the fluid, the diameter of the flow tube, and the coefficient of viscosity of the fluid are determined, the faster the speed, the larger the Reynolds number and the greater the likelihood of turbulent flow. Combined with the data of some cosmic galaxies we have observed now, we can roughly analyze some important properties of dark matter fluids.

2.3 The structures of dark matter fluid

2.3.1 Fluids composed of electric and magnetic fields

By observing electromagnetic waves, we can find an interesting phenomenon, that is, the electric and magnetic field oscillations in electromagnetic waves are symmetrical. That is, once the electric field oscillates, the magnetic field also oscillates in the same phase. Electromagnetic waves carry energy, which means that the basic reason for the separation of electric and magnetic fields when energy occurs. If no energy is present, the electric and magnetic fields will be a complex body. This may be the true state of the vacuum.

Therefore, we can further assume that the universe is full of dark matter fluids, which are a complex of electric and magnetic fields without being disturbed by energy. Therefore, if no energy enters, the dark matter flow will be very smooth and unobservable.

But if there is an energy input, there are two possible scenarios, the first is to increase the speed of the dark matter fluid. But this does not create turbulence in the second case it does. Since turbulence consumes additional energy and is a dissipative structure, turbulence will be able to be observed, forming the visible matter world we now have.

According to the above assumptions, the turbulence of dark matter fluids is essentially the separation of electric and magnetic field flows, which in turn leads to quantization in the form of electric or magnetic charges. This is what we see as electrons and protons.

The formation of turbulence in dark matter fluid is related to the flow rate of dark matter fluid and the viscosity of dark matter fluid. If the flow rate of the dark matter fluid is too fast, or the viscosity of the dark matter fluid is not high enough, it is easy to produce turbulence.

Fig. 1 shows the contrast between the electromagnetic waves formed by the separation of electric and magnetic field oscillations and the turbulence of dark matter fluids.

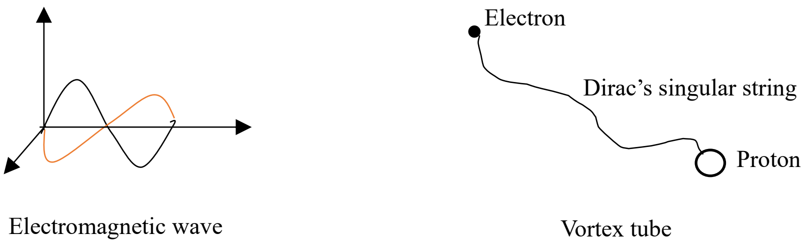

Fig. 1. EM wave and turbulence of dark matter fluids

2.3.2 Microstructure of dark matter fluids

Obviously, if the dark matter fluid can propagate electromagnetic waves, then the dark matter fluid must have a finer structure, so as to meet the needs of electric and magnetic field oscillations. This finer structure means that there must be vibrational waves in dark matter fluids faster than the speed of light.

This can be analyzed from the analogy between sound and electromagnetic waves. The propagation of sound takes the form of phonons, while the propagation of electromagnetic waves is in the form of photons. In solid state physics, vibrations in the lattice produce phonons. The vibration of this lattice is caused by thermal motion, which of course is also the result of energy input.

The viscosity coefficient of dark matter fluid is relatively large, which also shows that if dark matter has a fine structure, then the interaction between the most basic particles that make up dark matter should be relatively strong.

But on the other hand, in contrast to the vibration of sound, electromagnetic wave oscillation only has the separation and recombination of electric and magnetic fields. It can be seen from here that the microstructure of dark matter fluids should be much simpler than the microstructure of visible matter.

Considering the two properties of the electric field and magnetic field of dark matter fluids, we can divide the most basic particles composed of dark matter fluids into two types: one is electric fieldon, and the other is magnetic fieldon.

When the dark matter fluid is in a laminar flow state, the electric fieldon and the magnetic fieldon are in equilibrium, forming dark matter molecules. Once there is an energy input, the distance between the electric fieldon and the magnetic fieldon oscillates.

If it is an electromagnetic wave, dark matter molecules will propagate this vibration. And if the electric fieldon and magnetic fieldon in the dark matter molecule only oscillate locally and meet the conditions for quantization of the charge, so-called electrons and protons will be formed.

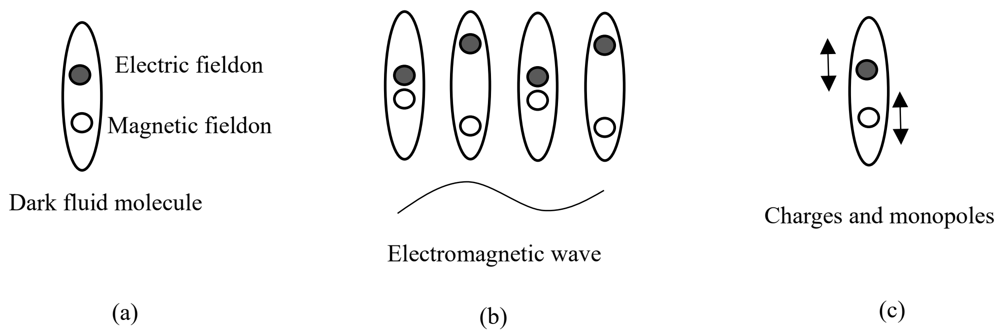

Fig. 2. Dark fluid molecule and energy

In Fig. 2, (a) is a dark fluid molecule. It consists of two elementary dark particles, Electric fieldon and Magnetic fieldon. (b) shows that when electromagnetic waves propagate, they cause the distance between two fieldons in dark molecules to oscillate and propagate. (c) shows that if the fieldon inside the dark molecule only oscillates, it does not propagate the energy of this oscillation. This is where the charge and magnetic monopoles appear. In Section 3.2 in this paper, it can be proved that such oscillations can automatically satisfy the charge quantization conditions. The oscillations of the magnetic fieldon form electrons and protons, which make up the real spacetime we can observe. The oscillations of Electric fieldon form magnetic monopoles, so-called imaginary spacetime or virtual spacetime. Such an imaginary spacetime cannot be observed in a real spacetime.

2.3.3 The level of matter structures in the universe

We can make a hierarchical division of the matter structures in the universe. The bottom layer is the dark matter fieldon, which is composed of two dark matter fieldons with different properties to form dark molecules. Dark molecules interact to form dark matter fluids. Dark matter fluids fill the entire universe and flow through it.

When energy is transferred to dark matter fluids, laminar and turbulent flows can be created. Through laminar flow, energy can accelerate dark matter fluids or use it to transmit electromagnetic waves. Turbulence can form electrons, protons, and magnetic monopoles. Electrons and protons make up the observable real spacetime. Magnetic monopoles, on the other hand, make up imaginary spacetime. Interactions between particles such as electrons and protons are mainly achieved by exchanging photons (propagating electromagnetic waves).

Fig. 3 shows the hierarchy of the matter structures of the universe. The orange text box in the figure represents the observable matter world. As can be seen from the figure, the matter that can be observed only accounts for a small part of the entire composition of matter in the universe.

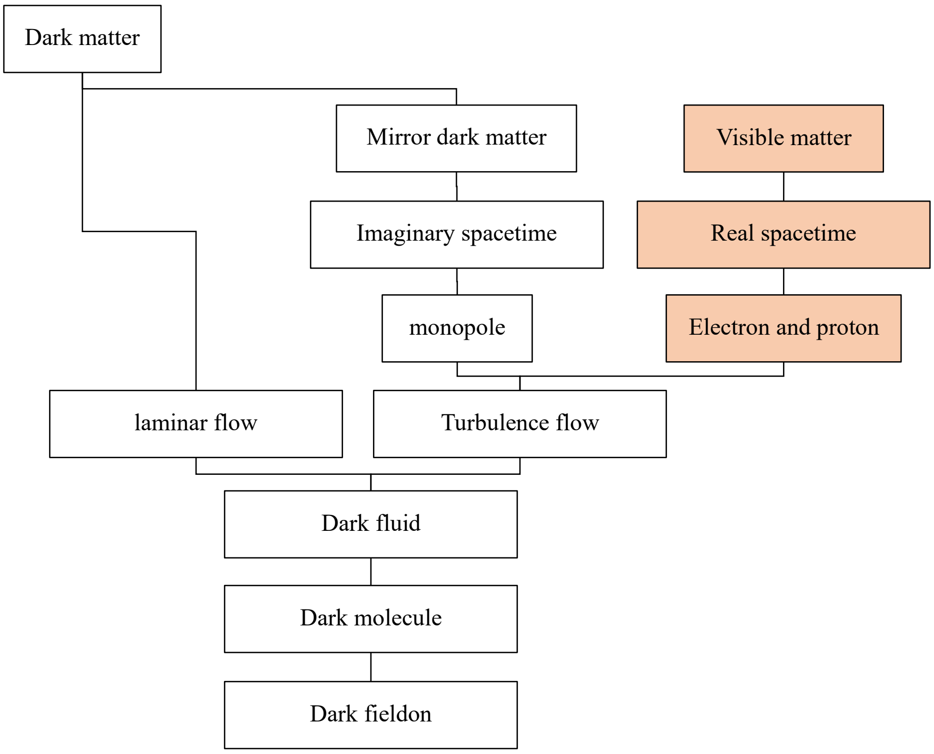

Fig. 3. The level of matter structures of the universe

As can be seen from the figure, the research of dark matter is mainly divided into two directions. One direction is the study of dark matter laminar flow. The other direction is the study of dark matter based on imaginary spacetime. Dark matter studies based on imaginary spacetime also study the turbulence of dark matter fluids. This is basically the same as the research method in Real spacetime, so the entire research process and results are relatively direct, and you can borrow the existing knowledge of physics. At present, in the dark matter model based on imaginary spacetime, some scholars have also begun to study the problem of mirrored dark matter. For example, the mirror dark matter theory can explain some important properties of dark matter (Tan. 2022).

3 Dark matter's turbulence

3.1 Imaginary spacetime physics

3.1.1 The basis of the existence of imaginary spacetime

3.1.1.1 Imaginary spacetime in the universe

As the theory of physics continues to improve, it has been found that to solve the various problems of the visible matter world, it is necessary to introduce more complex assumptions. This can be judged from the division of time-like, space-like, and light-like regions on Minkowski coordinates. Because since the real observable world is located in time-like space-time, there is no mathematical reason to prevent motion (including visible matter and dark matter) from crossing the light-like line from the time-like spacetime into the space-like space. For the analysis of this kind of problem, as early as 2005, some scholars mathematically used a complex spacetime C_n that containing real spacetime R_n to solve the Eigenwavelets problem of the wave equation (Kaiser, 2005), proving that the existence of imaginary spacetime is mathematically meaningful. Some authors have also pointed out that from the properties of imaginary numbers in time, it is reasonable to infer that there is a corresponding imaginary spacetime solution for the motion solution of any field equation (Hashimoto & Wang, 2005). In 2010, some scholars noticed that in the four-dimensional space-time we live in, there is a negative number in front of the time. This negative number reflects the existence of an imaginary spacetime corresponding to the real spacetime we are in today (He, 2010). In recent years, some authors have seen the symmetry of time-like space-time and space-like space-time from Minkowski coordinates, suggesting that there may be a real spacetime and an imaginary spacetime for the entire universe (Khoshsima, 2016). Some scholars hypothesize that before the birth of the universe, there was a black hole in the entire space-time, which corresponds to the imaginary spacetime, and then thermodynamic methods can be used to obtain explanations for gravity and galaxy motion curves (Kawamura, 2021).

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 imaginary spacetime respectively. Real spacetime refers to spacetime formed by the interaction of electric fields between electric charges. Imaginary 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 based on supersymmetry of real and imaginary spacetime (Cheng, 2019), there should be an imaginary 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 imaginary spacetime and real spacetime are always orthogonal.

3.1.1.2 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 imaginary 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.

3.1.2 Types of imaginary spacetime

3.1.2.1 Faster-than-light imaginary spacetime

The existence of this type of imaginary 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 imaginary 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 imaginary spacetime, and we cannot observe them.

These two sets of Maxwell's equations, which are very symmetrical, are as follows (Cheng, 2019):

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 imaginary 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 imaginary spacetime, respectively. The corresponding differential operators ∇ and ∇_y represent the spatial differentiation of real spacetime and imaginary 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. (Cheng, 2019)

3.1.2.2 Black hole imaginary spacetime

It can be seen from the Schwarzschild metric that when a black hole is formed, a imaginary spacetime is formed inside the black hole. And this imaginary 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 imaginary spacetime.

3.1.2.3 Microscopic imaginary 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 imaginary 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 imaginary spacetime is the uncertainty principle. Because in the microscopic world, you can't measure position and momentum, or time and energy, precisely 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

$$J = mrv \qquad (13)$$

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

$$p = mv$$

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 imaginary spacetime, the speed of light is the boundary between imaginary spacetime and real spacetime, then this imaginary 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 imaginary 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 (Cheng, 2019).

3.1.2 The boundary between real and imaginary spacetime

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

For the boundary between the imaginary 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 $\hbar/2$.

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 imaginary 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 imaginary spacetime, where the speed of virtual photons is greater than the speed of light.

We can determine the size of the boundary radius between imaginary 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 radius can find that the radius of this boundary surface is

$$r_c = \frac{r}{2} = \frac{\hbar}{2mc} \qquad (15)$$

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

3.1.3 Structure of particles

Considering the requirements of symmetry, the particles we can currently see in real spacetime should also have a corresponding particle in imaginary 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 imaginary 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 imaginary 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 imaginary 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 imaginary 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 imaginary spacetime. Particles larger than this radius will be located in real spacetime. The radius of a particle located in imaginary 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:

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

The electromagnetic radius of the proton is

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

The electromagnetic radius of electrons is:

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

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 2 shows the electromagnetic radii of eight particles.

Table 2. 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 2, 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 imaginary 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, and the other part is the isospin mass of the proton. In this way, we can multiply by a factor g to reflect the change in electromagnetic radius due to the strong interaction. namely

$$\frac{e^2}{8\pi\varepsilon g r_p} = m_e c^2$$

since

$$gr_p \approx 1.4089924 \times 10^{-15}(m)$$

Substituting the experimental value of 0.84fm, it can be obtained

$$g \approx \frac{1.4089924 \times 10^{-15}}{0.84 \times 10^{-15}} \approx 1.6774$$

Then we can get

$$m_{pf} \approx 0.5962m_p$$

Perhaps this is the true electromagnetic mass of protons.

3.2 Dark matter turbulence and charge quantization

3.2.1 Electromagnetic field vortex and charge quantization

The generation of turbulence in dark matter fluids means that the electric and magnetic fields of dark matter fluids are separated to form a vortex structure of fluids. Such a vortex structure is manifested in countless electric and magnetic field vortex tubes.

We can obtain the standing wave solution of electromagnetic waves through the charge quantization conditions envisaged by Dirac. This standing wave solution corresponds to the vortex in the fluid. Each vortex connects positive and negative charges or magnetic charges together to form the elementary particles that make up the matter world. The structure of the vortex tube can be done in this way with the Dirac singular string. A Dirac singular string resembles an infinitely long solenoid.

Since there are two space-time, such a singular string needs to have two, one in the imaginary spacetime is formed by the magnetic current, the singular string will generate electrons and protons at the real spacetime at both ends. The other, located in Real spacetime, is a singular string formed by the rotation of an electric field. The Singular string will generate two magnetic monopoles in Imaginary spacetime.

In order to form a magnetic monopole in a imaginary spacetime, this requires a singular string formed by an electric field rotational current in the real spacetime. It needs to meet the conditions for the Dirac's quantization of charge to ensure that the singular string will not be observed in real spacetime.

The magnetic currents that form the electric charge, the Singular string, follow similar quantization conditions, ensuring that the existence of the Singular string cannot be measured in Imaginary spacetime.

The rotating electric field that forms the magnetic monopole is located at the location of electrons and protons. Due to the small radius of electrons, the electric field rotates relatively quickly, possibly exceeding the speed of light. If the proton radius is relatively large, the rotation speed of the electric field is relatively small. In this way, the spin angular momentum generated by the spins of two electric fields is equal.

Of course, the spin of this electric field can also generate observable magnetic moments in real spacetime. But the magnetic moment itself does not carry energy, which is different from the magnetic monopole.

3.2.2 Flaws in the Dirac charge quantization model

The model of Dirac's charge quantization is relatively perfect, but there are some problems, and these flaws are mainly manifested

First, there is no definitive experimental evidence for the existence of magnetic monopoles, and the existence of magnetic monopoles is a necessary condition for the Dirac quantization of charge.

Second, the Dirac quantization of the charge only describes the magnetic monopoles produced by the rotation of the electric field. If the electric and magnetic fields under consideration are symmetrical, since the rotation of the electric field can produce magnetic monopoles, the rotation of the magnetic field should also be able to generate electric charges. To solve this problem, Schwinger's two-string singular potential can be used. The two-string singular potential solves the problem of both magnetic monopoles and electric charges exist at the same time.

Third, the Dirac charge quantization condition only tells us why the existence of singular strings cannot be observed, but if there are still singular strings in the universe that do not meet the requirements for charge quantization, can these singular strings that cannot be quantized by charge be measured? And if you can't answer this question, it means that you can't explain how Dirac's strange strings are produced.

3.2.3 The essence of a singular string is a fluid vortex

Since there is spin in the electric fields of both electrons and protons, we can further assume that this singular string is actually spinning as well. This forms a "vortex tube" similar to a vortex in a fluid. Then we can use some methods of fluid mechanics to deal with electrons and protons, and their corresponding magnetic monopoles.

3.2.4 Structure of electromagnetic field vortex tubes

Consider that in the universe, the number of positive and negative charges is exactly equal. This also means that the number of electrons and protons is exactly equal. Therefore, we can think of electrons and protons as two properties of a physical agent. More specifically, electrons and protons can be connected to each other with a single string. Since this string cannot be observed, Dirac called it a "singular string". In this way, whether in real spacetime or imaginary spacetime, we cannot observe the existence of singular strings. Only individual electrons and protons are actually observed.

If we consider that this singular string is the vortex in the fluid, then the spin of the electric field or magnetic field is the vortex motion of the fluid. It's just that unlike the fluids we are familiar with, the structure of this electric or magnetic field vortex is simpler. The fluid equations that describes the motion of an electric or magnetic field in such a vortex tube is Maxwell's equations.

3.2.5 Quantization of magnetic monopoles of Schwinger's singular strings

If the singular string between electrons-protons or magnetic monopoles is regarded as vortex tubes in fluid mechanics, then these vortex tubes are similar to coils, and if they are rotations of electric fields, magnetic fields can be generated at both ends, forming magnetic charges or magnetic monopoles. If the magnetic field rotates in it, an electrostatic field can be generated at both ends, forming an electric charge. Then, through the quantization conditions of Schwinger's two-string singular potential, the relationship between the rotation of the electric field and the magnetic charge of the magnetic monopole can be calculated.

For electrons, if its electromagnetic radius is a, the magnetic induction intensity generated by spin is calculated as $B = \mu i / 2a$

where i is the current intensity and μ is the magnetic permeability in a vacuum.

Then

$$B = \frac{\mu i}{2a} = \frac{\mu}{2a}\frac{e\omega}{2\pi} = \frac{\mu}{2a}\frac{e m_p a^2 \omega}{2\pi a^2 m_p}$$

If we consider the spin angular momentum of electrons

$$m_p a^2 \omega = \frac{\hbar}{2}$$

In elementary particle model based on Imaginary spacetime, an electron is a complex of the magnetic monopole of Imaginary spacetime and the electrostatic field of electrons in Real spacetime. Therefore, suppose that the spin of an electron is generated by the rotation of the magnetic monopoles in Imaginary spacetime. Considering the symmetry, it can be known that the mass brought by the magnetic monopole of the electron is equal to the mass of the proton. Correspondingly, the mass brought by the magnetic monopole contained in the proton is equal to the mass of the electron.

such

$$B = \frac{\mu}{2a}\frac{e\hbar}{4\pi a^2 m_p}$$

If the vortex tube of the electric field will form a magnetic monopole at both ends, the magnetic field strength of the magnetic monopole is

$$B = \frac{\mu}{4\pi}\frac{g_p}{a^2}$$

So

$$g_p = \frac{e\hbar}{2am_p}$$

The Dirac charge quantization condition is

$$eg_e = \frac{nh}{\mu}$$

However, if both charge and magnetic monopole are considered, Schwinger charge quantization condition need to be used, i.e

$$eg_e = \frac{2nh}{\mu}$$

So

$$eg_e = \frac{e^2\hbar}{2am_p} = \frac{2nh}{\mu}$$

Considering

$$am_p = bm_e$$

where *b* is the electromagnetic radius of the proton.

And

$$b = \frac{e^2}{8\pi\varepsilon m_e c^2}$$

Therefore

$$n = \frac{e^2\mu}{8\pi a m_p} = \frac{e^2\mu}{8\pi b m_e} = 1$$

It can be seen that the conditions for quantization of the charge are automatically satisfied. This automatic satisfaction also means that there can be no charge without quantization. That is, if an electric field or magnetic field is formed in a vortex, the charge or magnetic charge at both ends of the vortex must be quantized.

In this way, the vortex connected between electrons and protons is not visible. The same calculation can be done for magnetic monopoles in Imaginary spacetime. Eventually, we can find that the singular strings of magnetic monopoles connected to each other in Imaginary spacetime are also unobservable.

4 Laminar flow of dark matter

4.1 Conditions for turbulent flow in dark matter fluids

If dark matter is regarded as a fluid, the fluid has a viscosity coefficient μ. If the velocity of dark matter flow is v, the Reynolds number can be calculated as:

$$R_e = \frac{\rho v D}{\mu} \qquad (23)$$

The condition for dark matter to form turbulent flow is that the Reynolds number is greater than a certain critical value. The current critical value of the Reynolds number in the matter world is 3200. It can be seen from formula (23) that the Reynolds number of the dark matter fluid is mainly related to such factors, including the density of the dark matter fluid, the diameter of the channel through which the dark matter fluid flows, the viscosity coefficient of the dark matter fluid and the velocity of the dark matter fluid.

For example, as the viscosity coefficient of dark matter fluid increases, the dark matter fluid is less likely to form turbulent flow. The faster the flow of dark matter, the easier it is to form turbulence. Of course, the denser the dark matter, the easier it is to form turbulence.

4.2 Viscosity coefficient and gravitational constant of dark matter

An important parameter in the dark matter fluid is the viscosity coefficient of the dark matter fluid. The viscosity coefficient of dark matter fluid is mainly the interaction between dark matter molecules. This can be explained by the van der Waals constant a. In the van der Waals equation:

$$\left(p + \frac{a}{v^2}\right)(v - b) = kT \tag{24}$$

The larger the constant a, the larger the viscosity coefficient. therefore:

$$\mu \propto a$$

or

$$\mu = ka$$

Of course, if we assume that all dark matter in the universe exists uniformly, the viscosity coefficient should be the same, which can be regarded as a constant. But if we consider that dark matter fluids also have the same thermodynamic properties as the objects we know today. That means that the viscosity coefficient of the dark matter fluid should be related to the temperature and pressure of the dark matter fluid. Generally, the higher the temperature of the fluid, the lower the viscosity coefficient.

There is already some evidence that dark matter is affected by gravitational interactions. Gravitational interactions lead to stronger gravitational interactions as dark matter piles up. This is one reason dark matter becomes less stable. Therefore, we can assume that the interaction between dark matter molecules is directly related to the gravitational interaction. If this assumption is true, it means that by calculating the change in the viscosity coefficient of the dark matter fluid, we can also calculate the change in the gravitational constant.

We can express such a relationship as a function. First of all, for the interaction force between dark matter molecules, there are:

$$a = f(G)$$

In this way, the viscosity coefficient of the dark matter fluid is also a function of G, which can be expressed as:

$$\mu = kf(G)$$

We further assume that if the viscosity coefficient of the dark matter fluid is a monotonically increasing function of G, it means that the larger the G, the smaller the Reynolds number, and the less likely it is to form turbulent flow.

Considering that if dark matter is distributed in the entire universe, even in the solar system, if the temperature distribution is uneven, it may cause fluctuations in the gravitational constant. And if we analyze what factors cause the uneven temperature distribution of dark matter, we should be able to calculate fluctuations in the gravitational constant.

4.3 Inequality of inertial force and gravitational force

If we consider that dark matter is a more macroscopic state of matter, and gravity is limited by the speed of light of gravitational waves, gravity is actually a microscopic force on the scale of the entire universe. If there is a force in dark matter that is more macroscopic than gravity, that force can also be equivalent to another inertial force. In this case the inertial force will not be equivalent to Newtonian or relativistic gravitational force. Perhaps under the influence of this more macroscopic dark-gravity, we can find cases where the equivalence principle of general relativity fails.

Considering this dark-gravity should be able to cause dark matter to realize the overall motion of the cosmic scale, such as the flow of dark matter. The range of this force should be very large. Of course, the dark-gravitational wave formed by this force naturally propagates faster than the speed of light. Of course, since the interaction occurs on the macroscopic scale of the universe, this dark-gravity should be a very weak interaction.

In this way, galactic matter operates on a more macroscopic scale, and dark matter has at least two interactions. One is the interaction between dark matter molecules and atoms. This interaction is very similar to electromagnetic interaction. The intensity of action is very strong, but because it does not have a cumulative effect. As described in Section 2.3.2, this interaction between dark matter molecules should be produced by positive and negative fieldon. It cannot directly cause the motion of dark matter on a cosmic scale. And more fieldons are combined together to form the aggregation of dark matter, then a dark-gravity can be formed at this time. This kind of dark-gravity is the very weak force that can constrain the motion of the entire dark matter fluid, but the action distance is very long.

The interaction between positive and negative fieldon can be represented by Figure 4.

Positive fieldon Negative fieldon

Figure 4. Interaction between fieldons

The figure shows that in the microscopic state, there is an interaction between two fieldons of opposite signs. The interaction between fieldons with opposite signs is mainly accomplished by exchanging dark waves. The cause of dark wave is different from the cause of electromagnetic wave. The formation of dark matter waves is mainly formed by the oscillation of the dark matter field, which is like the oscillation of electric or magnetic fields to form electromagnetic waves. The formation of electromagnetic waves is caused by the mechanical vibration of fieldons, which is similar to the oscillation of ions in solid state physics to produce phonons.

Dark waves should be limited by the maximum velocity in dark matter. That is to say, we should also be able to apply the knowledge of relativity to deal with the laws of physical motion in the dark matter world. It's just that the propagation speed of a dark wave is much faster than the speed of light.

The main difference between sound waves and electromagnetic waves is the difference in wave speed. For sound, its propagation speed is:

$$v_s = 340m/s$$

And the propagation speed of electromagnetic waves is

$$c = 3 \times 10^8 m/s$$

There is a very simple way to estimate the speed of dark waves. Since the speed of light is about one million times faster than the speed of sound, it can be guessed that the speed of dark waves should also be one million times the speed of light. which is

$$v_d = \frac{c}{v_s} \times c \approx 10^6 c$$

It can be guessed that the propagation speed of the Dark wave is approximately

$$v_d \approx 3 \times 10^{14} m/s$$

It is about 0.03 light-years away in one second.

This speed seems to be quite large, but compared to the entire universe, it is not very large. For example, based on the diameter of 100,000 light-years, it takes 925 hours for the dark wave to traverse the entire galaxy, which is about 2.5 years. This is also a long time. By Comparing to the 14 billion light-years of the universe we know now, it will take 14,000 years to travel through the universe for dark waves. Perhaps in addition to the dark wave, there will be higher-speed waves traveling through the universe, so that the integrity of the entire universe can be better maintained.

From the above analysis, we can get some important characteristics of dark wave, including the following aspects:

1. Super speed of light. Just like sound waves propagate in the medium, electromagnetic waves are excited. The speed of electromagnetic waves is far supersonic. Therefore, the dark wave radiation in dark matter will inevitably exceed the speed of light.

2. The propagation hypothesis of dark wave is also quantized, so dark wave is actually the propagation of dark wave quantum. The dark wave quantum is the intermediary particle of the interaction between dark matter.

3. To form a complete structure, dark matter needs to interact. This interaction allows static dark

matter to gather together. Taking into account the super-luminous nature of the dark wave quantum, it means that two resolvable dark matter at extremely long distances can interact with each other.

4.4 Dark matter flow and turbulence in the universe

With the previous assumptions of dark wave and dark-gravitational wave, then we can have a more intuitive picture of the dark matter fluid in the universe. Considering that it is more appropriate to adopt a closed four-dimensional model of the entire universe, this is similar to the surface of the earth on which we humans live. The flow of the entire atmosphere and ocean on the earth's surface is a cyclic circular motion. Then the dark matter in the universe is basically such a circular motion. The only difference between it and the surface of the earth in the universe is that the universe is a four-dimensional space-time, while the surface of the earth can be approximately regarded as a three-dimensional space-time. The ultra-long-range effect of the considered dark-gravity is very weak, so the flow of dark matter is mainly restricted by the dark-gravity. Therefore, in the fluidity of the entire dark matter flow, the possibility of a spiral vortex structure similar to the atmospheric flow is relatively high. What constrains this vortex structure is the limitation of dark-gravity. This dark-gravity restriction results in a cosmic-scale Coriolis force constraining the flow of dark matter.

Fig. 5 assumes that the flow of dark matter throughout the universe is a giant vortex.

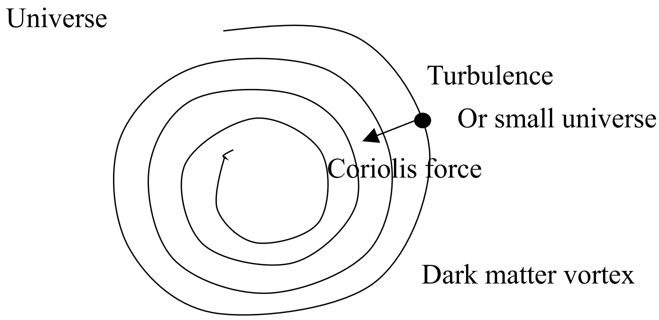

Fig. 5. The Dark flow and Turbulence

As can be seen from Fig. 5, in the entire universe, Dark flow is a huge vortex. And somewhere in the vortex, there is turbulence due to too fast flow. What these turbulences represent is a galaxy.

If Dark flow also conforms to the laws of thermodynamics. Then Dark flow is mainly affected by thermodynamic parameters such as temperature and pressure. On the periphery of Dark flow, the flow velocity is very fast, which makes it easier to form turbulent flow on the periphery of Dark matter vortex. Each turbulent location can be thought of as a miniature universe. The appearance of turbulence leads to uneven temperature and pressure distribution in Dark flow, which leads to the appearance of countless Dark Typhoons locally. And a Dark Typhoon can be regarded as a galaxy.

4.5 Estimate some parameters of dark matter flow based on existing cosmic observations

Of course, because the Milky Way is too large for humans, the various cosmic parameters we have now are actually very similar. It can only be the result of an estimate, and the error of the estimate will be quite large.

The idea of the whole estimation is as follows. First of all, we think that the energy of dark matter turbulence mainly includes translational kinetic energy and pulsation kinetic energy. Translational kinetic energy is the state in which dark matter fluids flow without creating turbulence. And once the turbulence is generated, there will be pulsations of the dark matter fluid, and this pulsation also carries energy. Therefore, if there is turbulent pulsation, part of the energy will be absorbed, resulting in a decrease in the translational kinetic energy of the fluid.

At present, there have been some estimates of the overall mass of the Milky Way, and the reliability of these estimates is still relatively high. Therefore, we can estimate some important parameters of the dark matter fluid from the mass of the Milky Way. Considering that in the theory of relativity, we have equalized mass and energy, the mass of the Milky Way actually reflects the pulsating energy of the turbulent dark matter fluid. This is what we can directly observe.

The translational energy of dark matter fluids is something we cannot observe, but these translational energies also have an effect on the pulsating energy, which is the effect of dark matter on the motion of galaxies. It can also be seen from this that there is indeed a Newtonian gravitational interaction between dark matter and matter.

At present, the proportions of dark matter, dark energy, etc. we estimate in the entire universe vary greatly. Here, dark matter and dark energy account for 95% of all matter for calculation. This means that the total mass of the Milky Way actually reflects about 5% of the energy of the dark matter fluid, from which we can estimate the total mass and energy of the dark matter that drives the flow of visible matter in the Milky Way or the entire Milky Way.

Assuming that in a certain cosmic region, the volume is V, the volume of turbulent flow is V_T, and the volume of the remaining advection is V_q. Then

$$V = V_q + V_T \tag{25}$$

From a macroscopic level, the overall energy density of dark matter should be uniformly distributed. therefore

$$\rho = \frac{E}{V} = Const.$$

The translational kinetic energy of all dark matter fluids is reduced due to turbulent pulsations that absorb some of the energy. It is assumed that the translational kinetic energy of turbulent flow is equal to that of normal fluid. therefore:

$$E = E_k + E_p \tag{26}$$

Where E_p is the pulsating energy.

Applying it to the motion of galaxies, in this formula E_p corresponds to the mass of the Milky Way.

This is done by:

$$E = \frac{1}{2} M_d v^2 \tag{27}$$

where M_d is the total mass of dark matter. Before the turbulence is generated, the velocity v of the dark matter flow.

After the turbulent flow is generated, the translational kinetic energy of the dark matter drops to v_k, so in the dark matter flow that generates the turbulent flow, the translational kinetic energy in it becomes

$$E_k = \frac{1}{2} M_d v_k^2 \tag{28}$$

It is obvious that $v_k < v$. This is because a part of the translational kinetic energy before the turbulent flow is not generated is consumed as the pulsating kinetic energy E_p of the turbulent flow.

According to the calculation formula of Reynolds number:

$$R_e = \frac{\rho v D}{\mu} = \frac{\rho D}{\mu} v = kv \tag{29}$$

The critical value of Reynolds number is

$$R_c = 3200$$

This can be calculated

$$v > \frac{3200}{k} \tag{30}$$

The formation of turbulent flow proves that the flow rate has just reached the critical point. therefore

$$v_k \approx \frac{3200}{k} \tag{31}$$

Considering the mass of the Milky Way is (Fragione and Loeb, 2017):

$$M_M = 1.5 \times 10^{12} M_{\odot} \tag{32}$$

If we assume that the matter in these galaxies is all the pulsating energy of the turbulent flow of dark matter. but

$$E_p = M_M c^2 = 1.5 \times 10^{12} M_{\odot} c^2 = E - 2E_k \tag{33}$$

From this it can be calculated

$$E - 2E_k = \frac{1}{2} M_d (v^2 - v_k^2) = 1.5 \times 10^{12} M_{\odot} c^2 \tag{34}$$

Therefore:

$$\frac{1}{2} M_d (v^2 - v_k^2) = 1.5 \times 10^{12} M_{\odot} c^2$$

$$M_d = \frac{3.0 \times 10^{12} M_{\odot} c^2}{v^2 - v_k^2} \tag{35}$$

Calculated according to the speed of the Milky Way of 700km/s, that is

$$v_k = 700 km/s \tag{36}$$

This can be calculated

$$k \approx \frac{3200}{700} \approx 4.6 \tag{37}$$

Considering that various estimates are actually very different, here is calculated based on the fact that dark matter (including dark energy) accounts for 95% of the total energy (mass) of the universe, and the dark matter energy that drives the Milky Way is

$$M_d = \frac{1.5 \times 10^{12}}{0.05} M_{\odot} = 3 \times 10^{13} M_{\odot} \tag{38}$$

In this way, the flow velocity of the dark matter flow without turbulence can be calculated as

$$v^2 = 0.1c^2 + v_k^2 \tag{39}$$

therefore

$$v = \sqrt{0.1c^2 + v_k^2} \approx 10^5 km/s \tag{40}$$

Although this speed is large, the maximum speed of dark matter is lower than the speed of light, so we can still use approximate methods to calculate the kinetic energy of this fluid.

With the above calculation results, we can calculate some other parameters. According to the diameter of the Milky Way of 100,000 light-years and the mass of the Milky Way, we can calculate the density of the dark matter flow as

$$\rho = \frac{M_M}{V_M} = \frac{1.5 \times 10^{12} M_{\odot}}{\frac{4}{3}\pi \times 50000^3} = 2.87 \times 10^{-3}\ (M_{\odot}/ly^3) \tag{41}$$

Converted to the units of *kg* and *s*, there are

$$\rho = 6.77 \times 10^{-21}\ (kg/m^3) \tag{42}$$

Among them, M_M is the mass of the Milky Way, and the calculation of V_M considers that the distribution of all matter in the Milky Way (including visible matter and dark matter) is a sphere.

In addition, from the diameter of the Milky Way, which is 100,000 light-years, and the distances between the Large Magellanic Galaxy and the Small Magellanic Galaxy next to the Milky Way and the Milky Way, we can estimate that the diameter of the turbulent flow tube is about D = 300,000 light-years.

Combining Equation (29) and Equation (31) in this way, we can estimate the viscosity coefficient of the dark matter flow as

$$700000\frac{\rho D}{\mu} \approx 3200 \tag{43}$$

which is

$$\mu \approx \frac{700000\rho D}{3200} = \frac{700000 \times 6.77 \times 10^{-21} D}{3200} \approx 4200(Pa \cdot s) \tag{44}$$

The viscosity coefficient is relatively large, which may be related to the faster speed of dark matter.

5 Conclusions

At present, in the process of studying the laws of the universe, the use of fluid models to solve cosmic problems has become a trend and has received more and more attention. Including the fluid numerical simulation of the CMB, but also the simulation of the fluid dynamics of the black hole model, and so on. Of course, all of these existing results are basically for visible matter. The fluid-like properties produced by visible matter are essentially caused by the flow of deeper dark matter fluids.

From the analysis of this paper, dark matter fluids mainly include two flow modes: laminar flow and turbulent flow. In Real spacetime, we mainly observe various matter phenomena through the gravitational effects caused by energy, and the generation of this energy in Real spacetime is mainly based on the interaction of electric charges. This results in magnetic monopole interactions and dark laminar flow not being observable in Real spacetime.

However, if the fluid of these dark matter can carry the corresponding energy and affect the visible matter in the real spacetime, the energy effect of the dark matter can also be observed in the real spacetime. Among them, the energy form of magnetic monopoles is mainly represented in real spacetime in the form of rest mass. The energy carried by the laminar flow of dark matter can form gravitational effects similar to gravitational lensing in the large scale of the universe.

The analysis of this paper argues that dark matter turbulence is the basic cause of real spacetime and imaginary spacetime. Due to the turbulence created in the dark fluid, a dissipative structure of energy is formed. This dissipative structure of energy is mainly produced by the vortex of dark matter fluids. The vortex of the dark matter fluid creates a large number of vortex tubes. Each vortex corresponds to a singular string in the quantization of Dirac's charge. At both ends of these vortex tubes in the form of exotic strings, positive and negative charges and positive and negative magnetic monopoles are formed. Of course, because the conditions for quantization of charges can be automatically met, these singular strings cannot produce observable physical effects in real spacetime, and therefore cannot be observed. This can be used to explain the formation of elementary particles, as well as the interactions between elementary particles.

Of course, from the perspective of fluid mechanics, the dark matter fluid must have a corresponding viscosity coefficient inside. This viscosity coefficient may still be relatively large on the cosmic scale, which also leads to dark matter fluids that can only produce turbulence when the flow velocity is relatively high, forming the real spacetime matter we can observe. From some known data, we can roughly estimate the viscosity coefficient of dark matter fluids to be about μ≈4200 (Pa·s)

Although the viscosity coefficient error estimated in this way is relatively large, it can still give us a more intuitive feeling to a certain extent, and then understand some basic properties of dark matter fluids.

Then, by analyzing the more microscopic structure of the dark matter fluid, we found that the dark matter fluid should be composed of more microscopic particles. In this paper, these microscopic particles that make up dark matter fluids are called fieldons. This fieldon has two symbols, positive fieldon and negative fieldon. In this way, we can associate dark matter fluids with the fluid mechanics or solid state physics we are familiar with. The vibrations of dark matter molecules produce electromagnetic waves, which travel at the speed of light, similar to the propagation of sound in fluid mechanics or solid mechanics. The microscopic motion of the dark matter field formed by the fieldon produces dark matter waves. Since we know very little about the nature of this dark matter wave, the ratio of the propagation speed of electromagnetic waves and sound is used in this article to estimate the speed of dark matter waves. The results of this paper suggest that the velocities of dark matter waves may reach $v_d \approx 3 \times 10^{14} m/s$

If such a speed estimate is correct, it means that there are still signal propagation speeds far beyond the speed of light in the universe, and such dark matter waves have become the best choice for interstellar signal communication in the future.

Another important contribution of this paper is to divide the matter in the universe, including dark matter and visible matter, into a hierarchical relationship. Such a hierarchical relationship does not exist in existing physics, including general relativity and so on. This hierarchical relationship is important because it allows us to see the relationship between dark matter and visible matter, rather than studying dark matter on top of the visible matter as it is now.

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A dark matter fluid model based on virtual spacetime

Abstract

This paper constructs a model of the universe based on the flow of dark matter fluids in space-time in the universe, the model analyzes the hydrodynamic equations of dark matter fluids and the composition of dark matter fluids. It is also pointed out that the flow of dark matter fluids can be divided into two states: laminar flow and turbulent flow. The laminar flow of dark matter fluids is the main component of dark matter in the universe at present. The turbulence of dark matter fluids forms two symmetrical space-time. One is observable real spacetime, and the other is unobservable virtual spacetime. Virtual Spacetime is also part of dark matter. In dark matter turbulence, vortex structures of fluids can be formed. When vortexes of electromagnetic fields are formed, electrons, protons and magnetic monopoles are produced. Vortexes of electromagnetic fields will be able to automatically satisfy the conditions for Dirac's quantization of charge. Finally, this paper gives a hierarchy of matter in the universe.

1 Introduction

In my work last year, I envisioned a fluid model of dark matter [1]. This fluid model is composed of dark matter atoms, molecules, etc., and finally forms a dark matter fluid. Following this model, I tried to calculate the viscosity coefficient of dark matter fluids and the effect on the movement of galaxies [2].

Now I have a new idea by reflecting on the virtual spacetime physics [3]. Perhaps the structure of dark matter fluids is simpler than I originally thought. The basic composition of dark matter fluids may be electromagnetic fields. It's just that in the absence of energy input, dark matter fluids will be very stable, forming fluid structures that cannot be observed in our current physical world. But once energy is entered, it causes turbulence in dark matter fluids. The formation of this turbulence will form a separation of electric and magnetic fields on the microscopic structures of the dark matter fluid, and then form a vortex structure of the fluid. This vortex structure is the singular string [4] in the model of Dirac's quantization of charge. With this vortex structure, I have been able to calculate the mass ratio of electrons and protons and analyze the reasons why cause these mass differences [5]. This also brings confidence to the establishment of new dark matter fluid models.

2 Fluid equations and turbulence for dark matter fluids

2.1 Dark matter fluid equations

It can be described using Maxwell's equations [3] that span two space-times. In fact, Maxwell's equations are fluid equations.

With the addition of the description of virtual spacetime magnetic fluids, Maxwell's equations spanning two space-time can more effectively describe this duality of dark matter fluids.

The Maxwell equations in three-dimensional space are

$$\begin{cases} \nabla \cdot \boldsymbol{F} = \rho_e \\ \nabla \cdot \boldsymbol{G} = 0 \\ \nabla \times \boldsymbol{F} = -\dfrac{\partial \boldsymbol{G}}{\partial y} \\ \nabla \times \boldsymbol{G} = \dfrac{\partial \boldsymbol{F}}{\partial y} + \boldsymbol{J}_e \end{cases}$$

The Maxwell equations in three-dimensional time are

$$\begin{cases} \nabla_y \cdot \boldsymbol{G} = \rho_m \\ \nabla_y \cdot \boldsymbol{F} = 0 \\ \nabla_y \times \boldsymbol{G} = -\dfrac{\partial \boldsymbol{F}}{\partial x} \\ \nabla_y \times \boldsymbol{F} = \dfrac{\partial \boldsymbol{G}}{\partial x} + \boldsymbol{J}_m \end{cases}$$

Some common parameters are used here. Thereinto

$$\rho_e = \frac{\rho}{\sqrt{\varepsilon}}$$

$$J_e = \sqrt{\mu}J$$

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

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

In addition, *x, y* is used to represent the time in virtual spacetime and real spacetime. ∇ and ∇_y represent differential operators in Real Spacetime and Virtual Spacetime, respectively.

With these very symmetrical Maxwell's equations, multiple wavefunction solutions can be obtained. At present, the electromagnetic solution has been fully confirmed and applied.

2.2 Laminar and turbulent flow of dark matter fluids

If the dark matter fluid is in a laminar flow state, the electric and magnetic fields in the dark matter fluid are compounded. It cannot be observed in both space-time at this time. But considering that the dark matter fluid is in flow, the dark matter fluid should also be able to absorb energy and accelerate the speed of the fluid.

The absorption of energy also means that it should be able to produce a gravitational effect. This may be the source of the currently observed gravitational phenomenon of dark matter in the universe. It deserves further in-depth analysis.

However, if the dark matter fluid absorbs energy, the flow of the fluid is disturbed, resulting in the separation of the electric field or magnetic field in the fluid, then it corresponds to the propagation of electromagnetic waves in the dark matter fluid.

From the solution of Maxwell's equations, the wave equation of electromagnetic waves is the most important solution. Therefore, electromagnetic waves reflect the fluctuation phenomenon of dark matter fluids. The fluctuation of this fluid is similar to the propagation of sound in the fluid, capable of transmitting energy. Electromagnetic waves do not cause energy dissipation during propagation, so this is just a property of dark matter fluids transmitting oscillating signals.

However, if the input of energy causes the dark matter fluid to vortex, this will lead to the phenomenon of energy dissipation. This also means that the dark matter fluid has a turbulent phenomenon.

Given that the structure of dark matter fluids is relatively simple, the turbulence formed mainly occurs in the form of electromagnetic vortex tubes. These electromagnetic vortexes make up the elementary particles in Real spacetime and Virtual spacetime: electrons, protons, and magnetic monopoles.

Dark matter fluids should be viscous. This viscosity affects the formation of turbulence. If the viscosity of the dark matter fluid is relatively low, turbulence can be formed when the dark matter fluid flow rate is not very large. If the viscosity of the dark matter fluid is relatively large, turbulence needs to be formed when the flow velocity of the dark matter fluid is relatively large.

Considering that the current speed of the solar system in the Milky Way reaches nearly three hundred kilometers, and the entire galaxy may travel at a speed of seven hundred kilometers, the viscosity coefficient of dark matter fluid should be relatively large.

If we assume that dark matter occupies 95% of the entire universe, and gravity is the cause of dark matter viscosity, then through the calculation of paper [2], we believe that the viscosity coefficient of dark matter fluids can be achieved

$$\mu \approx 4200(Pa \cdot s)$$

In contrast, the viscosity coefficient of water at 27 °C is $0.85 \times 10^{-3} Pa \cdot s$

2.3 Electromagnetic field vortex and charge quantization

The generation of turbulence in dark matter fluids means that the electric and magnetic fields of dark matter fluids are separated to form a vortex structure of fluids. Such a vortex structure is manifested in countless electric and magnetic field vortex tubes.

We can obtain the standing wave solution of electromagnetic waves through the charge quantization conditions envisaged by Dirac. This standing wave solution corresponds to the vortex in the fluid [6]. Each vortex connects positive and negative charges or magnetic charges together to form the elementary particles that make up the matter world. The structure of the vortex tube can be done in this way with the Dirac singular string. A Dirac singular string resembles an infinitely long solenoid.

Since there are two space-time, such a singular string needs to have two, one in the virtual spacetime is formed by the magnetic current, the singular string will generate electrons and protons at the real spacetime at both ends. The other, located in Real spacetime, is a singular string formed by the rotation of an electric field. The Singular string will generate two magnetic monopoles in Virtual spacetime.

In order to form a magnetic monopole in a virtual spacetime, this requires a singular string formed by an electric field rotational current in the real spacetime. It needs to meet the conditions for the Dirac's quantization of charge to ensure that the singular string will not be observed in real spacetime.

The magnetic currents that form the electric charge, the Singular string, follow similar quantization conditions, ensuring that the existence of the Singular string cannot be measured in Virtual spacetime.

The rotating electric field that forms the magnetic monopole is located at the location of electrons and protons. Due to the small radius of electrons, the electric field rotates relatively quickly, possibly exceeding the speed of light. If the proton radius is relatively large, the rotation speed of the electric field is relatively small. In this way, the spin angular momentum generated by the spins of two electric fields is equal.

Of course, the spin of this electric field can also generate observable magnetic moments in real spacetime. But the magnetic moment itself does not carry energy, which is different from the magnetic monopole.

Since the magnetic charge coexists with the electric charge, it is necessary to use the Schwinger charge quantization condition, ie

$$eg_e = \frac{2nh}{\mu}$$

After the calculation of the magnetic monopole magnetic charge [6] generated by the rotating electric field, the quantization conditions described above can be found

$$n = 1$$

This shows that the conditions for quantization of the charge are automatically satisfied. In this way, the vortex formed between electrons and protons is not visible.

3. Structure of dark matter fluids

3.1 Fluids composed of electric and magnetic fields

By observing electromagnetic waves, we can find an interesting phenomenon, that is, the electric and magnetic field oscillations in electromagnetic waves are symmetrical. That is, once the electric field oscillates, the magnetic field also oscillates in the same phase. Electromagnetic waves carry energy, which means that the basic reason for the separation of electric and magnetic fields when energy occurs. If no energy is present, the electric and magnetic fields will be a complex body. This may be the true state of the vacuum.

Therefore, we can further assume that the universe is full of dark matter fluids, which are a complex of electric and magnetic fields without being disturbed by energy. Therefore, if no energy enters, the dark matter flow will be very smooth and unobservable.

But if there is an energy input, there are two possible scenarios, the first is to increase the speed of the dark matter fluid. But this does not create turbulence, in the second case it does. Since turbulence consumes additional energy and is a dissipative structure, turbulence will be able to be observed, forming the visible matter world we now have.

According to the above assumptions, the turbulence of dark matter fluids is essentially the separation of electric and magnetic field flows, which in turn leads to quantization in the form of electric or magnetic charges. This is what we see as electrons and protons.

The formation of turbulence in dark matter fluid is related to the flow rate of dark matter fluid and the viscosity of dark matter fluid. If the flow rate of the dark matter fluid is too fast, or the viscosity of the dark matter fluid is not high enough, it is easy to produce turbulence. For the viscosity coefficient of dark matter fluids, I estimated it in [2].

Fig. 1 shows the contrast between the electromagnetic waves formed by the separation of electric and magnetic field oscillations and the turbulence of dark matter fluids.

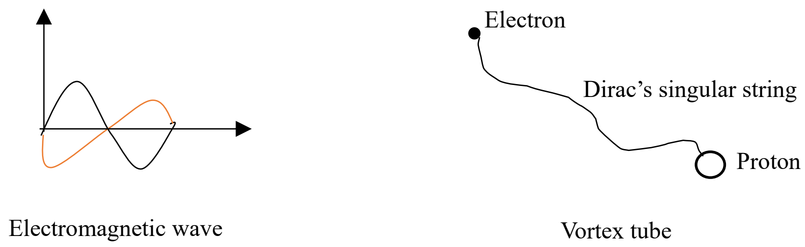

Fig. 1. EM wave and turbulence of dark matter fluids

3.2 Microstructure of dark matter fluids

Obviously, if the dark matter fluid can propagate electromagnetic waves, then the dark matter fluid must have a finer structure, so as to meet the needs of electric and magnetic field oscillations. This finer structure means that there must be vibrational waves in dark matter fluids faster than the speed of light.

This can be analyzed from the analogy between sound and electromagnetic waves. The propagation of sound takes the form of phonons, while the propagation of electromagnetic waves is in the form of photons. In solid state physics, vibrations in the lattice produce phonons. The vibration of this lattice is caused by thermal motion, which of course is also the result of energy input.

The viscosity coefficient of dark matter fluid is relatively large, which also shows that if dark matter has a fine structure, then the interaction between the most basic particles that make up dark matter should be relatively strong.

But on the other hand, in contrast to the vibration of sound, electromagnetic wave oscillation only has the separation and recombination of electric and magnetic fields. It can be seen from here that the microstructure of dark matter fluids should be much simpler than the microstructure of matter.

Considering the two properties of the electric field and magnetic field of dark matter fluids, we can divide the most basic particles composed of dark matter fluids into two types: one is electric fieldon, and the other is magnetic fieldon.

When the dark matter fluid is in a laminar flow state, the electric fieldon and the magnetic fieldon are in equilibrium, forming dark matter molecules. Once there is an energy input, the distance between the electric fieldon and the magnetic fieldon oscillates.

If it is an electromagnetic wave, dark matter molecules will propagate this vibration. And if the electric fieldon and magnetic fieldon in the dark matter molecule only oscillate locally and meet the conditions for quantization of the charge, so-called electrons and protons will be formed.

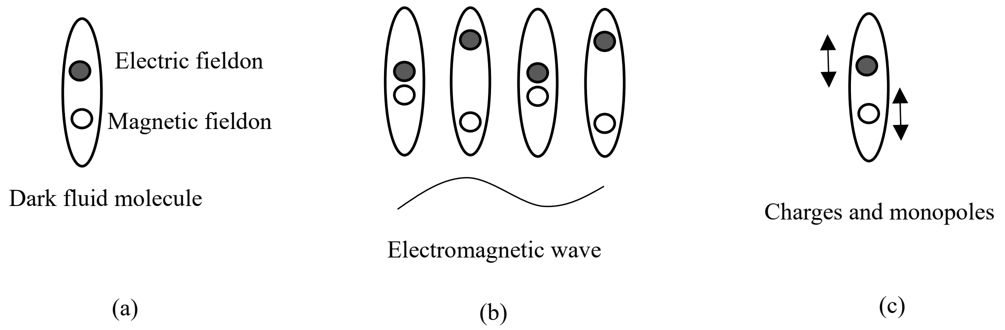

Fig. 2. Dark fluid molecule and energy

In Fig. 2, (a) is a dark fluid molecule. It consists of two elementary dark particles, Electric fieldon and Magnetic fieldon. (b) shows that when electromagnetic waves propagate, they cause the distance between two fieldons in dark molecules to oscillate and propagate. (c) shows that if the fieldon inside the dark molecule only oscillates, it does not propagate the energy of this oscillation. This is where the charge and magnetic monopoles appear. In the article [6], it has been proved that such oscillations can automatically satisfy the charge quantization conditions. The oscillations of the magnetic fieldon form electrons and protons, which make up the real spacetime we can observe. The oscillations of Electric fieldon form magnetic monopoles, so-called virtual spacetime or imaginary spacetime. Such a virtual spacetime cannot be observed in a real spacetime.

4 The level of matter in the universe

We can make a hierarchical division of the composition of matter in the universe. The bottom layer is the dark matter fieldon, which is composed of two dark matter fieldons with different properties to form dark molecules. Dark molecules interact to form dark matter fluids. Dark matter fluids fill the entire universe and flow through it.

When energy is transferred to dark matter fluids, laminar and turbulent flows can be created. Through laminar flow, energy can accelerate dark matter fluids or use it to transmit electromagnetic waves. Turbulence can form electrons, protons, and magnetic monopoles. Electrons and protons make up the observable real spacetime. Magnetic monopoles, on the other hand, make up virtual spacetime. Interactions between particles such as electrons and protons are mainly achieved by exchanging photons (propagating electromagnetic waves).

Fig. 3 shows the hierarchy of the matter composition of the universe. The orange text box in the figure represents the observable matter world. As can be seen from the figure, the matter that can be observed only accounts for a small part of the entire composition of matter in the universe.

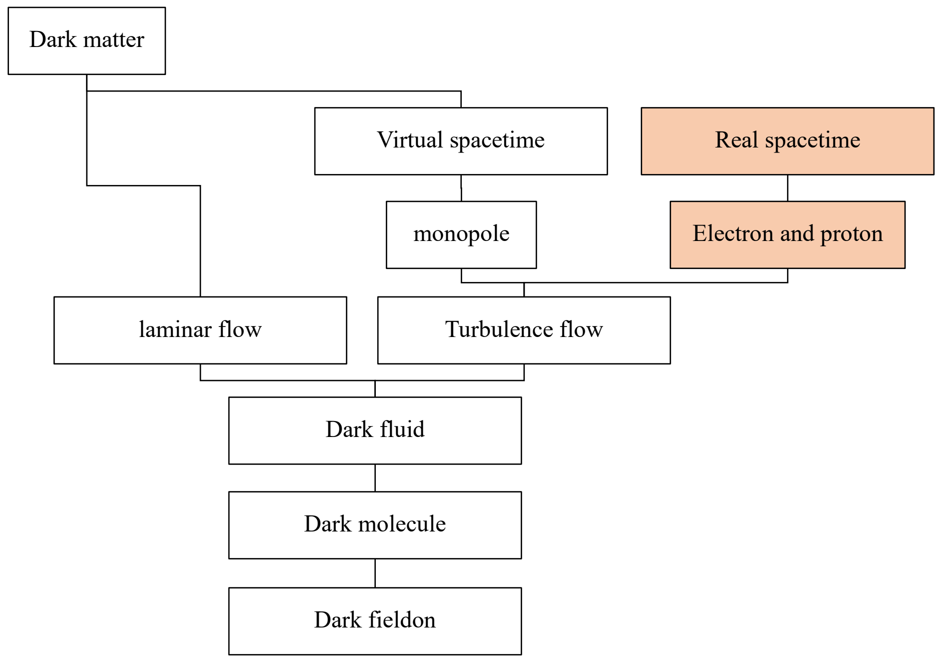

Fig. 3. The level of matter composition of the universe

5 Conclusions

From the above analysis, it can be seen that the structure of the universe may be much more complex than the physics we know now. What we currently know may be just one of many flow modes of dark matter fluids. In fact, from the Maxwell equations based on virtual spacetime, there are dozens of solutions to the wave equation across two space-time [3], which means that we can only observe a few of these oscillation modes, and many more oscillation modes that we cannot observe.

In addition to the turbulence of dark matter fluids caused by the input of energy, dark matter fluids also have the ability of laminar flow. The laminar flow of this dark matter fluid is difficult to observe by Real Spacetime. This also means that there are more dark matter laws that we cannot directly detect. Perhaps on the cosmic scale, the energy transfer methods of these dark matter fluids would produce some observable effect. For example, gravitational lensing of dark matter and other cosmic macroscopic phenomena. But I believe this is still only a very small number of observable effects of dark matter fluids.

If we consider the structure of dark matter fluid molecules. Just like the elementary particles, atoms, and molecules in our real spacetime matter world, the molecular structure of dark matter fluids has a hierarchy. This means that on bottom of our existing particle physics, there may be a dark matter particle physics. Dark matter particle science will contain knowledge that completely surpasses all of our current theoretical physics. It is believed that faster-than-light is a very common phenomenon in it, which also makes it possible for us humans to communicate quickly with the wider cosmic world.

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A fluid model of dark matter

Abstract: This paper further constructs a new dark matter model based on my previous work. In this model, it is assumed that the dark matter existing in the universe exists in the form of a fluid. This dark matter fluid may be gaseous and possibly liquid. Since the scale of the universe is very large, and the dark matter fluid may encounter various disturbances when it flows, the thermodynamic parameters of dark matter in different locations, including pressure and temperature, may change. And these changes in temperature, pressure, etc., may lead to changes in the flow velocity and viscosity coefficient inside the dark matter fluid. These changes will cause changes in the Reynolds number of dark matter fluids. In fluid mechanics, we already know that if the Reynolds number exceeds a certain critical value, then the fluid will produce turbulent flow. There are many forms of turbulence, among which vortex is one of the forms of turbulence. Among the various galaxies we have observed so far, spiral galaxies are relatively common. If these spiral galaxies are turbulent flows of dark matter fluids, then we can explain many incomprehensible galactic

phenomena. For example, why the scale of the Milky Way reaches 100,000 light-years, but the gravitational effect of the Milky Way can cover the entire Milky Way. In fact, using the dark matter fluid model, these problems can be easily solved if we think of each galaxy as a swirling airflow like a hurricane on Earth. In this paper, some properties of dark matter fluid are calculated, and the relationship between the viscosity coefficient and gravitational constant of dark matter fluid is analyzed. I also point out that if we can understand how the variation of the viscosity coefficient of the dark matter fluid is related to the inhomogeneity of the dark matter fluid, then we can hope to calculate the variation of the gravitational constant. So as to solve the problem of why it is difficult for us to accurately measure the gravitational constant. In addition, I have also estimated the velocity of the dark matter fluid based on some known data, and obtained approximate results of the dark matter mass, flow velocity, and viscosity coefficient. It is believed that these results will be helpful for us to further analyze the thermodynamic properties of dark matter. This paper assumes that dark matter also conforms to the laws of thermodynamics. Dark matter has volume, temperature, and pressure, and the interaction between dark matter conforms to the van der Waals equation. The dark matter fluid conforms to the conservation of momentum and energy.

1 Introduction

Dark matter is a substance with many properties in an unknown state in current physics. Unfortunately, we currently know very little about dark matter. Of course, various phenomena observed on a scale like the universe have strongly shown the existence of dark matter. This shows that we need a new model to explain the laws of physics in the universe we live in.

The fluid model of dark matter [1, 2] is mainly based on the following important facts.

First of all, the limitation of the action distance of various interactions that we know so far. That is, all known interactions, including gravitational interactions, electromagnetic interactions, etc., are limited by the speed of light. Although the speed of light is very fast compared to humans, the speed of light is actually very, very slow on the scale of the universe we have observed so far. This is actually the same as the speed of a sound signal at the center of a storm. Although the speed of the sound signal far exceeds the speed at which the storm can move, that speed is very limited relative to the size of the entire Earth.

From the facts of the galaxies that have been observed so far, all kinds of galaxies show a phenomenon of material aggregation. We know that the mass of matter is actually energy, which means that the accumulation of galaxies is the accumulation of energy. From a variety of shapes, galaxies are mainly a spiral structure. And this spiral structure is basically the same as what we now know as storms on the earth, that is, the gathering effect of energy generated by the flow of air. Considering that air is a kind of fluid, is it possible that the formation of this cosmic "storm" may also be the effect of a fluid? If we think that dark matter is such a fluid, then it should also be able to form turbulent phenomena unique to various fluids.

Another fact is that we currently have very poor measurements of the gravitational constant. And what we now know is that dark matter also has gravitational interactions. Given the limited distance of gravitational interaction, we can even think of gravitational interaction as a very close interaction between dark matter molecules. This shows that the viscosity coefficient of dark matter is directly related to the magnitude of the gravitational interaction. If dark matter also has the same thermodynamic effects as all kinds of matter we know now. That means that dark matter also has temperature, pressure, volume, and molecular interactions between dark matter, which also leads to the phenomenon that dark matter may produce various turbulence when it flows. And we now know the matter, its viscosity coefficient is affected by temperature, but also by pressure. If dark matter is flowing with uneven temperature distribution, it will naturally lead to changes in its viscosity coefficient. This leads to a change in the gravitational constant.

To this end, we try to build a fluid model of dark matter. In this model, the flow of dark matter fluids through the universe will be included. And this dark matter fluid has basically similar properties to the fluids we now know as gases, liquids, and so on. So we can calculate the temperature, pressure and volume of the dark matter fluid, as well as the interactions between the molecules inside the dark matter. And then calculate the viscosity coefficient of dark matter fluid.

When analyzing turbulence problems, one of the most useful parameters by far is the Reynolds number. Among the fluids we now know, the critical value of the Reynolds number is generally 3200. If the critical Reynolds number is exceeded, turbulent flow will occur. The Reynolds number is mainly directly related to the velocity of the fluid. If the density of the fluid, the diameter of the flow tube, and the coefficient of viscosity of the fluid are determined, the faster the speed, the larger the Reynolds number and the greater the likelihood of turbulent flow. Combined with the data of some cosmic galaxies we have observed now, we can roughly analyze some important properties of dark matter fluids.

2 Conditions for turbulent flow in dark matter fluids

If dark matter is regarded as a fluid, the fluid has a viscosity coefficient μ. If the velocity of dark matter flow is v, the Reynolds number can be calculated as:

$$R_e = \frac{\rho v D}{\mu} \tag{1}$$

The condition for dark matter to form turbulent flow is that the Reynolds number is greater than a certain critical value. The current critical value of the Reynolds number in the matter world is 3200. It can be seen from formula (1) that the Reynolds number of the dark matter fluid is mainly related to such factors, including the density of the dark matter fluid, the diameter of the channel through which the dark matter fluid flows, the viscosity coefficient of the dark matter fluid and the velocity of the dark matter fluid.

For example, as the viscosity coefficient of dark matter fluid increases, the dark matter fluid is less likely to form turbulent flow. The faster the flow of dark matter, the easier it is to form turbulence. Of course, the denser the dark matter, the easier it is to form turbulence.

3 Viscosity coefficient and gravitational constant of dark matter

An important parameter in the dark matter fluid is the viscosity coefficient of the dark matter fluid. The viscosity coefficient of dark matter fluid is mainly the interaction between dark matter molecules. This can be explained by the van der Waals constant a. In the van der Waals equation:

$$\left(p+\frac{a}{v^2}\right)(v-b)=kT \tag{2}$$

The larger the constant a, the larger the viscosity coefficient. therefore:

$$\mu \propto a$$

or

$$\mu = ka$$

Of course, if we assume that all dark matter in the universe exists uniformly, the viscosity coefficient should be the same, which can be regarded as a constant. But if we consider that dark matter fluids also have the same thermodynamic properties as the objects we know today. That means that the viscosity coefficient of the dark matter fluid should be related to the temperature and pressure of the dark matter fluid. Generally, the higher the temperature of the fluid, the lower the viscosity coefficient.

There is already some evidence that dark matter is affected by gravitational interactions. Gravitational interactions lead to stronger gravitational interactions as dark matter piles up. This is one reason dark matter becomes less stable. Therefore, we can assume that the interaction between dark matter molecules is directly related to the gravitational interaction. If this assumption is true, it means that by calculating the change in the viscosity coefficient of the dark matter fluid, we can also calculate the change in the gravitational constant.

We can express such a relationship as a function. First of all, for the interaction force between dark matter molecules, there are:

$$a = f(G)$$

In this way, the viscosity coefficient of the dark matter fluid is also a function of G, which can be expressed as:

$$\mu = kf(G)$$

We further assume that if the viscosity coefficient of the dark matter fluid is a monotonically increasing function of G, it means that the larger the G, the smaller the Reynolds number, and the less likely it is to form turbulent flow.

Considering that if dark matter is distributed in the entire universe, even in the solar system, if the temperature distribution is uneven, it may cause fluctuations in the gravitational constant. And if we analyze what factors cause the uneven temperature distribution of dark matter, we should be able to calculate fluctuations in the gravitational constant.

4 Inequality of inertial force and gravitational force

If we consider that dark matter is a more macroscopic state of matter, and gravity is limited by the speed of light of gravitational waves, gravity is actually a microscopic force on the scale of the entire universe. If there is a force in dark matter that is more macroscopic than gravity, that force can also be equivalent to another inertial force. In this case the inertial force will not be equivalent to Newtonian or relativistic gravitational force. Perhaps under the influence of this more macroscopic dark-gravity, we can find cases where the equivalence principle of general relativity fails.

Considering this dark-gravity should be able to cause dark matter to realize the overall motion of the cosmic scale, such as the flow of dark matter. The range of this force should be very large. Of course, the dark-gravitational wave formed by this force naturally propagates faster than the speed of light. Of course, since the interaction occurs on the macroscopic scale of the universe, this dark-gravity should be a very weak interaction.

In this way, galactic matter operates on a more macroscopic scale, and dark matter has at least two interactions. One is the interaction between dark matter molecules and atoms. This interaction is very similar to electromagnetic interaction. The intensity of action is very strong, but because it does not have a cumulative effect. This interaction between dark matter molecules should be produced by positive and negative darkon (or Anzi [1]). It cannot directly cause the motion of dark matter on a cosmic scale. And more darkons are combined together to form the aggregation of dark matter, then a dark-gravity can be formed at this time. This kind of dark-gravity is the very weak force that can constrain the motion of the entire dark matter fluid, but the action distance is very long.

The interaction between positive and negative darkon can be represented by Figure 2.

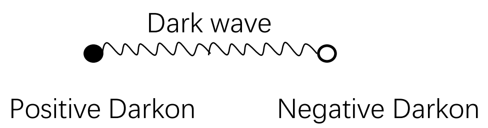

Figure 1. Interaction between Darkons

The figure shows that in the microscopic state, there is an interaction between two darkons of opposite signs. The interaction between darkons with opposite signs is mainly accomplished by exchanging dark waves. If Dark waves correspond to electromagnetic waves, then there should also be a dark-gravity interaction formed by the aggregation of dark matter atoms composed of Darkon.

Dark-gravity is a more macroscopic interaction than gravitational interaction. Of course, according to the inference of gravitational waves, we can also know that dark-gravity mainly propagates through dark-gravitational waves. Both dark waves and dark-gravitational waves should be limited by the maximum velocity in dark matter. That is to say, we should also be able to apply the knowledge of relativity to deal with the laws of physical motion in the dark matter world. It's just that the propagation speed of a dark wave or dark-gravitational wave is much faster than the speed of light. I have pointed out in an earlier article that the propagation speed of a dark wave or dark-gravitational wave may reach $v_d \approx 3 \times 10^{14}\, m/s$ [2]

5 Dark matter flow and turbulence in the universe

With the previous assumptions of dark wave and dark-gravitational wave, then we can have a more intuitive picture of the dark matter fluid in the universe. Considering that it is more appropriate to adopt a closed four-dimensional model of the entire universe, this is similar to the surface of the earth on which we humans live. The flow of the entire atmosphere and ocean on the earth's surface is a cyclic circular motion. Then the dark matter in the universe is basically such a circular motion. The only difference between it and the surface of the earth in the universe is that the universe is a four-dimensional space-time, while the surface of the earth can be approximately regarded as a three-dimensional space-time. The ultra-long-range effect of the considered dark-gravity is very weak, so the flow of dark matter is mainly restricted by the dark-gravity. Therefore, in the fluidity of the entire dark matter flow, the possibility of a spiral vortex structure similar to the atmospheric flow is relatively high. What constrains this vortex structure is the limitation of dark-gravity. This dark-gravity restriction results in a cosmic-scale Coriolis force constraining the flow of dark matter.

Figure 2 assumes that the flow of dark matter throughout the universe is a giant vortex.

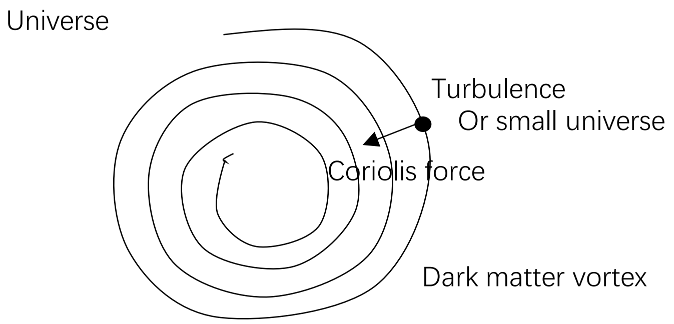

Figure 2. The Dark Flow and Turbulence

As can be seen from Figure 2, in the entire universe, Dark Flow is a huge vortex. And somewhere in the vortex, there is turbulence due to too fast flow. What these turbulences represent is a galaxy.

If Dark Flow also conforms to the laws of thermodynamics. Then Dark Flow is mainly affected by thermodynamic parameters such as temperature and pressure. On the periphery of Dark Flow, the flow velocity is very fast, which makes it easier to form turbulent flow on the periphery of Dark matter vortex. Each turbulent location can be thought of as a miniature universe. The appearance of turbulence leads to uneven temperature and pressure distribution in Dark Flow, which leads to the appearance of countless Dark Typhoons locally. And a Dark Typhoon can be regarded as a galaxy.

6 Estimate some parameters of dark matter flow based on existing cosmic observations

Of course, because the Milky Way is too large for humans, the various cosmic parameters we have now are actually very similar. It can only be the result of an estimate, and the error of the estimate will be quite large.

The idea of the whole estimation is as follows. First of all, we think that the energy of dark matter turbulence mainly includes translational kinetic energy and pulsation kinetic energy. Translational kinetic energy is the state in which dark matter fluids flow without creating turbulence. And once the turbulence is generated, there will be pulsations of the dark matter fluid, and this pulsation also carries energy. Therefore, if there is turbulent pulsation, part of the energy will be absorbed, resulting in a decrease in the translational kinetic energy of the fluid.

At present, there have been some estimates of the overall mass of the Milky Way, and the reliability of these estimates is still relatively high. Therefore, we can estimate some important parameters of the dark matter fluid from the mass of the Milky Way. Considering that in the theory of relativity, we have equalized mass and energy, the mass of the Milky Way actually reflects the pulsating energy of the turbulent dark matter fluid. This is what we can directly observe.

The translational energy of dark matter fluids is something we cannot observe, but these translational energies also have an effect on the pulsating energy, which is the effect of dark matter on the motion of galaxies. It can also be seen from this that there is indeed a Newtonian gravitational interaction between dark matter and matter.

At present, the proportions of dark matter, dark energy, etc. we estimate in the entire universe vary greatly [4]. Here, dark matter and dark energy account for 95% of all matter for calculation. This means that the total mass of the Milky Way actually reflects about 5% of the energy of the dark matter fluid, from which we can estimate the total mass and energy of the dark matter that drives the flow of visible matter in the Milky Way or the entire Milky Way.

Assuming that in a certain cosmic region, the volume is V, the volume of turbulent flow is V_T, and the volume of the remaining advection is V_q. Then

$$V = V_q + V_T \tag{3}$$

From a macroscopic level, the overall energy density of dark matter should be uniformly distributed. therefore

$$\rho = \frac{E}{V} = Const.$$

The translational kinetic energy of all dark matter fluids is reduced due to turbulent pulsations that absorb some of the energy. It is assumed that the translational kinetic energy of turbulent flow is equal to that of normal fluid. therefore:

$$E = E_k + E_p \tag{4}$$

Where E_p is the pulsating energy.

Applying it to the motion of galaxies, in this formula E_p corresponds to the mass of the Milky Way.

This is done by:

$$E = \frac{1}{2} M_d v^2 \tag{5}$$

where M_d is the total mass of dark matter. Before the turbulence is generated, the velocity v of the dark matter flow.

After the turbulent flow is generated, the translational kinetic energy of the dark matter drops to v_k, so in the dark matter flow that generates the turbulent flow, the translational kinetic energy in it becomes

$$E_k = \frac{1}{2} M_d v_k^2 \tag{6}$$

It is obvious that $v_k < v$. This is because a part of the translational kinetic energy before the turbulent flow is not generated is consumed as the pulsating kinetic energy E_p of the turbulent flow.

According to the calculation formula of Reynolds number:

$$R_e = \frac{\rho v D}{\mu} = \frac{\rho D}{\mu} v = kv \tag{7}$$

The critical value of Reynolds number is

$$R_c = 3200$$

This can be calculated

$$v > \frac{3200}{k} \tag{8}$$

The formation of turbulent flow proves that the flow rate has just reached the critical point. therefore

$$v_k \approx \frac{3200}{k} \tag{9}$$

Considering the mass of the Milky Way is [3]:

$$M_M = 1.5 \times 10^{12} M_{\odot} \tag{10}$$

If we assume that the matter in these galaxies is all the pulsating energy of the turbulent flow of dark matter. but

$$E_p = M_M c^2 = 1.5 \times 10^{12} M_{\odot} c^2 = E - 2E_k \tag{11}$$

From this it can be calculated

$$E - 2E_k = \frac{1}{2} M_d (v^2 - v_k^2) = 1.5 \times 10^{12} M_{\odot} c^2 \tag{12}$$

Therefore:

$$\frac{1}{2} M_d (v^2 - v_k^2) = 1.5 \times 10^{12} M_{\odot} c^2$$

$$M_d = \frac{3.0 \times 10^{12} M_{\odot} c^2}{v^2 - v_k^2} \tag{13}$$

Calculated according to the operating speed of the Milky Way of 700km/s, that is

$$v_k = 700 km/s \tag{14}$$

This can be calculated

$$k \approx \frac{3200}{700} \approx 4.6 \tag{15}$$

Considering that various estimates are actually very different, here is calculated based on the fact that dark matter (including dark energy) accounts for 95% of the total energy (mass) of the universe, and the dark matter energy that drives the Milky Way is

$$M_d = \frac{1.5 \times 10^{12}}{0.05} M_{\odot} = 3 \times 10^{13} M_{\odot} \tag{16}$$

In this way, the flow velocity of the dark matter flow without turbulence can be calculated as

$$v^2 = 0.1c^2 + v_k^2 \tag{17}$$

therefore

$$v = \sqrt{0.1c^2 + v_k^2} \approx 10^5 km/s \tag{18}$$

Although this speed is large, the maximum speed of dark matter is much faster than the speed of light, so we can still use approximate methods to calculate the kinetic energy of this fluid.

With the above calculation results, we can calculate some other parameters. According to the diameter of the Milky Way of 100,000 light-years and the mass of the Milky Way, we can calculate the density of the dark matter flow as

$$\rho = \frac{M_M}{V_M} = \frac{1.5 \times 10^{12} M_{\odot}}{\frac{4}{3}\pi \times 50000^3} = 2.87 \times 10^{-3} \ (M_{\odot}/ly^3) \tag{19}$$

Converted to the units of kg and s, there are

$$\rho = 6.77 \times 10^{-21} \ (kg/m^3) \tag{20}$$

Among them, M_M is the mass of the Milky Way, and the calculation of V_M considers that the distribution of all matter in the Milky Way (including visible matter and dark matter) is a sphere.

In addition, from the diameter of the Milky Way, which is 100,000 light-years, and the distances between the Large Magellanic Galaxy and the Small Magellanic Galaxy next to the Milky Way and the Milky Way, we can estimate that the diameter of the turbulent flow tube is about D = 300,000 light-years.

Combining Equation (7) and Equation (9) in this way, we can estimate the viscosity coefficient of the dark matter flow as

$$700000\frac{\rho D}{\mu} \approx 3200 \tag{21}$$

which is

$$\mu \approx \frac{700000\rho D}{3200} = \frac{700000 \times 6.77 \times 10^{-21} D}{3200} \approx 4200(Pa \cdot s) \tag{22}$$

The viscosity coefficient is relatively large, which may be related to the faster speed of dark matter.

7 Conclusion

From the above analysis, we can already see more evidence for the existence of dark matter fluid in this more macroscopic state. At present, I am very happy to see that some scholars are beginning to be interested in the fluid model of the universe [5]. And use the fluid model of the universe to analyze the basic composition of matter.

Usually when we study the laws of physics, one of the most basic questions we have to face is what is space-time. However, I feel that at the current stage, it may not be the right time to answer what time and space are. From the analysis of this paper, dark matter is just a cosmic state that is more macroscopic than our current material world. But in this article, to solve the problem of dark matter, we still have to rely on the existing space-time coordinates, including the time coordinates and the coordinates of the three spatial dimensions. The reason why I have to do this may be that I don't know whether there is a more macroscopic "dark dark-matter" world outside the macroscopic dark matter world. But I believe that if we can solve the dark matter world that is one level larger than the matter world we currently know, it will bring us a lot of hope for solving the problem. For example, if we are now conducting interstellar communication, we need to communicate with the nearest star system, and the light signal must travel for at least 4 years. This of course will not allow us to achieve efficient and high-speed communication between galaxies in the limited life years of human beings. Not to mention the star systems of other galaxies that are likely to harbor life. Those star systems that we know are likely to harbor life are thousands or even hundreds of thousands of light-years away from us. For humans, these exoplanets are practically out of reach. But if we can master the laws of the dark matter world at a macroscopic level than our current physical world, we should be able to use faster dark waves to communicate and obtain various information about the evolution of life in more distant galaxies.

Although the work we are doing is very preliminary, bringing hope is something worth striving for.

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A particle model based on virtual spacetime

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

$$r = \sqrt{\frac{2G\hbar}{c^3}} \tag{12}$$

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

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

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

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

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

$$r = \frac{\hbar}{mc} \qquad (14)$$

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

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

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:

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

The electromagnetic radius of the proton is

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

The electromagnetic radius of electrons is:

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

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 Dirac Equation and Imaginary Spacetime

The Dirac equation first represented relativistic energy in a linear form. This successfully separated the two space-time dimensions. In this way, energy can be represented as

$$E = \alpha^i p_i c + \beta mc^2$$

Where α^i refers to the three dimensions of space. And β is the imaginary time-space dimension, represented in tensor form.

$$E = \begin{pmatrix} mc & 0 & -ip_3 & ip_1 - p_2 \\ 0 & mc & -ip_1 + p_2 & ip_3 \\ ip_3 & ip_1 + p_2 & -mc & 0 \\ ip_1 - p_2 & -ip_3 & 0 & -mc \end{pmatrix} c$$

5 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.

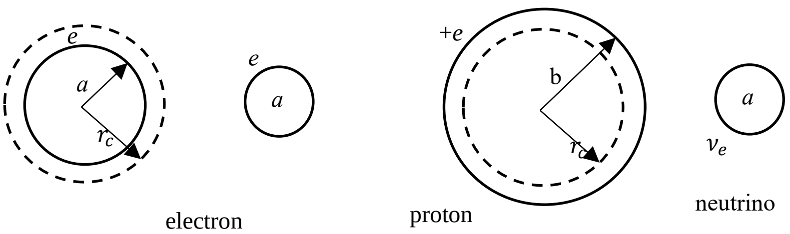

Fig. 1. Electromagnetic structure of electrons, protons, and electron neutrinos

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.

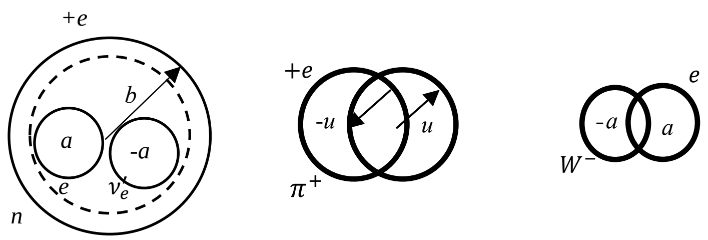

Fig. 2. Electromagnetic structure of neutrons, mesons and bosons

6 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.

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A charge-quantization model based on virtual spacetime

Abstract

Nearly 100 years have passed since the Dirac charge quantization model was established, but unfortunately one of the most important factors, magnetic monopoles, has not yet been detected. This paper attempts to solve this problem using the theory of virtual spacetime or imaginary spacetime. By treating the electric field rotation of electrons and protons as an infinitely long solenoid, and then calculating the magnitude of the magnetic charge carried by the magnetic monopole from the known parameters of the electrons and protons. In this way, it can be seen whether such a result can meet the requirements of charge quantization. The calculation results show that if the magnetic monopole is confirmed in the presence of virtual spacetime, the conditions for quantization of the charge can be automatically satisfied. This proves that the singular strings connecting electrons and protons cannot be observed. The automatic satisfaction of the charge quantization condition means that there can be no singular strings in the physical world that do not meet the charge quantization conditions.

1 Introduction

In the 20s of the last century, Dirac explored the quantization of electric charges. By introducing a singular string, as long as certain quantization conditions are met, the wave function of the electric field or magnetic field will not produce a physical effect on the singular string. The Dirac charge quantization model is physically and mathematically perfect. Nearly 100 years later, there is no better physical or mathematical model to explain the quantization of electric charge. However, magnetic monopoles must be introduced in the conditions of charge quantization. However, nearly 100 years have passed so far, and there is no conclusive evidence of the existence of magnetic monopoles. This also led to Dirac in his later years who seemed to have the idea of abandoning the magnetic monopole hypothesis.

However, at present, through the assumption of virtual spacetime or imaginary spacetime [1], we can very effectively place the existence of magnetic monopoles in virtual spacetime. Considering that the electric and magnetic fields in the electromagnetic field are very symmetrical, in the face of the physical laws of the unobservable virtual spacetime, we can transfer the laws in the real spacetime to the virtual spacetime according to the requirements of symmetry.

In this paper, some important properties of magnetic monopoles will be analyzed through existing observation experimental data of electrons and protons. See if the current charge characteristics of electrons or protons can be used to obtain results that meet the requirements of Dirac quantization of charge.

2 Flaws in the Dirac charge quantization model

The model of Dirac's charge quantization is relatively perfect, but there are some problems, and these flaws are mainly manifested

First, there is no definitive experimental evidence for the existence of magnetic monopoles, and the existence of magnetic monopoles is a necessary condition for the Dirac quantization of charge.

Second, the Dirac quantization of the charge only describes the magnetic monopoles produced by the rotation of the electric field. If the electric and magnetic fields under consideration are symmetrical, since the rotation of the electric field can produce magnetic monopoles, the rotation of the magnetic field should also be able to generate an electric charge. To solve this problem, Schwinger's two-string singular potential can be used. The two-string singular potential solves the problem of both magnetic monopoles and electric charges exist at the same time.

Third, the Dirac charge quantization condition only tells us why the existence of singular strings cannot be observed, but if there are still singular strings in the universe that do not meet the requirements for charge quantization, can these singular strings that cannot be quantized by charge be measured? And if you can't answer this question, it means that you can't explain how Dirac's strange strings are produced.

3 Elementary particle model based on Virtual Spacetime

The elementary particle model based on Virtual Spacetime [2] assumes that electrons and protons are symmetric particles. Due to the existence of virtual spacetime or imaginary spacetime, this means that electrons and protons are complex of electric charges in real spacetime and magnetic monopoles in virtual spacetime. The energy contained in the magnetic monopole of Virtual Spacetime is reflected in the mass of the particle in Real Spacetime.

Because the electric field energy of electrons in real spacetime is larger, considering the need for symmetry, the magnetic monopole energy of electrons in virtual spacetime will be relatively small, which results in a smaller mass of electrons. The electric field energy of protons in real spacetime is smaller, and their magnetic monopole energy in virtual spacetime will be large, which leads to a relatively large mass of protons.

From the supersymmetric Maxwell's equations [1], it can be seen that the electric and magnetic fields have very good symmetry. This symmetry is caused by the coexistence and disappearance of electric and magnetic fields. This means that the movement of the electric field will also lead to the movement of the magnetic field. The existence of a magnetic field must also mean the existence of a corresponding electric field. The two are inseparable.

4 The essence of a singular string is a fluid vortex

Since there is spin in the electric fields of both electrons and protons, we can further assume that this singular string is actually spinning as well. This forms a "vortex tube" similar to a vortex in a fluid. Then we can use some methods of fluid mechanics to deal with electrons and protons, and their corresponding magnetic monopoles.

4.1 Structure of electromagnetic field vortex tubes

Consider that in the universe, the number of positive and negative charges is exactly equal. This also means that the number of electrons and protons is exactly equal. Therefore, we can think of electrons and protons as two properties of a physical agent. More specifically, electrons and protons can be connected to each other with a single string. Since this string cannot be observed, Dirac called it a "singular string".[3] In this way, whether in real spacetime or virtual spacetime, we cannot observe the existence of singular strings. Only individual electrons and protons are actually observed.

If we consider that this singular string is the vortex in the fluid, then the spin of the electric field or magnetic field is the vortex motion of the fluid. It's just that unlike the fluids we are familiar with, the structure of this electric or magnetic field vortex is simpler. The fluid equation that describes the motion of an electric or magnetic field in such a vortex tube is Maxwell's equations.

4.2 Quantization of magnetic monopoles of Schwinger's singular strings

If the singular string between electrons-protons or magnetic monopoles is regarded as vortex tubes in fluid mechanics, then these vortex tubes are similar to coils, and if they are rotations of electric fields, magnetic fields can be generated at both ends, forming magnetic charges or magnetic monopoles. If the magnetic field rotates in it, an electrostatic field can be generated at both ends, forming an electric charge. Then, through the quantization conditions of Schwinger's two-string singular potential, the relationship between the rotation of the electric field and the magnetic charge of the magnetic monopole can be calculated.

For electrons, whose electromagnetic radius is a, the magnetic induction intensity generated by spin is calculated as $B = \mu i/2a$

where i is the current intensity and μ is the magnetic permeability in a vacuum.

Then

$$B = \frac{\mu i}{2a} = \frac{\mu}{2a}\frac{e\omega}{2\pi} = \frac{\mu}{2a}\frac{e\omega}{2\pi} = \frac{\mu}{2a}\frac{em_p a^2\omega}{2\pi a^2 m_p}$$

If we consider the spin angular momentum of electrons

$$m_p a^2\omega = \frac{\hbar}{2}$$

In elementary particle model based on Virtual spacetime, an electron is a complex of the magnetic monopole of Virtual spacetime and the electrostatic field of electrons in Real spacetime. Therefore, suppose that the spin of an electron is generated by the rotation of the magnetic monopoles in Virtual SpaceTime. Considering the symmetry [2], it can be known that the mass brought by the magnetic monopole of the electron is equal to the mass of the proton. Correspondingly, the mass brought by the magnetic monopole contained in the proton is equal to the mass of the electron.

such

$$B = \frac{\mu}{2a}\frac{e\hbar}{4\pi a^2 m_p}$$

If the vortex tube of the electric field will form a magnetic monopole at both ends, the magnetic field strength of the magnetic monopole is

$$B = \frac{\mu}{4\pi}\frac{g_p}{a^2}$$

So

$$g_p = \frac{e\hbar}{2am_p}$$

The Dirac charge quantization condition is

$$eg_e = \frac{nh}{\mu}$$

However, if both charge and magnetic monopole are considered, Schwinger charge quantization condition need to be used, i.e

$$eg_e = \frac{2nh}{\mu}$$

So

$$eg_e = \frac{e^2\hbar}{2am_p} = \frac{2nh}{\mu}$$

Considering

$$am_p = bm_e$$

where *b* is the electromagnetic radius of the proton.

And according to the literature [2].

$$b = \frac{e^2}{8\pi\varepsilon m_e c^2}$$

Therefore

$$n = \frac{e^2\mu}{8\pi am_p} = \frac{e^2\mu}{8\pi bm_e} = 1$$

It can be seen that the conditions for quantization of the charge are automatically satisfied. This automatic satisfaction also means that there can be no charge without quantization. That is, if an electric field or magnetic field is formed in a vortex, the charge or magnetic charge at both ends of the vortex must be quantized.

In this way, the vortex connected between electrons and protons is not visible. The same calculation can be done for magnetic monopoles in Virtual spacetime. Eventually, we can find that the singular strings of magnetic monopoles connected to each other in Virtual spacetime are also unobservable.

5 Conclusions

From the perspective of this charge quantization condition established in this paper, because the magnetic monopole is located in virtual spacetime or imaginary spacetime in the model, the existence of magnetic monopoles will not be observed in real spacetime, which can effectively solve the fact that the existence of magnetic monopoles cannot be detected at present.

But the fact that magnetic monopoles cannot be observed does not mean that magnetic monopoles do not produce observable effects in real spacetime. Since the energy in Virtual spacetime also affects the gravitational interaction of Real spacetime, this also means that the energy of magnetic monopoles is mainly expressed as the rest mass of particles. And the mass of this particle will also directly affect the spin angular momentum of the particle.

The electric field spin of an electric charge can also be understood by borrowing the concept of vortex tubes in fluid mechanics. The structure of this vortex can be calculated using the static magnetic field or electrostatic field generated by the solenoid in electromagnetism. This ensures that the model is computable.

From the results of the calculation, it can perfectly meet the charge quantization condition proposed by Dirac, that is, under the condition of quantization of charge or magnetic charge, the singular string of the connection between positive and negative charges cannot be observed. This also proves the correctness of the model.

This model also gives us another insight, which is that since the formation of vortex tubes is an important feature of fluid dynamics, it also means that we may have to reconstruct the vacuum model. The vacuum may be filled with a fluid that cannot be observed, but when energy is entered, it can cause the fluid to be disturbed, resulting in turbulence, and thus various vortex structures. The vortex produced by these turbulences is the matter world in our observable universe. Because these vortex tubes ensure the formation of electrons, protons and corresponding magnetic monopoles.

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

[2] Cheng, Z. (2022). A Particle Model Based on Virtual Spacetime. https://vixra.org/abs/2212.0070.

[3] Dirac, P. A. M. (1928). The quantum theory of the electron. Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character, 117(778), 610-624.

我们将电子和质子的静电场能量代入公式（16）和公式（17）可以得到

$$E_1 = \sqrt{(m_e c^2)^2 + \left(\frac{e^2}{8\pi\varepsilon a}\right)^2} \tag{23}$$

$$E_2 = \sqrt{\left(m_p c^2\right)^2 + \left(\frac{e^2}{8\pi\varepsilon b}\right)^2} \tag{24}$$

如果虚时空和实时空是对称的，则从虚时空来看实时空的尺度，需要满足：

$$aa' = r_c^2$$

虚时空看到的电子的半径应该是

$$a' = \frac{r_c^2}{a}$$

那么这个半径磁场的旋转，对应的能量将是

$$E_e' = \frac{hc}{2\pi a'} = \frac{\hbar c a}{r_c^2} = m_e c^2$$

即 a'可以看做是虚光子的德布罗意波长半径。这样

$$E_1 = \sqrt{\left(\frac{\hbar c a}{r_c^2}\right)^2 + \left(\frac{e^2}{8\pi\varepsilon a}\right)^2} \tag{25}$$

$$E_2 = \sqrt{\left(\frac{\hbar c b}{r_c^2}\right)^2 + \left(\frac{e^2}{8\pi\varepsilon b}\right)^2} \tag{26}$$

同时我们可以得到

$$\frac{\hbar c a}{r_c^2} = m_e c^2 \tag{27}$$

$$\frac{\hbar c b}{r_c^2} = m_p c^2 \tag{28}$$

将公式（28）代入公式（27）可以得到

$$m_e c^2 = \frac{m_p c^2}{b} a$$

即

$$\frac{m_p}{m_e} = \frac{b}{a}$$

另外

$$a = \frac{e^2}{8\pi\varepsilon m_p c^2}$$

$$r_c \approx \frac{\hbar}{2m_p c}$$

代入公式（27）可以得到

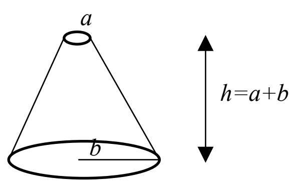
$$\frac{\hbar c 4m_p^2 c^2}{\hbar^2}\frac{e^2}{8\pi\varepsilon m_p c^2} = m_e c^2$$

$$\frac{m_p}{\hbar}\frac{e^2}{2\pi\varepsilon} = m_e c$$

因此

$$\frac{m_p}{m_e} = \frac{hc\varepsilon}{e^2} = \frac{2\varepsilon hc}{2e^2} = \frac{1}{2\alpha}$$

如果电子和质子的电荷都是由于磁单极子的磁场高速自旋而产生的, 则按照电子和质子的半径，可以电子和质子之间应该形成一个锥台的形状。即



这个圆锥台的形状构成了一个螺线管。磁单极子的磁场和绕该圆锥台自旋，并在两端产生静电场。

该圆锥台的体积可以按照棱台的体积来进行计算，即

$$V = \frac{1}{3}h\pi(a^2 + b^2 + ab) = \frac{\pi}{3}(a+b)(a^2 + b^2 + ab)$$

考虑到:

$$b \gg a$$

因此该体积也可以近似计算为

$$V \approx \frac{\pi}{3} b^3$$

如果磁单极子的磁荷为 m，则该螺线管半径为 b 的位置产生的磁场强度将是

$$B = \frac{\mu m}{4\pi b^2}$$

而磁场的总能量为

$$E = \frac{B^2}{2\mu} V = \frac{\mu m^2}{32\pi^2 b^4} \frac{\pi}{3} b^3 = \frac{\mu m^2}{96\pi b}$$

再考虑电荷量子化的要求，则

$$\alpha^2 \mu m^2 = \frac{e^2}{\varepsilon}$$

可以得到：

$$E = \frac{e^2}{96\alpha^2 \pi \varepsilon b} = \frac{e^2 hc}{48\alpha^2 \pi 2\varepsilon hcb} = \frac{hc}{48\alpha\pi b} = m_p c^2$$

因此

$$m_p = \frac{h}{48\alpha\pi bc}$$

而

$$b = \frac{e^2}{8\pi\varepsilon m_e c^2} = \frac{e^2 h}{4\pi 2\varepsilon hc m_e c} = \frac{\alpha h}{4\pi m_e c}$$

$$m_p = \frac{h}{48\alpha\pi c} \frac{4\pi m_e c}{\alpha h} = \frac{1}{12\alpha^2} \frac{m_e}{1}$$

$$\frac{m_p}{m_e} = \frac{1}{12\alpha^2}$$

如果磁单极子的磁荷为 m，半径为 a，磁荷均匀分布在球表面。则能量为

$$E_m = \frac{\mu m^2}{8\pi b} = \frac{e^2}{8\alpha^2 \pi \varepsilon b}$$

The properties of dark matter fluid from Zou Metric

Abstract

Zou proposed a metric for rotation. The formation of galaxy velocity curves, etc., can be well explained by this rotation metric. It only needs to go through the field equations of general relativity, and no longer needs to be corrected by introducing additional dark matter gravity. This study believes that the rotation coordinates in the Zou metric are actually due to the dark matter vortex caused by the turbulent flow of the dark matter fluid. From the Zou metric, far from the center of the galaxy, the speed of the rotating coordinate will decrease to 0, becoming a flat metric. This reflects that far from the galactic matter, there is actually a laminar flow of dark matter fluid. Therefore, the Zou metric can be used to describe some important properties of dark matter fluids. This study applies it to explain the flight of the Voyager spacecraft after entering the galaxy space. It is thought that Voyager will first enter an interface between the visible and dark matter laminar flow of galaxies. The enter of dark matter turbulence will cause a certain degree of random change in the attitude of Voyager. Once it passes through this dark matter turbulent layer, the Voyager spacecraft will enter the high-speed dark matter laminar flow region. In this region, due to the energy dissipation characteristics of the dark matter fluid, the spacecraft will have an automatic acceleration phenomenon.

1 Introduction

In Zou's research [1], he pointed out that a rotating metric can be used to describe the space-time in which galactic matter resides.

The metric can formally be expressed in cylindrical coordinates as:

$$g_{\mu\nu} = \begin{pmatrix} -c^2 & 0 & -\beta(r) & 0 \\ 0 & 1 & 0 & 0 \\ -\beta(r) & 0 & r^2 - \frac{q}{b}\beta(r) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

In which

$$\beta(r) = -bsln\,(\frac{1+e^{\frac{r}{s}}}{e^{\frac{w}{s}}+e^{\frac{r}{s}}})$$

Where the *r, w, s* and *b* are constants.

If *r* is large enough, then

$$\beta(r) = -bsln\left(\frac{e^{-\frac{r}{s}}+1}{e^{\frac{w}{s}-\frac{r}{s}}+1}\right) \approx 0$$

Zou metric spacetime becomes flat metric spacetime

But if in the same time

$$e^{\frac{w}{s}-\frac{r}{s}} \gg 1$$

This corresponds to a position far from the center of the galaxy, but less than a certain speed limit. Corresponds to the main region of the visible matter distribution of galactic matter. Then

$$\beta(r) \approx bs\left(\frac{w}{s}-\frac{r}{s}\right) = b(w-r)$$

Its distance squared is

$$ds^2 = -c^2\left(dt + \frac{\beta(r)}{c^2}\,d\phi\right)^2 + dr^2 + \left(r^2 + \frac{q}{b}\,\beta(r) + \frac{\beta(r)^2}{c^2}\right)d\phi^2 + dz^2$$

So

$$d\phi' = \sqrt{r^2 + q(w-r) + \frac{b^2}{c^2}(w-r)^2 d\phi}$$

Therefore the Zou metric is reduced in scale in the $d\phi$ direction. Therefore, under the condition of constant *v*, as *r* increases, the angular velocity will decrease compared to the flat space-time. Of course, under gravitational conditions, the reduction in angular velocity helps the matter to be bound in galaxies.

That is to say, under the condition of using the Zou metric, it is not necessary to modify Newton's law of gravity. There is also no need to introduce additional dark matter to maintain a constant velocity of galactic matter.

2 Vortex and rotating coordinates

If we think of the entire visible matter system as being built on a giant vortex of dark matter fluid. This way we can also obtain a rotated coordinate system. The rotational speed of this rotating coordinate system is the same as the flow velocity of the dark matter vortex.

If the rotation speed of this dark matter vortex is consistent with the Zou metric, Zou's method can be applied to the so-called solution process of solving the galaxy velocity curve and the energy density distribution.

But the dark matter vortex is only one component of the entire dark matter fluid. The dark matter vortex is the turbulent part of the dark matter fluid. Beyond the turbulent flow of the dark matter fluid, there is the laminar flow of the dark matter fluid. As shown in Figure 1.

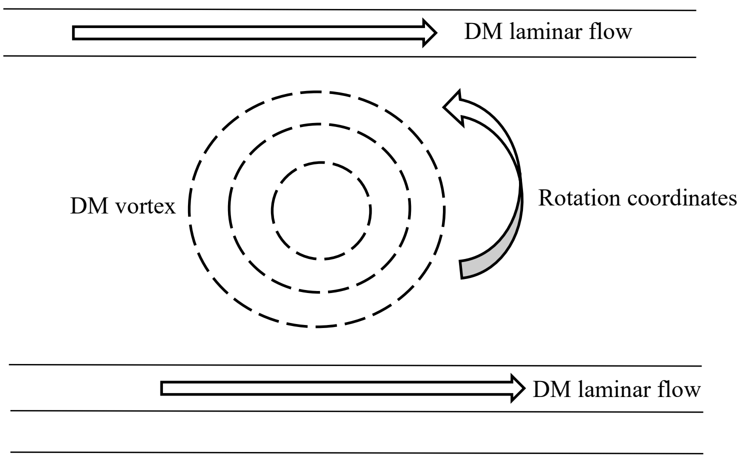


Figure 1. Vortex and laminar flow of dark matter

From Zou's paper, the position where r is small in Zou paper's Figure 1 [1]is the center of the vortex. And the speed v is constant is the main part of the dark matter vortex. When r is relatively large, the speed of rotating the coordinates drops rapidly to 0. At this time, it means that the coordinates no longer rotate, which corresponds to the laminar flow region of dark matter. Similar to a normal inertial frame of reference, the metric of flat spacetime can be used for calculations.

But existing observational data suggest that there is still a gravitational interaction between the dark matter fluid and visible matter. Therefore, in such a dark matter fluid inertial system, all visible matter has energy dissipation. That is to say, in such an inertial frame of reference with a seemingly constant velocity, visible matter will continue to gravitationally interact with the dark matter fluid. And finally, driven by the dark matter fluid, it is continuously accelerated until it remains relatively static in the dark matter fluid. Considering that dark matter has a relatively high laminar velocity. Therefore, in the galactic reference frame, the visible matter will be observed to be gradually accelerated by the dark matter fluid.

3 The fate of Voyager in interstellar space

On May 18, 2022, NASA's Voyager 1 project issued an announcement [2, 3], confirming that there were some problems with the data transmitted by Voyager 1's Attitude Articulation and Control System (AACS).

I did a simple analysis in my previous paper [4]. With the Zou metric, we can analyze the operation of Voyager 1 after entering interstellar space in more detail.

The first is to enter the turbulent region of dark matter.

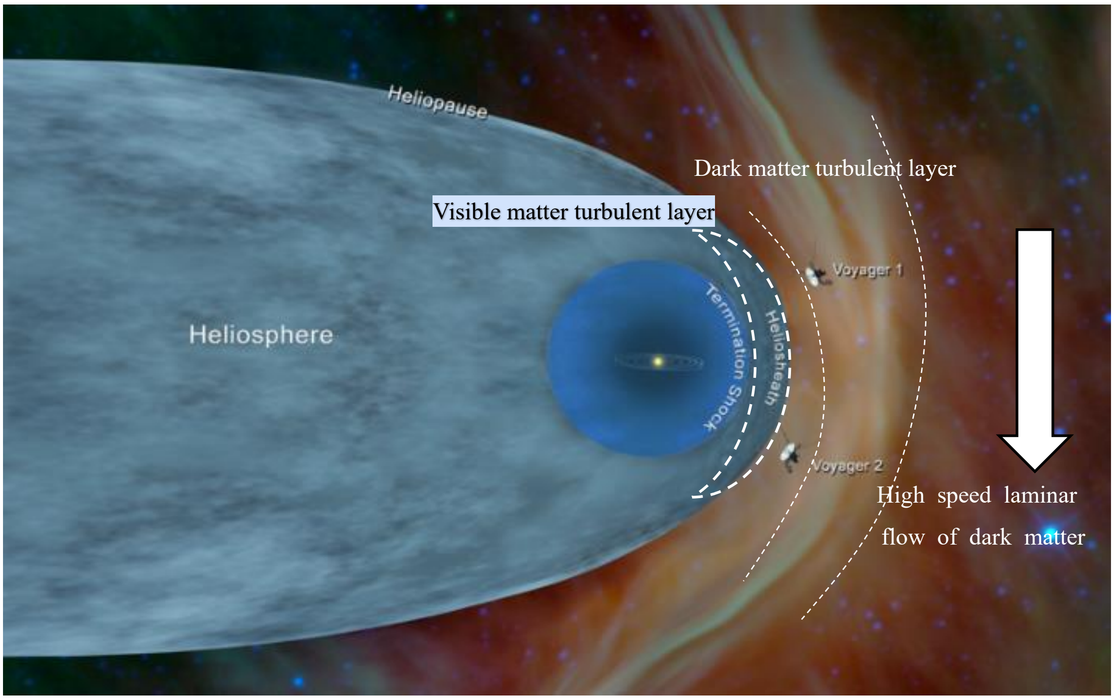


Figure 2. Voyager and the heliosphere

In Figure 2 there are two turbulent layers. One is the turbulent layer of visible matter. This can be measured by various instruments that measure radiation. The other is the dark matter turbulent layer. This cannot be measured by radiation detection instruments. But it may affect the flight status of the spacecraft.

Because of the existence of this dark matter turbulent layer. As we can see from the Zou metric above, the way this dark matter fluid flows can also affect the speed and mass distribution of galaxy matter. So the space-time properties inside and outside the heliosphere of the solar system will be very different. Since the turbulent flow of dark matter fluid is very random, a relatively random space-time bending phenomenon may occur in this part of the space-time.

If space-time curvature occurs in the dark matter turbulent layer at the edge of the sun's heliosphere, it may cause Voyager 1 to adjust its flight attitude and the direction of its antenna to obtain the strongest signal to communicate with Earth.

The curvature of spacetime due to turbulence can also be very random. This causes the spacecraft to continuously adjust its controller data, allowing the spacecraft to always maintain the strongest signal connection to Earth's ground equipment.

This possibility may also explain why the spacecraft's control data is abnormal, but the actual direction of the ground communication equipment aimed at the earth is always correct.

Of course, if Voyager can still successfully pass through the dark matter turbulent layer shown in Figure 2. Then there may be more serious problems later.

From the law of turbulence, we can see that at the edge of turbulence, the intensity of turbulence will become weaker and weaker. In regions far from turbulent flow, the dark matter fluid becomes laminar. Since the frictional force on the fluid is reduced after moving away from the turbulent region, the velocity of the fluid becomes very fast. The high-velocity dark matter fluid layer shown in Figure 2.

Although the gravitational interaction between dark matter and visible matter may be very weak. But given that the Voyager spacecraft has been flying long enough, such an effect will also become very large. Therefore, after the Voyager flew out of the dark matter turbulent layer, it entered the high-speed dark matter laminar layer, which will be driven by the dark matter fluid, and then continuously accelerated. Until the speed of the spacecraft is the same as that of the dark matter fluid.

It can be seen from one of my previous estimates that the laminar velocity of dark matter fluid can reach $v_d \approx 3 \times 10^{14}\, m/s$ [5]

Of course, due to the relatively high density of visible matter in the Milky Way, it is still impossible for the dark matter in the Milky Way to reach such a speed. But once the spacecraft enters the laminar flow of dark matter, its speed will also be quite fast. At least as fast as the entire galaxy.

Therefore, it is foreseeable that once the Voyager spacecraft flies out of the dark matter turbulent region, we will find that the spacecraft will continue to accelerate in a relatively short period of time. This phenomenon cannot be explained by gravitational interactions between visible matter. Because there are no other stars in this part of interstellar space, the phenomenon of gravitational slingshots is impossible. The only possible explanation is the interaction of dark matter with the spacecraft. Therefore, if such a phenomenon occurs, it means that this will be the first time that humans have experimentally confirmed the existence of dark matter.

Of course, if the Voyager spacecraft can successfully receive the signals sent by the earth, it should also be able to continue to communicate with the earth and send some important scientific data of dark matter fluids back to the earth. Just considering the delay of the signal transmitted by the earth and the speed of the spacecraft becoming very fast, it is possible that the ground antenna will not be able to adjust the angle of the transmitted signal in time. Eventually we may lose communication with Voyager.

4 Conclusions

So far Zou has done a very good job [1]. This job is to establish a rotating coordinate system. By performing general relativity calculations in this rotating coordinate system, it is found that no additional dark matter gravitational force is required, the galaxy velocity curve can be obtained, and the energy density distribution consistent with the actually observed luminous mass density profile of a real galaxy can be calculated.

This study argues that this rotating coordinate system can actually be explained by dark matter fluids. Because if the dark matter fluid is turbulent, it may appear like a fluid vortex. If we can establish a space-time metric consistent with the vortex of dark matter, we can deal with the gravitational problem of visible matter in a relatively stationary frame of reference. Zou's work provides a great start.

Voyager 1, on the other hand, has now entered an area completely unknown to mankind. Therefore, any abnormality in the signal sent back by Voyager is worthy of high attention.

The abnormality of the Voyager 1 control data this time indicates that the spacecraft has entered a relatively special area. Although the cosmic ray signal is relatively strong in this region, considering that the radiation signal of the solar wind is also decreasing synchronously, the possibility of the spacecraft signal being affected by cosmic radiation is weaker. So the most likely influence on Voyager 1's control data is dark matter. This also provides a very rare opportunity for humans to directly obtain data on dark matter [6, 7].

This paper argues that Voyager 1 is currently entering a region called the "dark matter turbulent layer." But this dark matter turbulence is not a vortex, but a relatively random change in space and time. This results in random changes in the spacecraft attitude due to the randomness of the turbulence. The spacecraft's Attitude Articulation and Control System will adjust accordingly. However, the signals sent by the spacecraft can still be received normally on Earth, and it seems that the spacecraft does not need any attitude adjustment. This led the ground station staff to believe that there might be a problem with the spacecraft's control data transmission. This study believes that if the hypothesis of this paper is correct, considering the uncertainty of dark matter turbulence, the possibility of losing contact between Voyager 1 and the earth ground station during the process of crossing the dark matter turbulent layer exists.

But since we still have Voyager 2 as a backup. So in about eight months or so, if the same phenomenon occurs on Voyager 2, it can prove that this dark matter turbulent layer is real.

In addition, this paper also analyzes the fate of the Voyager spacecraft after passing through this dark matter turbulent layer. This study considers that there will be high-speed laminar flow of dark matter in addition to the dark matter turbulent layer. Once the spacecraft enters this area, it means that just like an object floating on the surface of flowing water, the spacecraft will also flow with the dark matter fluid. This means that in the laminar flow of dark matter, we should be able to observe that the spacecraft will be continuously accelerated until the speed of the spacecraft is consistent with the speed of the dark matter fluid.

Considering that the laminar flow of dark matter far exceeds the speed of turbulent dark matter, the spacecraft will be accelerated to an unusually high speed. Eventually we will lose contact with the Voyager spacecraft due to the inability of signals from Earth's ground station to adjust the transmit and receive angles in time.

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Dark matter fluid explanation for anomalies in Voyager 1 control data

5 月 18 日，NASA 公布了旅行者一号的控制系统发回的飞船姿态数据出现异常。目前还不清楚这一异常问题原因是什么。我这里进行了一些简单分析。认为这种异常可能源自宇宙射线的干扰，导致数据发回地球的时候出现问题。另外我也从暗物质流体模型来进行分析。认为也有可能是在太阳系日光层边沿有可能出现时空异常现象，导致飞船需要根据时空弯曲的不同而频繁调整姿态。但是整个过程在地球上并没有发现实际的飞船姿态有何问题。如果是因为暗物质流体的原因，则很可能在不久的将来，我们会失去跟旅行者一号的联系。不过这两种假设似乎都没有很扎实的理论证据。因此更进一步的情况还需要旅行者二号来进行证实。

5 月 18 号，美国航空航天局旅行者 1 号项目发布公告【1】，证实旅行者 1 号的姿态关节和控制系统(AACS)传过来的数据出现了一些问题。这个问题主要表现在传过来的这些控制数据都是错误的，而实际的情况是旅行者 1 号的天线是准确无误的对准地球的。这可以从地面站接收到旅行者 1 号的信号强度、信噪比等等来获得证实。

目前还无法对这一异常现象进行任何理论上的解释。

从 NASA 发出的新闻稿上，我们可以看出这次控制期数据出问题，在 NASA 的新闻稿当中描述为“the data may appear to be randomly generated”。

虽然我们无法获得 NASA 的具体数据，但是从这个新闻稿的描述当中，我们还是可以看出，这些异常数据的一些重要特点。首先在新闻稿当中强调的是“may appear”，也就是说 NASA 现在还不是很确定这个异常数据是随机的。也就是说也有可能是系统性的一个错误。其次也说明这一个控制数据的问题变化还是比较缓慢的。正是因为异常数据变化比较缓慢，也就是使得 NASA 无法获得足够的数据来证明这些异常的数据是随机出现的。

按照这样的分析，我们可以大致确定影响控制器数据异常的原因，可能存在这么 3 个方面问题。

第 1 个问题可能是传感器的问题。也就是说如果传感器感受到的数据是错误的，比如说感受到从地球发送过来的信号变弱了，那就意味着需要调整天线或者飞船的姿态，以便重新对准地球。这一过程明显是闭环的。既然是一个闭环的过程，也就意味着如果传感器的传过来的数据是错误的，自然飞船的姿态或者天线的方向也会出现调整错误，导致飞船与地球最终失去联系。但实际情况是目前为止从地球接收到飞船发送过来的信号相关参数来看，飞船目前的姿态和天线方向无疑是正确的。而且传过来的信号也是非常强的，只要飞船不去调整目前的姿态，地面的信号接收站将能够继续正常接收到飞船传过来的各种数据信号。

第 2 个问题。既然第 1 个可能性被排除了，也就是说至少在传感器到调整飞船的姿态或者天线方向这一个闭环的控制当中是没有问题的，那么就有可能是传感器的数据传到飞船的信息处理系统，然后信息处理系统再将这些数据发送回地球的过程当中出现了问题。如果是目前的数字计算机，这样的问题显然是不会出现的，因为数字信号一旦出现了干扰，那么所有的后续信号处理都会出现问题，传给地球的也将是乱码。不过在上个世纪 70 年代还没有我们现在这样先进的微型计算机技术，因此所处理的信号预计基本上还是模拟信号。既然从传感器接收到的模拟信号，然后经过飞船的模拟信号处理系统再发回地球，那么在这个过程当中，模拟信号就有可能受到宇宙射线的干扰，从而将错误的数据发送回给地球。因此这

种可能性是存在的。

第 3 个可能存在的问题则是本文的分析结果。在前几篇文章当中【2】，我已经分析了暗物质的流体模型。整个宇宙是由大量的暗物质流体构成的，而暗物质流体如果受到干扰或者流动速度过快或者粘滞系数的变化等等，都可能导致湍流的出现。而这种湍流就是我们在宇宙当中可见的物质和能量。太阳系当中的恒星太阳和围绕太阳运行的行星都是可见的物质。另外太阳的核聚变能量和太阳辐射等等都是可见的能量。因此这些都可以看作是暗物质流体的湍流。

在 NASA 的科学普及的文章当中【3,4】，给了一个非常形象的模拟，就是用水池当中的水流来进行模拟太阳风。如图 1 所示。在图中当水龙头的水流滴到水池底部的时候，这个时候水就会快速的扩散开来。在水流快速扩散的过程，就相当于在太阳系当中超音速运行的太阳风。不过在这个模拟的图中，我们也可以看到一个非常有趣的现象，就是当水流扩散到一定的距离之后，这个时候水流的速度就会突然减慢。并且在水流和周围的慢速甚至静止的水流之间，形成一个非常明显的边界。这一个边界由于水流的速度变化过快，所以它实际上也是一种湍流的现象。图中将其称作是“湍流层”。如图中虚线框中所示。

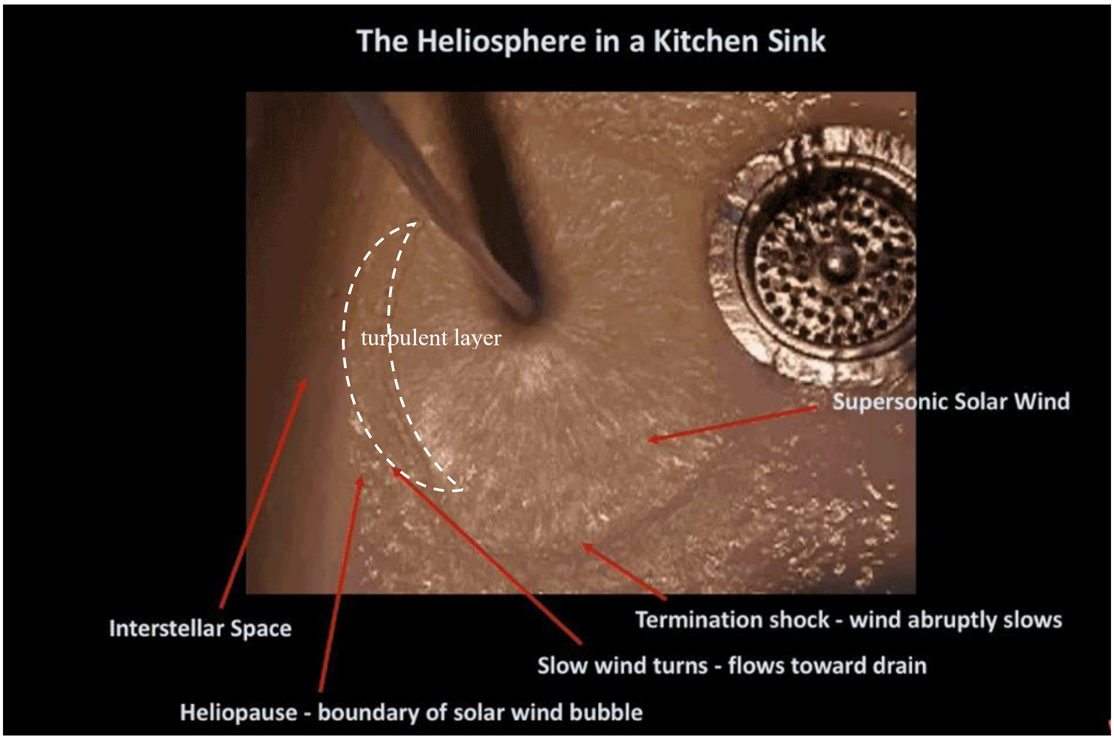

Figure 1. Simulating the heliosphere with a pool

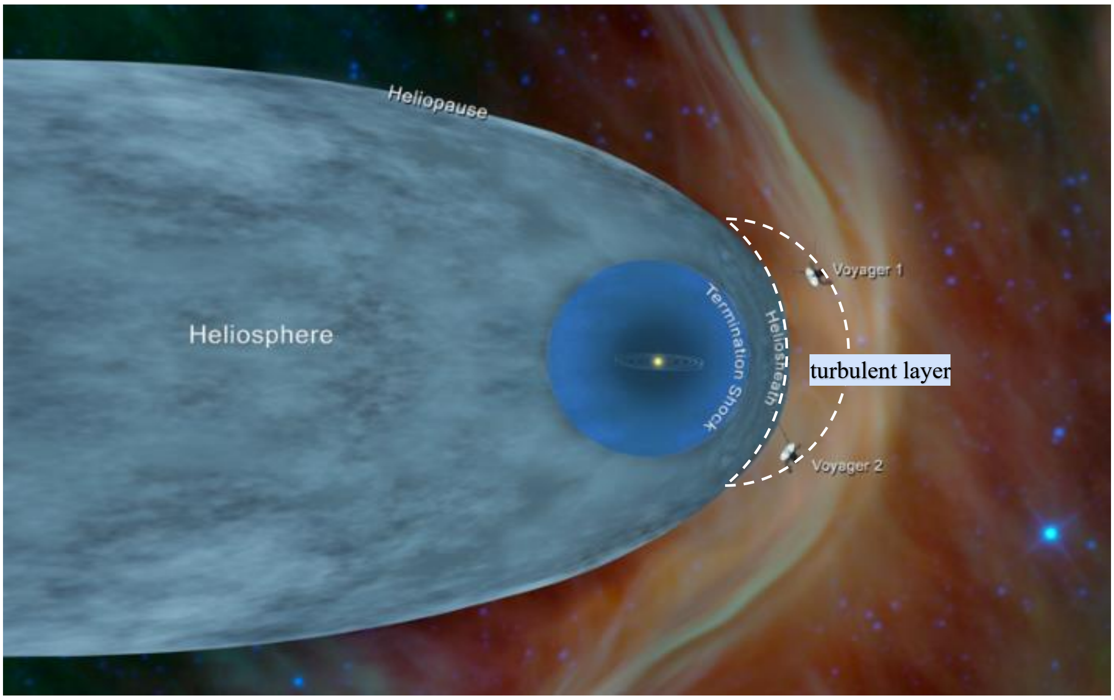

Figure 2. Voyager and the heliosphere

在图 1 当中，这种在水流边界所形成的这个湍流的边界就对应了图 2 中的实际的太阳日光层边界。在太阳的日光层边界也存在这么一个湍流层，对应了图 2 中虚线框。

当然太阳风的这种湍流的形成，实际上是跟整个太阳系的所处位置暗物质流体有关系的。这种太阳风在边界所形成的湍流层。也必将引起暗物质流体的流动性质的变化，这样也就会直接改变了在这一部分的暗物质流体所形成的时空特性。

也就是说在这一个太阳日光层的边缘，它的时空特性就跟在太阳系内部和太阳系外部的时空特性非常不一样。由于这种太阳风形成的湍流是非常随机的，所以这一部分的时空也就可能会出现比较随机的时空弯曲现象。

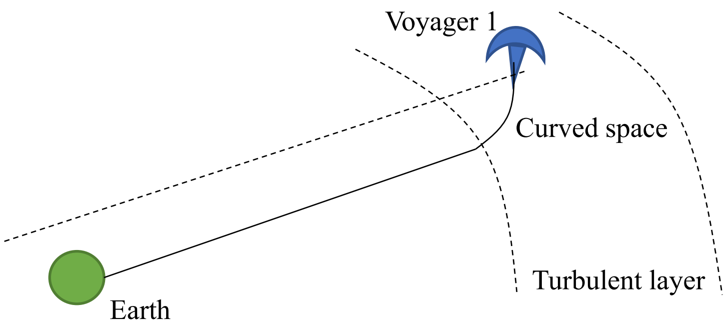

Figure 3. The effect of curved spacetime on the direction of the Voyager 1 antenna

从图 3 中可以看出，如果在太阳日光层边沿的湍流层中出现了时空弯曲，则可能会引起旅行者 1 号调整飞行的姿态以及天线的方向，从而能够获得最强的跟地球进行通信的信号。

由于湍流层中的湍流随机性非常强，因此这种湍流产生的时空弯曲也可能是非常随机的。这导致飞船会不断调整自己的控制器数据，从而使得飞船能够始终保持与地球地面设备的最强信号的连接。

这种可能性也可以解释为何飞船的控制数据出现异常，但是非常实际瞄准地球地面通信设备的方向又是始终保持正确的方向的。

考虑到通过湍流层之后在湍流层中的时空弯曲现象仍然具备随机性。相信这种数据的异常会在旅行者 1 号的后续旅行过程中始终存在。当然如果旅行者 1 号远离这个湍流层，则有可能因为湍流层的时空弯曲问题被放大，从而出现旅行者 1 号跟地球的通信丢失的情况。这时候，或许是我们跟旅行者 1 号永远再见的时候了！

另外考虑到旅行者 2 号也快要进入这一个湍流层。因此旅行者 2 号是否会出现这种控制器数据异常则是用来检验本文假设的是否正确的一个重要证据。

也就是说大约再过 9 个月之后，如果旅行者 2 号出现同样的控制器数据异常，则基本上可以证实本文的这个模型是正确的。

3 如果飞船飞出暗物质湍流区域

当然如果旅行者号还是顺利穿越了图 2 和图 3 显示的暗物质湍流层。那后面还是会遇到更严重的问题。

从湍流的规律我们可以看出，在湍流边沿，湍流的强度会越来越弱。在远离湍流的区域，流体就会变成层流。而由于远离湍流区域之后，流体受到的摩擦力减少，流体的速度也就会变得非常快。如图 2 所示的 High-speed laminar flow of dark matter 区域。

虽然暗物质和可见物质之间的引力相互作用可能是非常弱的。但是考虑到旅行者号飞船的飞行时间足够长，这样的影响也将变得非常大。因此旅行者号飞出了暗物质湍流区域之后，进入了高速暗物质平流区域，将被暗物质流体带动，然后不断被加速。直至飞船的速度跟暗物质流体的速度相同。

从前面我的一个估算中可以看出，暗物质流体的层流速度可以达到$v_d \approx 3 \times 10^{14} m/s$ [5]

当然由于银河系中的可见物质密度比较大，银河系中的暗物质要达到这样的速度还是不太可能的。但是一旦飞船进入暗物质平流，其速度也将是相当的快。至少会跟整个银河系的运行速度一样。

因此可以预见一旦旅行者号宇宙飞船飞出了暗物质层流区域，我们会发现宇宙飞船会在比较短的时间中出现不断加速的现象。这种现象是无法通过可见物质之间的引力相互作用来进行解释的。因为在这一部分星际空间中，并不存在其他的恒星，因此也不可能出现引力弹弓的现象。唯一可能的解释就是暗物质与宇宙飞船的相互作用。因此如果这样的现象出现，也就意味着这将是人类第一次通过实验证实暗物质的存在。

当然如果旅行者飞船还能够顺利接收到地球发送过来的信号，也应该能够持续跟地球进行通信，并将暗物质流体的一些重要科学数据发送回地球。只是考虑到地球发射信号的延迟，以及飞船的速度变得非常快，可能地面天线无法及时调整发射信号的角度。最终我们还是会失去与旅行者号的通信联系。

4 结论

旅行者 1 号目前已经进入一个人类完全未知的区域。因此旅行者号发送回来的信号的任何异常都是值得高度重视的。

这次旅行者一号控制数据的异常，说明该飞船已经进入了一个比较特殊的区域。虽然在这个区域的宇宙射线信号比较强，然而考虑到太阳风的辐射信号也在同步降低，飞船信号受到宇宙辐射的影响的可能性较弱。因此最有可能对旅行者一号控制数据产生影响的是暗物质。这也提供了一个非常难得的机会让人类直接获取暗物质的数据【6, 7】。

本文认为旅行者一号目前进入了一个叫做"暗物质湍流"的区域。由于湍流的随机性，这导致飞船姿态的随机变化。而飞船的 Attitude Articulation and Control System 则会做出相应的调整。然而在地球上还能够正常接收到飞船发送过来的信号，似乎飞船并不需要进行任何的姿态调整。这导致地面站工作人员认为可能是飞船的控制数据发送出了问题。本研究认为如果本文的假设是正确的，考虑到暗物质湍流的不确定性，在穿越暗物质湍流层的过程中，旅行者一号与地球地面站之间失去联系的可能性是存在的。

但是由于我们还有旅行者 2 号作为备份。因此在大约八个月左右之后，如果旅行者 2 号也出现同样的现象，可以证明这个暗物质湍流层是真实存在的。

另外本文也分析了旅行者飞船穿越这个暗物质湍流层之后的命运。本项研究认为考虑到在暗物质湍流层此外将是高速的暗物质层流。飞船一旦进入这个区域，则意味着就像一个物体漂浮在流动的水面上一样，飞船也将随着暗物质流体一起流动。这意味着在暗物质层流当中，我们应该可以观察到飞船会被不断加速，直到飞船的速度跟暗物质流体的速度一致。

考虑到暗物质平流速度要远超过暗物质湍流的速度，飞船将被加速到异常高的速度。由于地球地面站的信号无法及时调整发射和接收角度，最终我们会失去与旅行者号飞船的联系。

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Dark matter fluid interpretation of quantum entanglement

Abstract

This paper explains the transmission of quantum entanglement information by establishing a completely new theoretical model of quantum entanglement. This model is based on the cosmic dark matter fluid model. In this model, we consider that the vortex tube that forms positive and negative magnetic monopoles or positive and negative charges is not limited by electromagnetic interaction. This will cause the exchange and movement of the vortex tubes to reach 1 million times the speed of light. The transmission of quantum entanglement information is based on the high-speed exchange and movement of this vortex tubes. The contribution of this paper is to construct a completely new theory that can be used to explain the phenomenon of quantum entanglement, and this theory can be used to replace the previous theory of hidden variables.

1 Introduction

According to the dark matter fluid model, the entire universe is filled with dark matter fluids. Dark matter fluids have a viscosity coefficient, which leads to turbulence during the flow of dark matter fluids. The emergence of this turbulence phenomenon means that a dissipative structure of energy appears in dark matter fluids. This energy dissipation structure is a direct result of the emergence of countless vortex tubes. Each Vortex tube is connected with positive and negative charges or positive and negative magnetic monopoles. In Real Spacetime, the Vortex tube connects positive and negative charges, corresponding to proton-electron pairs. Positive and negative magnetic monopoles appear in imaginary spacetime.

Due to the limitations of Dirac's quantization conditions, this means that the Vortex tube does not produce observable physical effects in either Real Spacetime or Imaginary Spacetime. This means that the rotation, movement, etc. of the vortex tube will not cause energy absorption and consumption. This also means that the motion of the Vortex tube is a phenomenon unique to dark matter fluids. Its interaction is not related to electromagnetic interactions, but to dark matter interactions. If the intermediary of the interaction of the vortex tube is dark matter waves, the motion speed of this vortex tube will reach very high speeds. According to my other research results [1], this dark matter wave may travel up to a million times faster than electromagnetic waves. Such a high speed means that the vortex tube of the dark matter fluid may also move a million times faster than the speed of light.

The reason why the Vortex tube can move so fast is because the Vortex tube is not directly involved in electromagnetic interactions. The vortex at both ends of the vortex tube will participate in electromagnetic interactions, so the speed of the vortex will be limited by the speed of light.

To form positive and negative charges or positive and negative magnetic monopoles at both ends of the vortex tube, there must be a special interface to form. This is like a vortex in a fluid, and only on the surface or at the bottom of the water interface will a special vortex structure be formed. In dark matter fluids, in order to obtain vortex structures at both ends of the vortex tube, there must be a relatively special interface. This interface may be the interface of the container in which the dark matter fluid is located, or it may be formed by the interaction of photons or other electrons or protons. This could explain why there is a problem of wave function collapse in quantum mechanics. That is, once the measurement occurs, the wave function collapses and the position of the particle is determined. If the vortex tube encounters photons or other particles that interact, the vortex tube of the dark matter fluid forms a vortex structure. This vortex structure is a particle.

2 Interactions between Vortex tubes

2.1 vortex tube exchange

The Vortex tube is combined with positive and negative charges or positive and negative magnetic monopoles. Figure 1(a) shows a pair of electron proton. The electron proton pair is ended by an electron vortex and a proton vortex. In the middle is the vortex tube that connects electron to proton vortices. Since they are connected to both ends of a tube, the spins of electron and proton are observed from different directions, and the spin directions of the two particles may be opposite. However, if you find it inconvenient to assume that such an assumption, you can also assume that the spin direction of the two particles should be the same. This is mainly due to the difference in the method of choosing the reference frame of different particles.

Figure 1(b) shows two pairs of electron proton. One of the pairs is electron proton pair 12 formed by electron 1 and proton 2, where the vortex tube is called the 12 vortex tube. The other electron proton pair is 34. The spins of electrons 1 and 3 are the same, so the spins of protons 2 and 4 must also be the same. When the vortex tube is connected between them, two pairs of electron protons are formed, as shown in Figure 1(c), two vortex tubes, 14 and 32, respectively. In Figure 1(c), the positions of electrons 1,3 and protons 2,4 do not change, but the vortex tube is exchanged to become 14 vortex tube and 32 vortex tube. But since the vortex tube does not produce observable physical effects, this exchange of the vortex tube does not cause a change in the physical state of the two pairs of electron proton. Of course, Vortex tubes 14 and 32 can continue to separate, which becomes the state of Figure 1(d). At this point, the 14 and 32 vortex tubes no longer cross together.

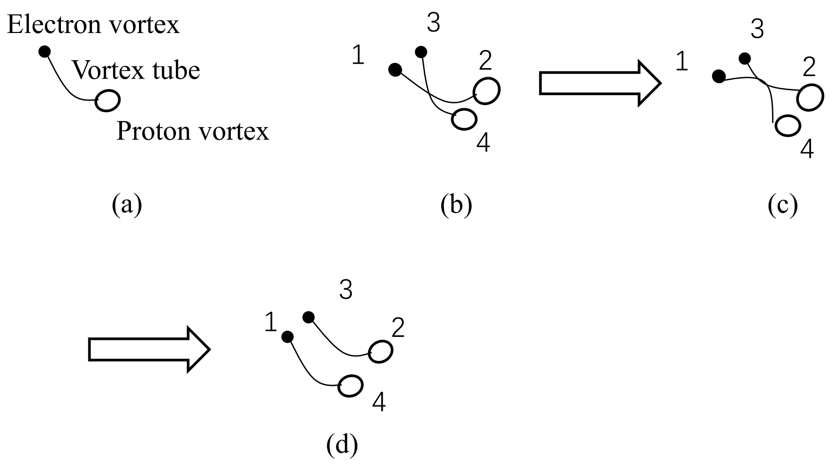

Fig. 1 The exchange of vortex tube

In Figure 1(c), we can also think that because the conduction speed of the Vortex tube exchange is very fast, electron 1 moves to position 3. Although such particle position exchange consumes energy in a macroscopic sense and produces observable physical effects, but at the microscopic scale, since electrons 1 and 3 are identical in state and are homogeneous particles, the exchange of positions between them does not produce observable physical effects.

If the spin direction of the two electrons is different, the vortex tubes can also be exchanged with each other in the same way as shown in Figure 2.

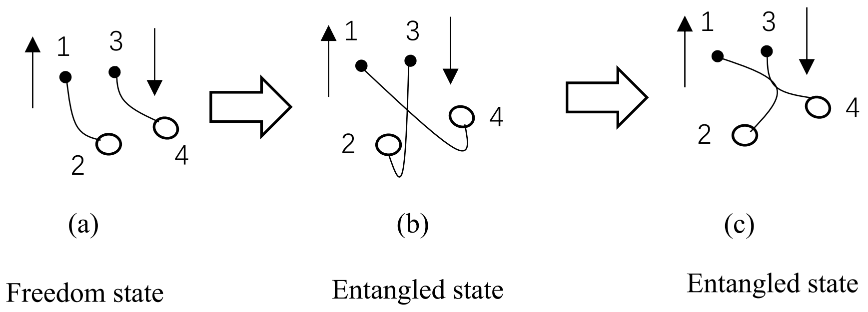

Fig. 2 The exchange of vortex tube with different particle spin

Figure 2(a) shows two pairs of electron proton, but the spin direction of the electrons is different, and of course the spin direction of the corresponding protons is also different.

If the two Vortex tubes want to exchange with each other, they only need to connect the Vortex Tube from the other end of the proton. This is shown in Figure 2(b). This is because if the vortex is seen as a ring, the spin direction seen from above and below the ring is exactly the opposite.

After forming the state of Figure 2(b), the vortex tube can be further exchanged to form the state of Figure 2(c). In the state of Figure 2(c), the vortex tube reconnects the upper end of the proton, ensuring that the spin direction of the electron proton pair is reversed.

The time required for the exchange of the Vortex tube is very short. Therefore, we can also think that electrons or protons move teleportarily to another location with the exchange of the vortex tube. But because the Vortex tube itself does not produce an observable effect, this movement makes it appear as if it moves from one position to another in an instant. This instantaneous effect can be used to provide a theoretical basis for the interpretation of the probability of the wave function. Because the movement and exchange of the vortex tube has a lot of randomness, and the position is not deterministic, the position results of the particles measured at different times are also uncertain.

2.2 Entangled state

If two Vortex tubes cross each other. For this state of vortex tube crossing, we can call it the entangled state. In the entangled state, the state of the two electrons can be described by a wave function:

$$|\psi> = \sum A_{ij}|\psi_i\,\psi_j>$$

ψ_i or ψ_j is the wave function of two independent electrons.

If two electrons are entangled, the states of the two electrons will be related to each other, for example, if two electrons have the same spin, then the two electrons can be in the state of all spins up $|00>$ or the state of all spins down $|11>$.

Thus the wave function of the electrons in these two entangled states can be described

$$|\psi> = A_{00}|00> + A_{11}|11>$$

where 0 and 1 represent the spin direction up and down, respectively. Considering that the probability of spin up and spin down is the same, the above equation can also be written

$$|\psi> = \frac{1}{\sqrt{2}}(|00> + |11>)$$

In Figure 2(a), since the two Vortex tubes do not cross each other, this also means that the two Vortex tubes can be distinguished from each other. This is called the free state.

In Figure 2 (b) and (c), the vortex tube can be freely exchanged without affecting the state of the particle, so this state is called the entangled state.

Of course, even if the two Vortex tubes do not cross each other, it is possible that with the movement of the particles, the Vortex tubes will cross together at a certain moment, which can also form an entangled state. That is, the change from Figure 2(a) to Figure 2(b) or (c).

For two electrons with different spins in an entangled state, if the vortex tube corresponding to one electron is transferred to the other electron, then the other end of the vortex tube must be transferred from the corresponding proton to the other proton. For another vortex tube, the same effect. In this way, after the exchange of the vortex tube, it means that the state of the two electrons remains unchanged without observable physical effects.

3 Quantum entanglement

From the above analysis, we can see that in an entangled system, two electrons can be described by a wave function. So when the state of one electron changes, we can predict the change in the state of another electron.

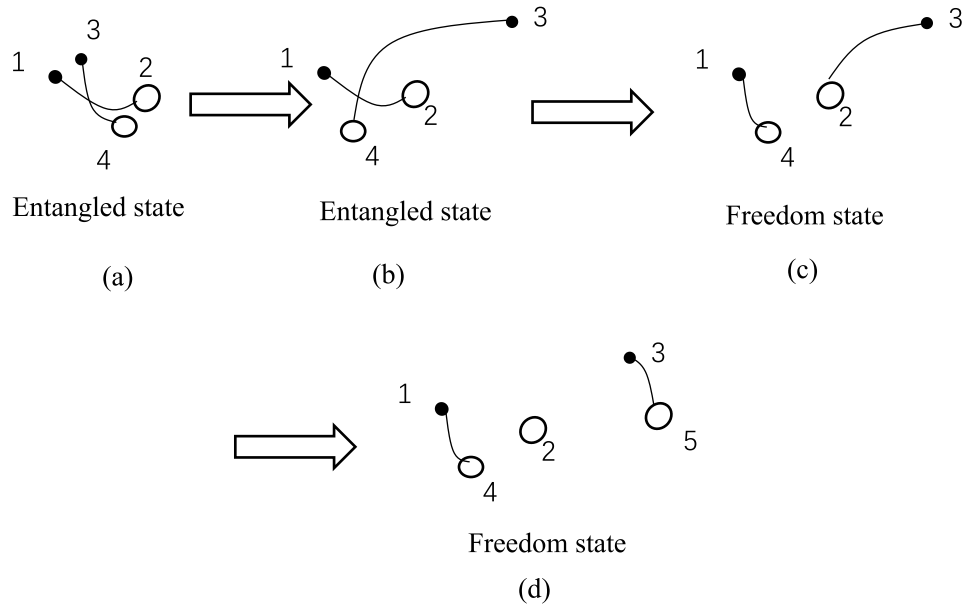

Fig. 3 Communication principle of quantum entanglement

In Figure 3(a), where the electron-proton pairs 1-2 and 3-4 are entangled, electrons 1 and 3 can be described by a wave function. Figure 3(b) shows electron 3 moving away from electron 1, and remaining in this entangled state if the vortex tube is not exchanged. The motion of electron 3 is limited by the speed of light. But the state of electrons 1 and 3 is determined by the connected vortex tubes 12 and 34. That is, a change in the state of electron 1 necessarily leads to a change in the state of electron 3.

Figure 3(c) shows that the two vortex tubes, 12 and 34, begin to exchange to the 14 and 32 vortex tubes and the entangled state disappears. In this way, the two vortex tubes no longer cross or become entangled, and the two electrons 1 and 3 enter a free state. Figure 3(d) shows that if there are other extra protons 5 near electron 3, electron 3 can also connect this new proton 5 by establishing a new vortex tube. This new Vortex tube is shorter in length.

This exchange of vortex tubes takes place in dark matter fluids, and the speed is mainly affected by dark matter waves, so the speed is very fast.

4 Manipulation and communication of entangled states

4.1 Distribution of entangled particles

When two elementary particles, such as electrons or photons, are entangled, the uncertainty of the Vortex tube exchange causes each particle to be in a random state. Therefore, if it is in the state of Figure 3(b), it means that although the two particles have been distributed, they are still entangled. At this time, we only need to manipulate particle 1 so that it is in a certain state, and the state of particle 3 will be determined immediately, and the exchange process between the two vortex tubes will stop. Thus, information is instantly transmitted from particle 1 to particle 3 at the speed of dark matter interaction.

4.2 Speed of Information Dissemination

Because it is in an entangled state, the whole process does not involve the propagation of electromagnetic waves, so the propagation of state information is completely determined by the propagation speed of dark matter waves. This dark matter wave interaction can transmit the state change of one particle to another particle at a speed far faster than the speed of light, so that the information can arrive "instantaneously".

4.3 Time to propagate of quantum entangled information

If the speed of the information transmitted by quantum entanglement is fixed, propagating at the speed of dark matter waves, then it is roughly estimated that its speed may reach 1 million times the propagation speed of electromagnetic waves [1].

According to the propagation path in Figure 3(b), the entire state change involves four particles, so its propagation path includes two vortex tubes. Therefore, the length of the entire propagation is the length of two vortex tubes.

Divide the sum of the lengths of the two Vortex tubes by the propagation speed of the dark matter wave, and we can get the time it takes for the entangled signal to propagate.

However, if the distance between the two particles distributed is relatively long, then this distance will be much greater than the length of the first two vortex tubes distributed, so we can approximate the distance between the two particles to represent the distance of quantum entanglement information propagation.

For example, in the quantum entanglement experiment conducted by the Micius satellite [2], two photons were distributed over a distance of 1,000 kilometers. This also reflects the distance of information transmission of 1,000 kilometers. Then we divide this distance by the speed of dark matter wave propagation $v_d \approx 3 \times 10^{14}\, m/s$ [1], we can get the entire quantum information propagation time.

$$t = \frac{1000 \times 10^3}{3 \times 10^{14}} \approx 3.3 \times 10^{-9} (s)$$

This information transmission time should be very short. If it is the propagation of electromagnetic waves, such a long distance takes 3.3 milliseconds.

Therefore, from the results of this calculation, it can be seen that the time for quantum information to propagate is very short, and it can basically be said that it can be completed "instantly". This speed is 1 million times the speed at which electromagnetic waves propagate.

Therefore, it is difficult to measure the time of this information propagation using current experimental techniques on Earth. Such a delay can only be measured on the scale of the universe.

5 Conclusions

Quantum entanglement has always been a very controversial topic, but in recent years, due to more and more evidence support, quantum entanglement related research has become more and more in-depth.

However, for such a phenomenon as quantum entanglement, there is still a lack of relevant theories to satisfactorily explain. Physicists, including Einstein, Bohm and others, have also tried to build hidden variable theories, but these theories are more or less flawed in one way or another.

From the results of this paper, if we adopt the idea of Dirac's charge quantization and build a model of dark matter fluids, the matter in real and imaginary Spacetime is formed by the turbulence of dark matter fluids, then due to the special properties of the vortex tube connecting electron and proton or positive and negative magnetic monopoles, which leads to quantum entanglement can be explained by a new theory of dark matter fluids.

From the analysis results of this paper, because we use the unobservable property of the vortex tube in the idea of Dirac's charge quantization, it is shown that the vortex tube connecting positive and negative charges does not interact with the electromagnetic waves of the visible matter world, so that it can escape the speed limit of light in relativity. That is to say, the movement of the vortex tube connecting positive and negative charges or positive and negative magnetic monopoles can break through the speed of light. Perhaps it is this superluminal signal that can be transmitted in dark matter that leads to the existence of what Einstein thought was a ghostly action at a distance.

According to this paper and the author's previous research, this quantum entanglement information can be transmitted at a speed of 1 million times the speed of light, which is enough to make the observed particle state information in the matter world achieve the effect of instantaneous transmission.

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Effect of dark matter fluids on gravitational constant measurements

Abstract

This paper explores the possibility of experimentally testing the viscosity of dark matter fluids in laboratories on Earth's surface. From the theoretical calculation results, the viscous force of dark matter fluid and gravity are basically the same order of magnitude as the gravitational force. At the same time, because the experimental devices for measuring the gravitational constant are very precise and can accurately sense changes in gravity, we believe that the existing experimental devices for measuring the gravitational constant can be used to measure the viscosity of dark matter fluids. Since the experiment is carried out on the ground, it is convenient to control various parameters artificially. In this paper, the influence of the viscous force of dark matter fluid on the measurement results of gravitational constant is discussed by analyzing the existing experimental device for measuring the gravitational constant by the angular acceleration feedback (AAF) method. This paper argues that in some current experiments on measuring the gravitational constant by angular acceleration feedback methods, the influence of the viscous force of dark matter fluids has been ignored. If the influence of the viscous force of dark matter fluid is taken into account, the problem of inconsistent results of different experiments can be better solved. After the introduction of the viscosity of dark matter fluids, the upper and lower limits of the gravitational constant (HUST-19) measured by the angular acceleration feedback method of Huazhong University of Science and Technology can be extended to $6.674351 \times 10^{-11} m^3 \cdot kg^{-1} \cdot s^{-2}$ and $6.674551 \times 10^{-11} (m^3 \cdot kg^{-1} \cdot s^{-2})$, which can improve the inconsistency with the time-of-swing method results to a certain extent.

1 Introduction

If there is a large amount of dark matter fluid in the space-time of the universe, and this dark matter fluid is disturbed during the flow process, elementary particles of visible matter can be produced. Examples include electrons, protons, and neutrons [1]. These elementary particles formed by the turbulence generated by dark matter fluids are also affected by the viscous force of dark matter fluids [2].

From the observation facts, if this dark matter fluid exists, then their viscous force on visible matter will produce some observable cosmic scale effects. For example, the incline of the rotation axis of a star or planet that occurs during the movement of a galaxy. From the calculation results, this dark matter fluid model can predict the rotation axis tilt of stars or planets in the movement of galaxies [2]. After all, it is still difficult to solve the problem of the rotation axis of stars or planets from the current physical theories.

So can the viscous force of this dark matter fluid on visible matter produce observable effects on the scale of ground laboratories? After analysis, this paper believes that because the viscosity of dark matter on visible matter is equal to the effect of gravity in magnitude, the various experimental devices that can be used to measure the gravitational constant on Earth should be used to measure the viscosity of dark matter fluids. This also provides us with a very effective way to conduct dark matter fluid experiments on the scale of ground laboratories. At the same time, the results of this paper also provide a new perspective to explain how different the various measurements of gravitational constants currently being made can be.

The reason for these different measurement results of the gravitational constant is that dark matter fluids are not taken into account for experiments. For example, the impact of the Earth's rotation. Since the Earth is constantly rotating, the direction of the force of the dark matter fluid on the attraction ball also changes from time to time. If very effective measures are not taken into account to reduce this error, the effect of the viscous force of dark matter fluid will lead to a relatively large error in the results of the experiment. According to some important experimental results, these laboratories are located in cities at different latitudes. For example, the Gravity Experiment Center of Huazhong University of Science and Technology is located in Wuhan, 30 degrees north latitude. The gravitational experiment in Seattle, Washington, was conducted at 47 degrees north latitude. Experiments at these two different latitudes will cause the effect of dark matter fluids on the mass of the attraction ball in the laboratory to become very different. This may also be an important reason for the large difference in the values of gravitational constants obtained by the two laboratories.

2 Differences between the two methods of gravitational constant measurement

At present, there are two main methods for measuring the gravitational constant [3]. The first is the time-of-swing method (TOC). Since the attraction ball in the time-of-swing method does not move, the viscosity of the dark matter fluid will be relatively small. An important error that this method is easy to cause is that the elastic coefficient of the fiber is difficult to ensure that it is linear. Because when measuring the effect of gravity on the torsion, the twist angle of the fiber must be taken into account. This torsion's twist angle is mainly influenced by the fiber material. Especially in laboratory measurement processes, if more accurate data is required, a larger twist angle of the fiber is required. A large fiber twist angle means that the fiber twists into a nonlinear region. This in turn creates greater system error. Therefore, although this measurement method has been improved over the decades, its accuracy is still very limited. After all, the improvement of the accuracy of the entire experiment depends on the development of materials science.

The second is the angular acceleration feedback method (AAF). This angular acceleration feedback method was proposed in the 50s of the last century [4]. However, due to the complexity of the experimental setup, there are currently only two laboratories in the world that can complete this experiment better. The two laboratories are the laboratory in Seattle, Washington [5] and the laboratory of Huazhong University of Science and Technology [6]. The angular acceleration feedback method mainly uses two different turntables to ensure that the gravitational moment and the moment of inertia of the torsion pendulum are equal by adjusting the angular acceleration of the torsional pendulum. In this case, the torsion does not produce a torsion angle. The torsional angle is zero, which ensures that the measurement results do not cause serious systematic errors due to nonlinear problems with the torsional suspension fiber.

Therefore, in principle, the angular acceleration feedback method should be able to obtain more accurate gravitational constant results. However, due to the complexity of the device, there are not many laboratories in the world that can carry out this experiment. However, it is believed that with the increasing requirements for the measurement accuracy of gravitational constants in the future, the use of angular acceleration feedback to measure gravitational constants will become a mainstream.

At present, the angular acceleration feedback method has two turntables, including a turntable for placing the attraction ball and a turntable for suspension of the torsion, and the two move relative to each other at the same time. At the same time, the entire measurement process lasts a relatively long time, generally lasting about three to six days. In such a long time, the Earth also rotated three to six times. This means that the direction of the viscous force of the dark matter fluid changes by three to six cycles. Therefore, the uncertainty of the influence of the viscous force of dark matter fluid on the measurement results becomes relatively large.

Of course, in the angular acceleration feedback method, four to eight attraction balls placed symmetrically are used. These symmetrically placed attraction balls are subject to the same direction of the viscous force of the dark matter fluid, so the effect of the viscous force of the dark matter fluid they produce can cancel each other. However, when we delved deeper into the angular acceleration feedback method, we found that although these attraction balls are very symmetrical, their masses will be slightly different. For example, in the experimental setup of Huazhong University of Science and Technology, the mass difference between the two pairs of corresponding attraction balls reached $1g$. Considering that the viscous force of dark matter fluids is about the same as gravity in order of magnitude, although the mass of these four balls reaches $32kg$, their mass difference is only 1*g*, and the error can still rreach1/30,000. This error may not seem large, but for the current gravitational constant experimental results can reach 10 ppm, this error must be reduced to 1/100,000 to obtain more ideal results. The calculation results also prove that the difference between the results measured by the current angular acceleration feedback method and the results measured by the time-of-swing method has indeed reached an error of 10ppm.

In order to more accurately analyze the systematic errors caused by the viscous force of dark matter fluids in the angular acceleration feedback method, and understand the causes of these systematic errors, we make a more detailed calculation here.

First of all, we summarize the parameters of some equipment used by Huazhong University of Science and Technology in the experimental process. Among them, the mass of AAF's Pendulum is 40*g*, the mass of AAF's suction ball is: $m \approx m_A \approx m_B \approx m_C \approx m_D \approx 8.54kg$, the diameter of the four suction balls is 0.127*m*. and the rotation speed of the suction ball is *ω*=2.79*mrad/s*, corresponding to the period

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2.79 \times 10^{-3}} = 2250(s)$$

The distance from the center of mass of the ball to the center of torsional pendulum is $R = 0.17m$.

According to the results of paper [2], the velocity of dark matter relative to the attraction sphere is $8 \times \frac{10^7 m}{s}$, and $\mu = 10^{-31} Pa \cdot s$, so that the viscosity of the dark matter fluid subjected to the four attraction balls is

$$f_T = m_T f_{1kg} \approx 2.67 \times 10^{12} m_T \pi \mu v \approx 6.71 \times 10^{-11} m_T$$

Where

$$m_T = m_A + m_B + m_C + m_D \approx 4m$$

Figure 1 shows the force on a single attraction ball. The angle 23.4° is the inclination of the Earth's axis. 60° is the angle between the position of the laboratory of Huazhong University of Science and Technology and the axis of the earth.

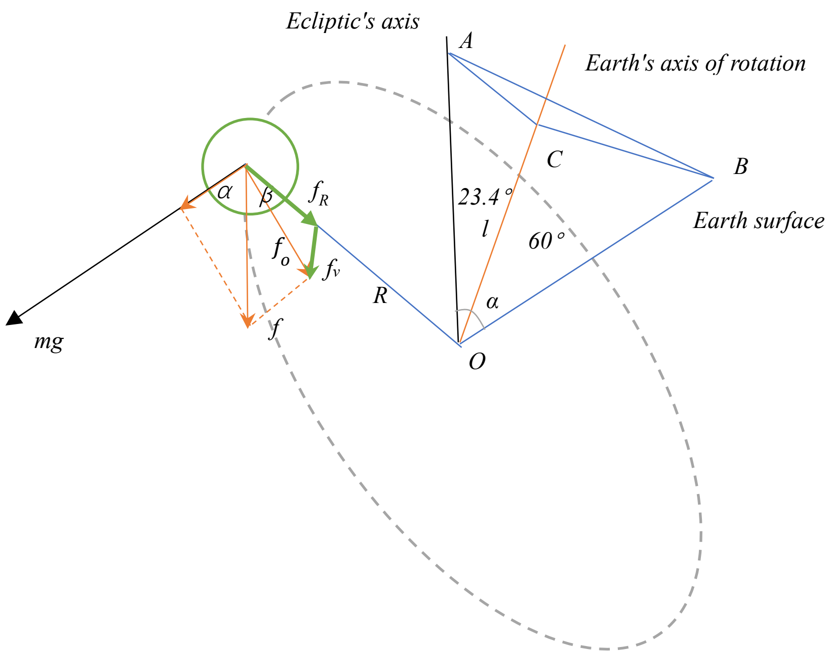

Figure 1. Force analysis of the attraction ball

Figure 1 plots the force of an attraction ball. where *mg* is the direction of gravity, that is, the direction of the vertical experimental plane in the laboratory. The viscous force of the dark matter fluid produces a direction that is inconsistent with the direction of gravity, because the Earth's axis of rotation is deflected. At the same time, the position of the laboratory is located above the latitude of a certain angle of the earth, which causes the viscosity of the dark matter fluid to form an angle α the direction of gravity.

The viscous force f of the dark matter fluid is projected into the orbital plane of the attraction ball to form a perpendicular force f_o. The force forms the two force components of f_R and f_v in the radius of the attraction ball orbit and the tangent direction of the orbit, respectively. The angle between f_o and f_R is β.

Since f_R is directed towards the center of mass of the torsional pendulum, no torque is generated, which does not affect the rotation of the torsion and attraction ball. Therefore, only the f_v component can affect the acceleration of the attraction ball and the rotation angle of the torsional pendulum.

However, because the entire angular acceleration feedback method measures for a relatively long time, due to the rotation of the earth in the measurement process, it will cause the viscous force of the dark matter fluid to rotate around the direction of gravity during the test of a cycle. The cycle is 24 hours. The angular velocity is $\Omega = 7.27 \times 10^{-5}\ rad/s$

This can be seen from Figure 1

$$\Omega = \frac{d\angle ACB}{dt} = \frac{d\varphi}{dt}$$

This is the angular velocity of the Earth's rotation.

$$cos\varphi = \frac{AC^2 + BC^2 - AB^2}{2AC \cdot BC} = \frac{l^2 \tan^2 23.4° + l^2 \tan^2 60° - AB^2}{2l^2 tan23.4° \cdot tan60°} = b(a - \frac{AB^2}{l^2})$$

And

$$AB^2 = OA^2 + OB^2 - 2OA \cdot OBcos\alpha = l^2 \left(\frac{1}{cos^2 23.4°} + \frac{1}{cos^2 60°} - \frac{2cos\alpha}{cos\, 23.4°\, cos60°} \right)$$

Or

$$AB^2 = l^2(c - dcos\alpha)$$

Then

$$cos\varphi = b[a - (c - dcos\alpha)] = b(a - c + dcos\alpha) = e + hcos\alpha$$

$$hcos\alpha = cos\varphi - e$$

$$cos\alpha = \frac{-e + cos\Omega t}{h}$$

$$sin\alpha = \sqrt{1 - \left(\frac{-e + cos\Omega t}{h}\right)^2}$$

Where a, b, c, d, e, f are the constants.

$$a = \tan^2 23.4° + \tan^2 60°$$

$$b = \frac{1}{2tan23.4° \cdot tan60°}$$

$$c = \frac{1}{cos^2 23.4°} + \frac{1}{cos^2 60°}$$

$$d = \frac{2}{cos\, 23.4°\, cos60°}$$

$$e = b(a - c)$$

$$h = bd$$

Since the viscous force of dark matter fluid is different from the direction of gravity and the normal direction of the attraction ball orbit, the viscous force will form the component of the viscous force of dark matter in different directions for a certain period of time. Among them, the acceptance component perpendicular to the radius of the orbit has an effect on the angular acceleration of the attraction ball f_v. This force is located in the tangent direction of the orbit, so it can be directly accelerated or decelerated by the angular acceleration of the attraction ball. Due to the requirement of conservation of angular momentum, a small acceleration or deceleration of the attraction ball will affect a large change in the angular acceleration of Pendulum, which will cause the measured gravitational constant to deviate from the normal value.

Of course, if the masses of all attraction balls are completely equal, and these attraction balls are arranged symmetrically, the direction of f_v is also exactly the same, so that the moment formed by the rotation of all attraction balls around the torsional center of mass is also equal and can cancel each other out. This means that the viscous force of the dark matter fluid does not affect the angular momentum of the attraction ball. However, because the masses of the attraction balls are not exactly equal, there is an imbalance in the torque. The difference in the quality of these attraction balls is

$$\Delta m = 8543.5826 + 8540.5282 - 8541.4167 - 8541.5575 \approx 1.14g \qquad (1)$$

As can be seen from Figure 1, the viscous force of dark matter fluid attracting a single ball along the gravitational direction is

$$f_g = fcos\alpha$$

The other two directions are

$$f_v = fsin\alpha sin\beta$$

$$f_R = fsin\alpha cos\beta$$

Of these three force analyses, we only need to consider f_v. Then we find the average over a measurement period

$$\overline{f_v} = \frac{1}{T}\int_0^T fsin\alpha sin\omega tdt = \frac{1}{T}\int_0^T f\sqrt{1-\left(\frac{e-cos\Omega t}{h}\right)^2}\, sin\omega tdt$$

$$= \frac{-1}{T\omega}\int_0^T f\sqrt{1-\left(\frac{e-cos\Omega t}{h}\right)^2}\, dcos\omega t$$

where T is the experimental measurement of one period of rotation of the attraction ball, which is 2250s.

From the numerical calculation results, if the entire experiment is completed in just one day, the moment generated by the viscous force of the dark matter fluid can cancel each other.

However, the reality is that the start time and end time of the experiment may be inconsistent, and there will be a little error. From the situation disclosed in the paper [6], AAF experiments generally last 3 to 6 days, so *216T* is taken as the upper limit here. From the numerical calculations in Figure 2, the range of change is between [-0.002, 0.004] after about the fifth day. We can take the upper limit of 0.004 and the lower bound of -0.002.

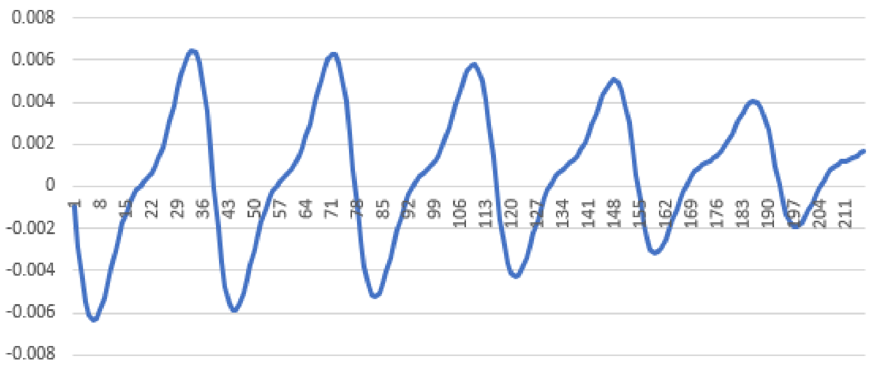

Figure 2. Calculation results of the change in viscosity force of dark matter

Consider the upper limit of the viscosity force of 0.004*f* first, ie

$$\overline{f_v} \approx 0.004 \times 6.71 \times 10^{-11} m \approx 2.68 \times 10^{-13} m$$

The viscous force produced by the mass difference of the four attraction balls is

$$\Delta\overline{f_v} \approx 0.004\Delta f \approx 2.68 \times 10^{-13} \Delta m$$

It can be seen that this resistance force is still relatively large. Even if the actual experimental time is limited, the viscosity of this dark matter fluid will still have a considerable impact. From the calculation results, the shorter the duration of the experiment, the greater the impact of the viscous force of dark matter fluids.

The angular acceleration of the attraction ball produced by this force is

$$\bar{\alpha} = \frac{\Delta\overline{f_r}}{m_T R} = \frac{2.68 \times 10^{-13} \times 1.14 \times 10^{-3}}{34.16 \times 0.17} \approx 5.27 \times 10^{-17} (rad \cdot s^{-2})$$

According to the conservation of angular momentum, the change in the angular momentum of the attraction ball is transferred to the torsion. namely

$$m_T R\bar{\alpha} + \frac{1}{12} m_p (a^2 + b^2) \Delta\alpha_e = 0$$

Therefore, the change in torsional angle acceleration is

$$\Delta\alpha_e = -\frac{12m_T R\bar{\alpha}}{m_p(a^2+b^2)} = -174216\bar{\alpha} = -9.18\times 10^{-12}(rad\cdot s^{-2})$$

The average amplitude of the angular acceleration of the torsional pendulum measured experimentally is

$$\alpha_e = 462\times 10^{-9}(rad\cdot s^{-2})$$

It can be seen that the effect of the angular acceleration generated by the viscous force of the dark matter fluid on the angular acceleration of the pendulum is

$$p = -\frac{9.18\times 10^{-12}}{462\times 10^{-9}} = -2.0\times 10^{-5}$$

Considering that the acceleration of the torsional angle velocity is proportional to the gravitational constant, the experimental measured value of the gravitational constant change is

$$\triangle G = pG = -2.0\times 10^{-5}G = -1.33\times 10^{-15}\, m^3 \cdot kg^{-1} \cdot s^{-2}$$

$$G_c = G + \triangle G = 6.674484\times 10^{-11} - 1.33\times 10^{-15}\, m^3 \cdot kg^{-1} \cdot s^{-2}$$

$$G_c = 6.674351\times 10^{-11}\, m^3 \cdot kg^{-1} \cdot s^{-2}$$

For the lower bound of -0.002*f*, the corresponding change in gravitational constant is

$$G_c = 6.674551\times 10^{-11}\, m^3 \cdot kg^{-1} \cdot s^{-2}$$

The average value measured by the TOC method is

$$G_c = 6.674184\times 10^{-11}\, m^3 \cdot kg^{-1} \cdot s^{-2}$$

Therefore, if the influence of dark matter viscosity is considered, the problem of inconsistency between the two experimental measurements should be solved to a certain extent. Of course, because this is the systematic error that may be caused by the viscous force of the dark matter fluid, as long as some factors in the experimental process are effectively controlled, such as the start measurement time and the end measurement time, if it can be accurate to an integer multiple of 24 hours, this systematic error should be eliminated to a certain extent.

3 Conclusions

Through the analysis of this paper, it is proved that the influence of the viscous force of dark matter fluid on the measurement of gravitational constant is very obvious. The influence of the viscous force of dark matter fluid on the measurement of gravitational constant is mainly manifested in the fact that the attraction ball of relatively large mass motion is affected by the viscous force of dark matter and produces additional torque. This additional moment can cause these attraction balls to generate angular acceleration, and then transfer this angular acceleration to the torsion pendulum by conserving angular momentum, which in turn causes a change in the angular acceleration of the torsional pendulum, and then the sensor measures a changed angular acceleration. The value of the gravitational constant calculated from this changing angular acceleration will be larger or smaller than the true gravitational constant.

In this paper, the experiments of angular acceleration feedback method to measure the gravitational constant conducted by Huazhong University of Science and Technology are analyzed. It is pointed out that because the entire experimental process lasts relatively long, it is not necessarily an integer multiple of 24 hours, which leads to the moment generated by the viscous force of dark matter cannot be canceled out during the entire experimental period. The results of the measurement may depend on how long the experiment continues after the end of the experimental cycle. If the experiment were to end immediately after the full 24-hour cycle, the effect of dark matter viscosity might not be too obvious. However, if it is completed in the subsequent measurement cycles, it may have a large impact on the measured gravitational constant. Of course, as the subsequent extended measurement time becomes longer and longer, this effect may begin to gradually weaken.

The effect of the viscous force of dark matter fluid on the measurement results of the gravitational constant is also related to the latitude of the laboratory where the measurement is located. Theoretically, laboratories with low latitudes, because the angle between the laboratory plane and the Earth's axis of rotation is relatively large, resulting in a larger angle between the direction of the viscous force of the dark matter fluid and the direction of gravity, which should cause a greater impact on the viscosity force of the dark matter fluid, and the measurement in the area with a relatively high latitude The resistance of the dark matter fluid and the angle between the direction of gravity are relatively small, and the results measured at this time should be affected by the viscosity force of the dark matter fluid should be relatively small.

Of course, the influence of the viscous force of dark matter fluid on the experimental measurements of the gravitational constant can be eliminated by dealing with the symmetry of the attraction ball and the torsion. For example, if the masses of all four or eight attraction balls are exactly equal, then the effects of this viscous force of the dark matter fluid can cancel each other out without additional effect on the experimental results.

Of course, from the analysis of this paper, it can also be seen that the viscous force of dark matter fluid is comparable to gravity in orders of magnitude. This also shows that in fact, the effect of the viscous force of dark matter fluids is also very obvious. If we rationally arrange the various factors in the experiment to eliminate these symmetries, then the viscosity of dark matter fluids will be more obvious and easier to measure. This also provides a breakthrough for measuring the viscosity of dark matter fluids and various other parameters of the dark matter fluids in the ground laboratory in the future.

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有光速作为需时空和实时空之间的边界，这一点来看，我们就可以得出结论，虚时空和实时空之间的尺度关系，实际上就是一个相互倒数的关系。

这可以解决物理学当中的无限小和无穷大之间的关系的问题。

实时空的存在，只是因为他存在能量相互作用，也就是我们常说的四种相互作用，这样我们就能够通过应的方式来探测到这些能量和物质的存在，但如果不存在这些相互作用，我们探测不到他们的存在，则这些时空对于我们这个时时空来说，他应该是不存在的，然而他又可能会存在，比如说通过非常微弱的引力相互作用，对实时空产生了影响。

目前，在宇宙尺度的观测下面，我们已经获得了足够多的证据，证实了暗物质和暗能量的存在。

另外，我们在研究球对称的引力场和库仑力场的时候，我们又可以发现，当引力场或者电磁场延伸的无限远的地方，这样才能够构成一个封闭的电场的电力线。这有可能意味着无穷远更灵点是一致的。如果我们把无穷大和 0 做倒数的运算，我们就可以发现，其实二者也是可以等同起来的在数学上。

$$v_c = \frac{v}{c}$$

而

$$v^a = \frac{dx^a}{dt}$$

其中 a=1, 2, 3

我们总是可以通过旋转坐标的方式获得：

$$v = \frac{dx}{dt}$$

当超过光速的时候

当超过光速的时候出现时空的反转

$$w = \frac{dt}{dx}$$

如果用无量纲速度，则

$$v_c = \frac{dx}{cdt}$$

$$w_c = \frac{cdt}{dx}$$

这样

$$v_c w_c = 1$$

或者

$$vw = 1$$

也就是说，如果

$$v < c$$

则

$$w > c$$

即在一个时空是正常的可以观察的小于光速的速度，则在另一个时空，该粒子的速度将是超光速，因此是不可以观察的。

如果我们对时间和空间的尺度度量进行区分。空间变量用大写的字母 X, Y，而时间变量用对应小写字母 y, x。

在球坐标中：

我们可以将空间尺度表示为：

$$X = r_x(\hat{x}^1 sin\theta cos\varphi + \hat{x}^2 sin\theta sin\varphi + \hat{x}^3 cos\theta)$$

$$Y = r_y(\hat{y}^1 sin\theta cos\varphi + \hat{y}^2 sin\theta sin\varphi + \hat{y}^3 cos\theta)$$

不过我们总是可以通过旋转坐标系的方式，将空间的变化限制在 z 轴上面，即$\theta = 0$，这样

$$X = r_x \hat{x}^3$$

$$Y = r_y \hat{y}^3$$

在球坐标中，假设只有径向运动，没有旋转。则

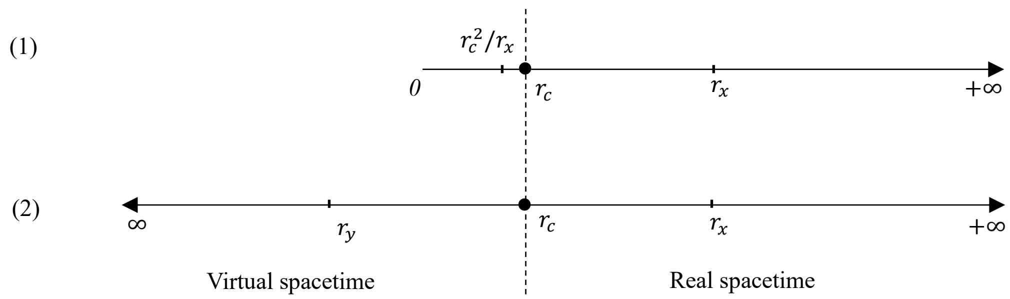
$$v_c = \frac{dX}{dy} = \frac{dr_x}{dy}(\hat{x}^1 sin\theta cos\varphi + \hat{x}^2 sin\theta sin\varphi + \hat{x}^3 cos\theta) = \frac{dr_x}{dy}$$

$$w_c = \frac{dY}{dx} = \frac{dr_y}{dx}(\hat{y}^1 sin\theta cos\varphi + \hat{y}^2 sin\theta sin\varphi + \hat{y}^3 cos\theta) = \frac{dr_y}{dx}$$

即

$$v_c w_c = \frac{dr_x}{dy}\frac{dr_y}{dx} = 1$$

我们可以考虑一个特殊的坐标。能够将虚时空空间延伸到无穷远



图中（1）坐标则反映出在实时空视图中，所观察到的虚时空的坐标大小。此时虚时空最短的距离为 0.

图中（2）坐标是将虚时空的坐标从 0 延伸到负无穷大。虽然这里正无穷小的倒数是正无穷大。但是我们可以考虑 0 点附近的负无穷小部分。这样虚时空的坐标轴就变成了负数。这样也就能够在同一个坐标上面同时将实时空和虚时空绘制出来。如图 1 中的坐标轴 (2) 所示。这或许可以为我们建立一套数学系统来解决无穷小和无穷大的问题提供新的思路。

因此。这主要是通过将（2）中对应虚时空的坐标做倒数运算。这样虚时空和实时空之间的坐标就可以对称起来了。

对比（1）和（2）坐标，可以看出（1）坐标中的 ry 到 rc 之间的长度明显比（2）坐标中的对应长度要短很多。

这也反映出从一个时空观察另一个时空的空间尺度跟在同一时空中观察到的时空尺度是不同的。

$$r_y = r_x$$

因此在实时空中观察到的虚时空的速度为:

$$v_v = \frac{d}{dy}\left(\frac{r_c^2}{r_x}\right) = -\frac{dr_x}{dy}\frac{r_c^2}{r_x^2} = -v\frac{r_c^2}{r_x^2}$$

可以看出，速度的方向相反。另外由于

$$r_x > r_c$$

因此可以观察到虚时空中的速度要小于实时空中对应的速度。

$$-\frac{dr_x}{dy}\frac{dr_y}{dx}\frac{r_c^2}{r_y^2} = 1$$

$$-\frac{dr_x}{dy}\frac{dr_y}{dx}\frac{r_x}{r_y} = 1$$

然后我们将虚时空和实时空的速度转换公式改变一下形式，则

$$dXdY = dydx$$

我们这里考虑时空变化是匀速线性的，则我们也可以写成：

$$\Delta X \Delta Y = \Delta y \Delta x$$

其中 xy 分别是两个时空的时间。如果设置时间刻度为单位时间，则应该有

$$\Delta X \Delta Y = \Delta y \Delta x = c^2$$

因此空间的尺度跟单位时间的定义是有关系的。

考虑图 1 中的坐标（2）表示的关系，有：

$$\Delta X = r_x - r_c$$

$$\Delta Y = r_c - r_y$$

为了便于使用球极坐标，这里的 rx 和 ry 都是直接使用正数。

因此：

$$(r_x - r_c)(r_c - r_y) = c^2$$

考虑到一个粒子沿着 z 轴方向匀速运动，同时没有加速度。因此两边分别对时间 x 和 y 求导

数，可以得到：

$$\frac{dr_x}{dy}(r_x - r_c) = 0$$

$$\frac{dr_y}{dx}(r_c + r_y) = 0$$

再将上述两个公式相乘可以得到：

$$\frac{dr_x}{dy}\frac{dr_y}{dx}(r_x - r_c)(r_c + r_y) = 0$$

由于

$$\frac{dr_x}{dy}\frac{dr_y}{dx} = 1$$

因此：

$$(r_x - r_c)(r_c + r_y) = 0$$

即：

$$-r_c^2 + (r_x - r_y)r_c + r_x r_y = 0$$

由于这是同一个粒子在两个不同时空观察到的位置。因此：

$$r_x = r_y$$

这样我们可以得到：

$$r_x r_y = r_c^2$$

则 c 可以看做是一个虚时空和实时空之间的边界。

这反映出两个时空的时空尺度是互为倒数的。

如果存在关系：

$$r_x r_y = L^2$$

则

$$XY = r_x r_y(\hat{x}^1 sin\theta cos\varphi + \hat{x}^2 sin\theta sin\varphi + \hat{x}^3 cos\theta)(\hat{y}^1 sin\theta cos\varphi + \hat{y}^2 sin\theta sin\varphi + \hat{y}^3 cos\theta) = 0$$

考虑到:

$$\hat{x}^\alpha \hat{y}^\beta = 0$$

因此:

$$XY = 0$$

则:

$$\frac{dX}{dy}Y = 0$$

$$\frac{XdY}{dx} = 0$$

这是矛盾的。说明在电磁尺度，不存在上述关系，即

$$XY \neq L^2$$

Estimating the lifespan of galaxies using dark matter fluid models

Abstract

In the dark matter fluid model, dark matter creates turbulence, which forms galaxies in the universe. And this dark matter turbulence is an energy dissipation system. In the process of galaxy movement, there is a constant consumption of energy. Therefore, each galaxy forms visible galactic material from the time it is generated, and eventually the galaxy disappears due to the process of energy dissipation. This is like a tropical storm on Earth, which lasts for a period of time and eventually disappears into a laminar flow in the atmosphere. This turbulent energy dissipation process is mainly caused by the viscosity of the dark matter fluid itself. In the process of galaxy operation, due to the internal friction between galaxy turbulence and dark matter fluid, energy is continuously dissipated, and eventually dark matter galaxy turbulence disappears. This paper roughly estimates the lifespan of the formed galaxy based on the previously conceived dark matter fluid model.

1 Introduction

In the dark matter fluid model [1], it is assumed that the entire universe, like the atmosphere or oceans on Earth, is filled with dark matter fluids. When dark matter fluids are disturbed, turbulence may occur. These turbulences are made up of countless miniature vortices. The result is galaxies of different shapes that we see [2].

Dark matter fluid models are good at explaining why various different types of galaxies form. The structure of the most typical spiral galaxy is very similar to vortices in various fluids, such as the formation of tropical storms in the fluids of the Earth's atmosphere. At present, although we already have a lot of knowledge about tropical storms, if we can apply this knowledge to the laws of galaxy operation, I believe it will be of great help to our understanding of various cosmic galaxy phenomena. This article attempts to use such a model to estimate the lifespan of galaxies.

2 Estimation of galaxy lifetime

We can approximate the lifetime of turbulence using Newton's laws. If the viscosity coefficient inside a fluid is η, the spiral motion speed of the fluid as a whole is basically the same, which is v, so that the spiral motion of the fluid has no velocity gradient, because the energy loss caused by internal friction will be small. However, there is friction between turbulent flow and fluid laminar flow. This friction is related to the speed of the turbulence and the diameter of the turbulence.

Figure 1(a) shows an approximate model of galactic material in the Milky Way.

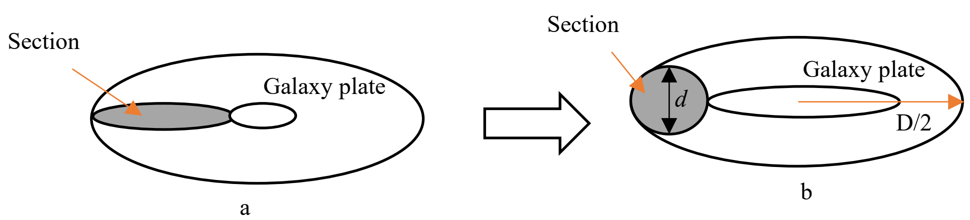


Figure 1.

Figure 1(a) approximates the actual galaxy structure. Figure 1(b) equivalents it as a sphere.

Now we assume that the diameter of the turbulent equivalent sphere is d, then according to the formula of the force of the object moving in the fluid, we can find that the force on the turbulence is

$$F = 3\pi\eta dv$$

where η is the viscosity coefficient of dark matter fluids, and v is the average speed of galactic matter.

Suppose that the entire galaxy travels L distance from the time it arises to the time it disappears, so the energy consumed by the friction of the turbulent motion is the energy

$$W = FL = 3\pi\eta dvL$$

If the total kinetic energy of a galaxy is E, this energy is completely consumed by the turbulence of dark matter fluid, and the turbulence disappears. That's it

$$E = W = 3\pi\eta dvL$$

Then

$$L = \frac{E}{3\pi\eta dv}$$

Therefore

$$\tau = \frac{L}{v} = \frac{E}{3\pi\eta dv^2}$$

It can be seen that the lifetime of the vortex is proportional to the energy viscosity coefficient and inversely proportional to the square of the velocity of the fluid.

For the lifespan of the Milky Way, it can be estimated like this.

$$E = \frac{1}{2}mv^2$$

where m represents the mass of the Milky Way, approximately $m = 1.5 \times 10^{12} \times 2 \times 10^{30} = 3 \times 10^{42}(kg)$

According to the estimation of the paper [1], the viscosity coefficient of the dark matter fluid is

$$\eta = 4000Pa \cdot s$$

Consider that the Milky Way is a flat disk shape. All galactic material is concentrated in a cylindrical volume averaging 1,000 light-years high and 50,000 light-years in radius. Its vertical cross-sectional area is about $1000 \times 50000 = 5 \times 10^7(ly^2)$, which is equivalent to a diameter

$$d = 2\sqrt{\frac{5 \times 10^7}{\pi}} = 8 \times 10^3(ly)$$

circular section.

So that we can convert it

$$d = 8 \times 10^3 \times 10^{16} = 8 \times 10^{19}(m)$$

The lifespan of the Milky Way can be estimated to be

$$\tau = \frac{m}{6\pi\eta d} = \frac{3 \times 10^{42}}{6 \times 3.14 \times 4000 \times 8 \times 10^{19}} \approx 5 \times 10^{-3+42-22} = 5 \times 10^{17}(s)$$

Converted to the unit of year, it is

$$\tau \approx 1.6 \times 10^{10}(year)$$

The current estimated age of the Milky Way is about 13.6 billion years. It's a little shorter than the calculation result. Therefore, this value is still quite reasonable.

However, in the above estimation, we ignore that the main mass of the Milky Way is concentrated in the area of the silver center about 20,000 light-years in diameter. And the speed of matter in this range is also significantly lower than that of peripheral galaxy matter. In this way, the resistance of the entire galaxy of matter moving in the dark matter fluid may be smaller than we calculate. So the actual lifespan of the Milky Way should be greater than 16 billion years.

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Estimation of dark matter fluid parameters and their influence on galaxy motion

Abstract

This paper explores the effects of dark matter fluids on galactic matter within the confines of the solar system. In this way, we can explore the possible effects of dark matter fluids on a smaller scale. The effect of this dark matter fluid in the solar system is mainly the tilt angle of the rotation of the planet or star. Because even in very large-scale cosmic scales, conservation of angular momentum can always be established, so the change of angular momentum has become the most sensitive parameter of galactic matter to external influences. Through the analysis and calculation results of this paper, it is shown that when there is a high-speed relative motion between galactic matter and dark matter fluid, the viscous force of dark matter fluid will cause changes in the orbital or rotational angular momentum of planets or stars like gyroscopes affected by gravity. This may be an important reason for the tilt of the eight planets in the solar system, as well as the sun itself. The calculation results according to the model in this paper show that the calculation results are basically consistent with the actual observed precession period of the major planets and the sun. A few inconsistencies can be corrected by external factors such as asteroid impacts. The significance of this study is to provide an important way to detect the existence of dark matter in a smaller galaxy range, and also estimate some important parameters of dark matter fluid, such as the flow speed of dark matter fluid and the viscosity coefficient of dark matter fluid.

1 Introduction

The concept of dark matter has been proposed for a long time, and more and more cosmic observation evidence has been obtained. This also means that there will be more and more exploration projects for dark matter. However, because the dark matter effect is mainly expressed on the scale of the universe, this brings certain difficulties to the direct verification of dark matter. So in the solar system where we humans live, is there a phenomenon that dark matter affects the movement of galactic matter? If it exists, it is believed that it will be very conducive to human exploration of the laws of dark matter. This paper attempts to explore the various observable effects of dark matter fluids from the perspective of the influence of dark matter on the motion of planets or stars. The analysis of these observable effects should provide us with some more direct evidence of the existence of dark matter, and some important parameters of dark matter fluids can be obtained.

This paper examines the tilt of the rotational axes of planets and stars in the solar system. We already know that for an object with angular momentum such as a gyroscope, if it is affected by gravity, its axis will tilt. The tilted shaft generates precession. But for stars or planets in the solar system, because they are floating in space and do not have a ground fulcrum like a gyroscope, why do these axes also tilt? This has always been a confusing question. There are also many different views on why the rotations of planets and stars in the solar system are tilted. This includes exploration from the perspective of conservation of angular momentum and collisions of asteroids.

This paper argues that if there is a dark matter fluid, and the dark matter fluid has a viscous force, the viscous force of the dark matter fluid is like the effect of gravity on the gyroscope, which will cause the rotation angular momentum of the planet or star to produce an increase in angular momentum in the vertical direction. This vertical increase in angular momentum is what causes the rotational momentum of a planet or star to deviate from its axis.

2 The effect of dark matter fluids on matter

Since matter is made of elementary particles. Therefore, the role of dark matter fluid should be directly acting on elementary particles. Electromagnetic and gravitational interactions then drive the entire matter to move.

Elementary particles mainly include electrons, protons, and neutrons.

The radius of the electron is very small, according to the paper [4], you can take $7.7 \times 10^{-19}m$. The radius of the proton is similar to the radius of the neutron, you can take 0.74fm.

For the action of elementary particles, a formula can be used

$$f = 6\pi\mu rv$$

The μ is the viscosity coefficient of dark matter, r is the radius of the elementary particle, and v is the velocity of the dark matter fluid relative to the elementary particle.

It can be seen that because the radius of protons or neutrons is much larger than that of electrons, the viscous resistance of dark matter fluids to electrons can be ignored. We only need to consider the viscous forces generated by protons and neutrons.

First, consider that 18g of water contains 6.02×10^{23} molecules, each of which contains 2+8+8=18 protons and neutrons. Therefore, 18g of water contains $18 \times 6.02 \times 10^{23} = 1.08 \times 10^{25}$ protons and neutrons.

For 1kg of water, the number of protons and neutrons contained is 6.02×10^{26}. This is basically the case with other substances.

Therefore, the number of protons and neutrons contained in 1kg of matter is subjected to the viscous force of dark matter

$$f_{1kg} = 6 \times 6.02 \times 10^{26} \times 0.74 \times 10^{-15}\pi\mu v \approx 2.67 \times 10^{12}\pi\mu v \tag{1}$$

For Earth, the viscous force of dark matter is

$$f_e = m_e f_{1kg} \approx 2.67 \times 10^{12} m_e \pi\mu v \tag{2}$$

Suppose the Earth decreases from its maximum orbital velocity to 0 and moves l distance, so the energy consumed by viscous friction to do work is

$$W = f_e l = 2.67 \times 10^{12} m_e \pi\mu v l$$

If the total kinetic energy of a planet is E, this energy is completely consumed by the viscous force of the dark matter fluid

$$E = W = 2.67 \times 10^{12} m_e \pi\mu v l$$

So

$$l = \frac{E}{2.67 \times 10^{12} m_e \pi\mu v}$$

Therefore

$$\tau = \frac{l}{v} = \frac{E}{2.67 \times 10^{12} m_e \pi \mu v^2}$$

It can be seen that the change in the speed of the planet's motion is proportional to the energy viscosity coefficient ratio, and inversely proportional to the square of the velocity of the fluid.

Changes in the orbital velocity of the Earth can be estimated as follows.

Thereinto

$$E = \frac{1}{2} m_e v^2$$

$$\tau = \frac{l}{v} = \frac{1}{5.34 \times 10^{12} \pi \mu}$$

where m_e represents the mass of the Earth, approximately $m_e = 6 \times 10^{24} (kg)$

According to the estimation of paper [1], the viscosity coefficient of the dark matter fluid is

$$\mu = 4000 Pa \cdot s$$

The lifetime of the Earth's orbital movement can be estimated to be

$$\tau = \frac{1}{5.34 \times 10^{12} \pi \mu} = \frac{1}{5.34 \times 10^{12} \times 3.14 \times 4000} \approx 1.5 \times 10^{-17} (s)$$

Converted to year, it is

$$\tau \approx 4.8 \times 10^{-25} (year)$$

This lifespan is simply too short. This is clearly not consistent with what is already known. The reason for the problem is that paper [1] only estimates the upper limit of the viscosity coefficient of dark matter fluids. The viscosity coefficient of actual dark matter fluids may be much smaller.

If analyzed according to the current state of the Earth's movement, if the sun does not change, the Earth's current orbit movement time should reach more than ten billion years. After all, the Earth has been in this orbit for more than four billion years.

So if we reduce the viscosity coefficient of dark matter fluids, take

$$\mu = 10^{-31} Pa \cdot s$$

Then we can get

$$\tau \approx 1.92 \times 10^{10} (year)$$

That is, the orbital life of the Earth should reach 19 billion years. This makes sense. This also shows that if there is a dark matter fluid, and this dark matter fluid has a viscous force, its viscosity coefficient is about $10^{-31} Pa{\cdot}s$. This is a very small viscosity coefficient.

Of course, the smaller the viscosity coefficient, it means that dark matter fluids are more likely to form turbulence, causing the entire universe to be filled with visible matter.

3 Effect of viscous force of dark matter fluid on planetary axis precession

From the point of view of the planet's rotation, the planet's axis of rotation should always remain in a fixed direction if no additional moment is applied. However, since the planets are also affected by the viscous force of a fluid while moving, a moment perpendicular to the direction of the planet's motion will be generated, which will affect the orbit or rotational momentum of the planet.

Fig. 1 shows the effect of such a moment.

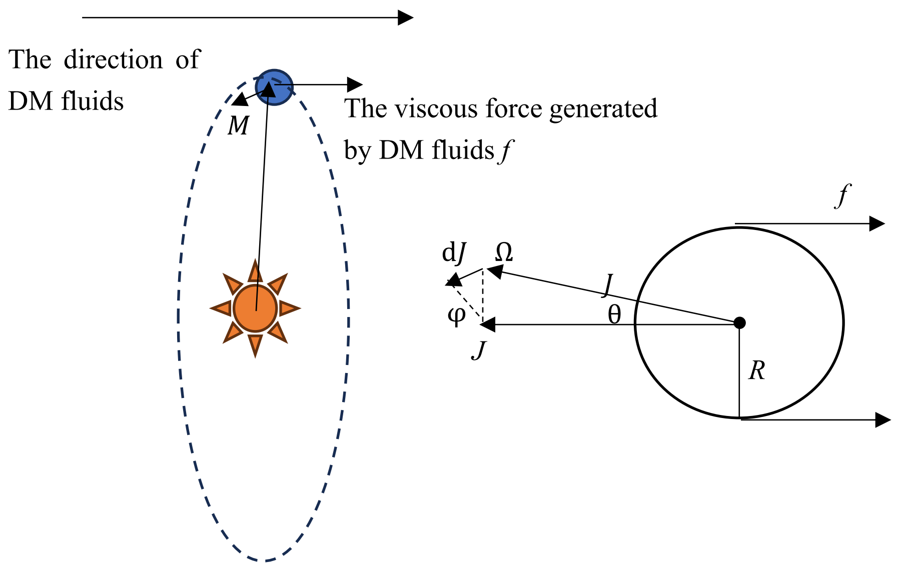

Fig. 1 The viscous force to which the planet or star is subjected

In Fig. 1, R is the radius of the planet, J is the rotational angular momentum of the planet, and f is the viscous resistance of the dark matter fluid. M is the moment generated by the viscous force of the dark matter fluid on the planet's surface. φ is the angle at which the angular momentum precession.

According to formula (2), as can be seen from the above figure, when the planet moves at a velocity v with respect to the dark matter fluid, the resistance of the dark matter fluid can be calculated by the Stokes formula

$$f_p = m_p f_{1kg} = 2.67 \times 10^{12} m_p \pi \mu v$$

The moment generated by this force on the planetary body is

$$M = R f_p$$

Here R is the radius of the planet. This moment is always perpendicular to the direction of the star's angular momentum of rotation. If the change in the momentum of the star's rotation angle generated by this moment is dJ, then

$$dJ = Mdt$$

Since the moment M is perpendicular to the rotational angular momentum, the change of the angular momentum will not affect the magnitude of the rotational angular momentum on the one hand, but will cause the rotational angular momentum to deviate from the axis, resulting in an inclination angle θ, which changes the direction of the rotation angular momentum. Thus creating a precession along the axis of motion around the planet. This is like a gravitational gyroscope precessioning around an axis. The angular velocity of its precession is

$$\Omega = \frac{\mathrm{d}\varphi}{\mathrm{d}t} = \frac{\mathrm{d}J}{J sin\theta \mathrm{d}t} = \frac{M}{J sin\theta}$$

It can be seen that the angular velocity of the planetary axis precession is proportional to the viscous force moment received, and is inversely proportional to the rotational angular momentum of the planet. We can also express the angular velocity in terms of period T.

$$\Omega = \frac{2\pi}{T} = \frac{M}{J sin\theta}$$

That is

$$T = \frac{2\pi J sin\theta}{M}$$

The angular rotation velocity of the planet is

$$J = \frac{2}{5} m_p R^2 \omega$$

Then

$$T = \frac{J sin\theta}{1.34 \times 10^{12} m_p \mu v R} = \frac{2R\omega sin\theta}{5 \times 1.34 \times 10^{12} \times 10^{-31} v} \qquad (3)$$

In the above formula, J is the orbital angular momentum of the planet, μ is the viscosity coefficient of dark matter, m_p is the mass of the planet, R is the radius of the planet, v is the velocity of dark matter relative to the planet, here take $v = 80000 km/s$.

4 The influence of the Moon on the momentum of the Earth's rotation angle

Unlike other planets, the Moon's rotation around the Earth is at an angle to the inclination of the Earth's axis of rotation. The Moon orbit itself has a 5-degree inclination angle to the plane of the perpendicular planetary orbit. The Earth's axis of rotation has an inclination of 23.44 degrees in the other direction. Therefore, when considering the tilt of the Earth's axis of rotation, the influence of the Moon must also be taken into account.

Take it here

$$m = 6.00 \times 10^{24} kg$$

$$R = 6400000m$$

$$\omega = 7.27221 \times 10^{-5} (rad/s)$$

It can be calculated that the rotational momentum of the Earth is

$$L = \frac{2}{5} mR^2 \omega = 7.2 \times 10^{33} (kgm^2 s^{-1})$$

Taking into account the influence of the movement of the Moon, the average inclination of the lunar orbit

$$\alpha = 5°$$

And the tilt of the Earth's axis of rotation is

$$\beta = 23.44°$$

The orbital angular momentum of the Moon

$$L_e = 7.2 \times 10^{33} (kgm^2 s^{-1})$$

$$L_m = 2.9 \times 10^{34} (kgm^2 s^{-1})$$

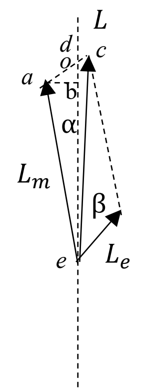

Fig. 2 The effect of the angular momentum of the Moon's orbit on the angular momentum of the Earth's rotation

The geometric relationships in Fig. 2 are as follows

$$ab = L_m sin\alpha$$

$$ao = \frac{ab}{sin\beta} = \frac{L_m sin\alpha}{sin\beta}$$

$$oc = L_e - ao = L_e - \frac{L_m sin\alpha}{sin\beta}$$

Make a perpendicular line *cd* perpendicular to the axis at point C, then

$$cd = oc \cdot sin\beta = \left(L_e - \frac{L_m sin\alpha}{sin\beta}\right) sin\beta = L_e sin\beta - L_m sin\alpha$$

In this way, we can find the angle between the total angular momentum *ec* and the axis *eo*

$$sin\theta = \frac{L_e sin\beta - L_m sin\alpha}{L}$$

Where

$$L^2 = L_e^2 + L_m^2 - 2L_e L_m \cos(\pi - \alpha - \beta)$$

It can be found that the rotational tilt angle produced by the total angular momentum of the Earth and Moon is

$$\theta = 0.54° = 0.00948 rad$$

In addition to Earth, the satellites of other planets are either too small in mass and the orbital angular momentum does not have much effect on the planet's rotational momentum, or the orbital plane of the satellite is consistent with the direction of the planet's rotational momentum, so it does not significantly affect the planet's rotational momentum tilt. Therefore, the rotation axis inclination data of these planets can be used directly.

5 Comparison of theoretical calculations and practical observations

By substituting the actual data into formula (3), we can calculate the period of the planetary axial precession caused by the influence of the viscous force of the dark matter fluid. The second column in the table, "Precession Period", is the actual observed axis precession period for each planet. The third column, "Calculation Period", is the result of calculations based on the model in this article. Other columns are additional parameters.

Table 1. Comparison of theoretical and observational data on the precession period of planetary rotations

Planets	Precession Period	Calculation Period	R(m)	θ(deg)	ω(rad/s)
Mars	170000	1.24E+05	3E+06	25.19	7.27E-05
Venus	29000	9.87E+01	6E+06	2.64	2.99E-07
Jupiter	4.30E+05	8.21E+05	7E+07	3.13	1.82E-04
Earth	26000	2.56E+04	6E+06	0.84	7.27E-05
Saturn	1.77E+06	5.30E+06	6E+07	26.7	1.65E-04
Uranus	1.69E+08	3.02E+06	3E+07	82	1.01E-04
Neptune	1.77E+06	1.58E+06	2E+07	30	1.08E-04

In Table 1, the Precession Period and Calculation Period units are both “years”.

As can be seen from Table 1, except for Venus and Uranus, the size of the calculation results of the precession period of the planets is basically consistent with the actual observations. For example, the precession period of Mars is greater than that of Earth. However, the data varies widely, which may be related to the fact that Venus' rotation is tidally locked by the Sun. Since the rotation of Venus is tidally locked by the Sun, it means that the initial rotation speed of Venus is also relatively fast. The gyroscopic effect of Venus' rotation will be relatively small now, so it will also be easily disturbed by external movements.

All four gaseous planets have greater precession periods than rocky planets. Of the four gaseous planets, Jupiter has the smallest precession period. Uranus calculations differ greatly from actual observations, which may be related to other factors. Such as asteroid impacts, and so on.

6 The axis of the sun precession

It can be seen from paper [2] that the current planetary orbital plane of the solar system is at an angle of 60 degrees to the direction of the movement of the solar system, and this angle is still showing periodic changes, with a period of about 60 million years. In other words, the axis of the sun has an angle of 30 degrees relative to its direction of motion. If we consider that this tilt of the sun's axis relative to its direction of motion is also related to the viscous force generated by dark matter fluids, then we can assume that the sun's axis of rotation has a 30-degree tilt, and the sun's axis of rotation presents a precession with a period of 60 million years around its direction of motion.

First, we calculate that the rotational momentum of the Sun is

$$L_s = \frac{2}{5} M r^2 \omega = 1.13 \times 10^{42} (kgm^2 s^{-1})$$

In addition to the rotational angular momentum of the Sun, the eight planets in the solar system also have orbital angular momentum. Just as the orbital angular momentum of the Moon has an effect on the angular momentum of the Earth's rotation, the orbital angular momentum of the eight planets also has an effect on the rotational angular momentum of the Sun. The sum of the orbital angular momentum of the eight planets calculated from the data of the eight planets is about 28 times the angular momentum of the Sun's rotation. Hence the total

$$L = 29 L_s$$

By use formula (3), we substitute the data of the sun, obtained

$$T = \frac{2 \times 29 \times R\omega sin\theta}{5 \times 1.34 \times 10^{12} \times 10^{-31} \times 80000} (s) \approx 3.35 \times 10^7 (year)$$

This cycle is basically consistent with the 60 million years of oscillation period of the solar system estimated in paper [2]. It also shows that the angle between the orbital plane of the solar system and the direction of the solar system's motion may be reflected because of the precession of the sun's axis.

7 Force analysis of galactic matter

The flow velocity of dark matter fluid reaches $8 \times 10^7 \ m/s$ is indeed very large, already close to the speed of light. Therefore, even considering that the viscosity of the dark matter fluid is only $10^{-31} Pa \cdot s$, the resistance of galactic matter is very large. Therefore, the motion of the entire galaxy is prone to slowing down or accelerating. This can be seen in the relative positions between some of the already observed galaxies. For example, the Milky Way and Andromeda, these two galaxies should be symmetrical. According to the theory of shock turbulence formation [3], the two galaxies should be arranged in parallel. But what we're seeing now is that the two galaxies seem to be approaching rapidly and colliding. This reflects the instability of the turbulence formed in dark matter fluids.

However, because the matter in the Milky Way galaxy is mainly gathered together by gravitational interactions, the viscous resistance generated by dark matter fluids is still very small relative to gravitational interactions, and will not affect the overall structure of the planet or the relative motion between the materials inside.

For example, according to the radius of the Earth to calculate, the Earth moves with the Milky Way at a speed of 80,000 km/s relative to the dark matter fluid, and the viscous resistance of the dark matter fluid is

$$f_e = m_e f_{1kg} = 2.67 \times 10^{12} m_e \pi \mu v \ = 4 \times 10^{14} (N)$$

And the gravitational force between the Earth and the Sun is

$$F_{se} = \frac{GMm}{R^2} = 3.56 \times 10^{22} (N)$$

The difference between the two is nearly 100 million times. Therefore, relative to gravitational interactions, the viscous force generated by dark matter fluids is negligible.

8 Conclusions

Because the basis of matter is relatively stable electrons, protons and neutrons. As a result, the distance between these elementary particles is very large. Therefore, for dark matter fluids, any macroscopic matter is loose. In this way, when we consider the viscosity of dark matter fluids on matter, we should analyze them from the perspective of the most basic protons, neutrons and electrons. However, because the radius of the electron is too small, the viscous force of the dark matter fluid mainly acts on protons and neutrons. In this way, we only need to consider the number of protons and neutrons in a substance to roughly determine the size of the viscous force of the dark matter fluid that the substance is subjected to. Through the analysis of this paper, we conclude that the viscosity coefficient of dark matter fluids may be as small as $10^{-31} Pa \cdot s$. Therefore, such a small viscous force is difficult to observe at the microscopic level. However, on the cosmic scale, due to the huge amount of matter, this viscous force will produce relatively large effects, such as the generation and drift of galaxies, and even the inclination of the rotation axis of planets and stars in a galaxy.

From the above analysis, we can see that the motion of dark matter fluid relative to galactic matter is an important factor that causes galactic matter to be subjected to viscous forces. The viscous resistance generated by this dark matter fluid, combined with the circular motion of galactic matter, can produce the tilt of the axis like a gyroscope. The tilted rotating shaft creates a corresponding precession. Then, by analyzing the angle of rotation of the axis of rotation and the period of precession, we can verify the existence of the viscous force of the dark matter fluid.

The rotation of galactic matter can be around a specific orbit, such as the rotational angular momentum of planets. The action of dark matter fluids can tilt this axis of rotation. The precession of the rotation axis is generated due to the change of rotation angular momentum.

During the entire analysis, we can note that among all 8 planets, Mercury's rotation axis itself is very weakly tilted, and the relevant data is incomplete, so this paper does not analyze. For the Earth, because there is a lunar orbital angular momentum orbiting the earth, its direction is very different from the direction of the Earth's rotation angular momentum, so the inclination of the Earth's rotation axis also takes into account the influence of the moon. Through detailed analysis, we can see that if the influence of the Moon is considered, then the axis tilt angle of the entire Earth-Moon system is actually very small. In the calculations in this article, it can be seen that it is only 0.54 degrees, which is a very small rotational tilt. Then for other planets, including Uranus, Neptune, and so on, their moons are consistent with the direction of the rotational momentum of these planets. That is to say, even if their satellites are very large, but because the direction of the angular momentum of the satellite's orbit is consistent with the angular momentum direction of the planet's rotation, the tilt of the rotation axis of these planets will not or rarely be affected by the angular momentum of the orbit of these satellites, so only the influence of the moon on the Earth's rotation angle is analyzed in this article.

From the results of the calculation, if the viscosity coefficient of the dark matter fluid we consider is only $10^{-31} Pa \cdot s$ and the movement speed of galactic matter, that is, the solar system relative to the dark matter fluid, reaches 80,000 *km* per second, then the rotation axis precession of the seven planets we calculated except Mercury is basically the same as the rotation axis precession of the actually observed planets by orders of magnitude.

In addition, the sun's rotation axis precession is calculated. If the angle between the sun's axis of rotation and the direction of the sun's motion is regarded as the tilt angle of the sun's axis of rotation, we can find that the tilt angle of the sun's axis of rotation reaches 30 degrees, and the precession period of its axis can reach more than 33.5 million years. The calculation results are basically consistent with the data predicted in some paper [2].

In our analysis of this article, we can also see a very interesting phenomenon, that is, if the speed of dark matter fluid relative to the speed of matter in the solar system galaxy reaches 80,000 kilometers per second, this is close to the speed of 300,000 kilometers per second at the speed of light. It can be seen that the flow speed of dark matter fluids is very fast. However, because dark matter fluids do not participate in electromagnetic interactions, theoretically, even if the speed of dark matter fluids has an upper limit, this upper limit should far exceed the upper limit of the speed of light. Just as in our Earth's matter system, many objects can easily exceed the speed of sound.

Of course, because the dark matter fluid is very fast relative to the galactic matter, this also causes a huge galaxy in the dark matter fluid, it will continue to drift. The speed and magnitude of this drift can also be considerable, and it can be the entire galaxy moving at a very high speed, spinning, or even flipping, just like we see the Milky Way and its sister galaxy, the Andromeda Galaxy. The two galaxies are currently approaching at a very fast speed and will collide soon.

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Use Bernoulli's force to explain how galaxies move between them

Abstract

In this paper, we try to solve the problem of motion between two adjacent galaxies by using the motion of the dark matter fluid driven by the rotation of galaxies. In this study, it is believed that when two adjacent galaxies differ in their direction and relative position, it is easy to lead to differences in the speed of dark matter fluid motion between the two galaxies, which will form the so-called Bernoulli force. This Bernoulli force is one of the reasons why the positions of galaxies in many of the multigalaxies we have observed so far are relatively random. If Newton's theory of gravity or general relativity is used to explain it, then the motion of galaxies due to gravitational effects purely should be circular. This is not quite the same as what we have observed. In fact, in the multigalaxies that we now observe, the movements of the various galaxies exhibit a state of random motion similar to Brownian motion. The existence of this state of random motion can be well explained by dark matter fluids. The estimates in this paper are also largely similar to those of my previous work that the effects of dark matter fluids are on the same order of magnitude as gravitational effects.

1 Introduction

The discovery of dark matter was originally intended to solve the anomaly of the motion curves of stars of galaxies [1], if there was no dark matter, the speed of the stars in a galaxy would slow down as they moved farther away from the center of the galaxy, but the actual observed phenomena showed that almost all the stars in a galaxy moved at basically the same speed. To solve this problem, it can be assumed that there is a large amount of dark matter in a galaxy, which surrounds the entire galaxy in a spherical state [2]. It's like a very large bubble formed around a galaxy. Jovica Vjestica, an aerodynamicist, envisions that all matter in galaxies, including the tiny nuclei of atoms, is made up of bubbles surrounding them [3]. When dark matter fluids flow through these bubbles, they are attracted by the Bernoulli effect. With this line of thinking, this study treats the dark matter sphere surrounding a galaxy as a whole, and when the galaxy rotates, the entire dark matter bubble drives the flow of dark matter fluid around it. If two adjacent galaxies rotate in different directions, the Bernoulli force will be generated due to the different velocities of the dark matter fluid between the two galaxies, which can cause the rotation direction of the galaxy to change.

2 Force analysis between adjacent galaxies

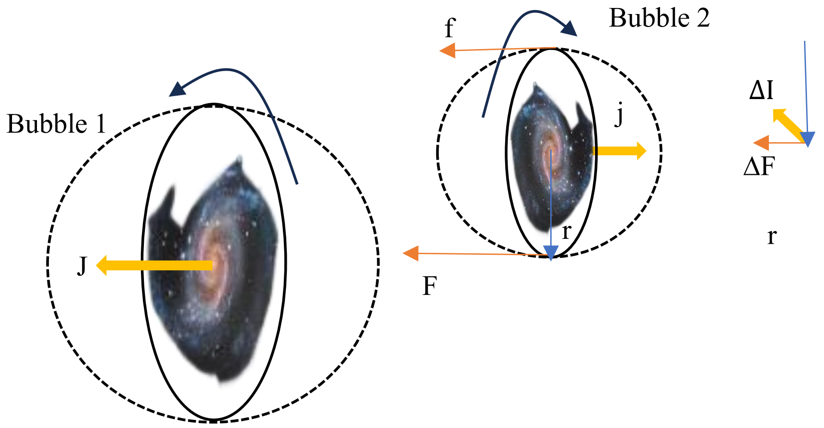

Fig. 1 Galaxies and dark matter bubbles

In the image above (Fig. 1), the two spiral galaxies, one large and one small, rotate in opposite directions. Due to the presence of dark matter, both galaxies are surrounded by dark matter bubbles. When the dark matter bubble rotates, it will drive the dark matter fluid to move.

The rotational velocities of the two galaxies Bubble are Ω and ω, and the angular momentum is J and j, respectively. Considering that the two galaxies rotate in opposite directions, driving the dark matter fluid, Bernoulli forces F and f are formed between the two. However, due to the difference in the positions of the two galaxies, F is slightly larger than f, which will form an angular momentum $dj=\Delta Idt$ in the direction of perpendicular j. This angular momentum will cause the galaxy on the right to drift away from its original direction.

The results of the actual observations are shown in the following figures. Therefore, the relationship between the positions of these galaxies, which occur in pairs and rotate in opposite directions, can be explained by the Bernoulli force of the dark matter fluid. Gravity, on the other hand, may not explain why these galaxies are in a state of separation rather than merging.

We can make a simple analysis of the entire force situation. For Bubble 2 in 1 in Fig. 1, because its rotation position is slightly away from the axis of rotation of the two galaxies, and the rotation of the galaxy drives the motion of the dark matter fluid, this deviation of this position causes the galaxy to be subjected to uneven force at both ends, one side of which is F, and the other side is f, so that there is a force difference:

$$\Delta F = F - f$$

This force difference results in a moment that reverses the direction of rotation of the galaxy:

$$\Delta I = r\Delta F$$

$$dj = \Delta I dt$$

It can be seen that this moment will result in an increasing amount of change in angular momentum over time. If the moment difference ΔI does not change with time, then

$$\Delta j = \Delta M \Delta t$$

This angular momentum is combined with the rotational angular momentum j of the galaxy to form a new direction of angular momentum, the magnitude of which is:

$$d\boldsymbol{L} = \boldsymbol{j} + d\boldsymbol{j}$$

If the moment difference does not change with time, then

$$\Delta L = \sqrt{j^2 + \Delta j^2}$$

3 Simple estimates

If the mass of small galactic Bubble2 consists of dark matter is $m_2 = 1.2 \times 10^{43} kg$

The mass of the large galaxy Bubble1 consists of dark matter is $m_1 = 2.4 \times 10^{43} kg$

The distance between the two galaxies is $r = 2.5 \times 10^{22} m$

Through Newton's gravitational force calculation formula, it can be calculated that the gravitational force between two galaxies is

$$F_g = G\frac{m_1 m_2}{r^2} = 6.67 \times 10^{-11} \times \frac{2.88 \times 10^{86}}{6.25 \times 10^{44}} \approx 3.07 \times 10^{31}(N) \quad (1)$$

If Bubble2 moves in a circular motion around Bubble1, we can approximate the velocity of Bubble2 as

$$v = \sqrt{\frac{F_g r}{m_2}} = \sqrt{\frac{3.07 \times 10^{31} \times 2.5 \times 10^{22}}{1.2 \times 10^{43}}} \approx 2.77 \times 10^5(m/s) \quad (2)$$

It can be seen that as long as the speed of operation is 277 kilometers per second, one galaxy can move in a circle around another galaxy. However, as far as we can see now, it seems that the movement between galaxies is not in a circular motion. For example, in the Stephen Quintet, from the relative positions of the five galaxies, they are more like a random motion, like the Brownian motion of particles. And if the galaxy moves due to Bernoulli's force, according to the formula for calculating Bernoulli's force

$$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2 \tag{3}$$

Considering that the average diameter of the two galaxies is 100,000 light-years, i.e., $D \approx 10^{21}m$, if the width of the dark matter flow between the bubbles of the two galaxies is equal to *D*, it can be calculated that the cross-sectional area of the dark matter fluid flowing between the two galaxies at the entrance is approximate

$$S_1 \approx 2.5 \times 10^{22} \times 10^{21} \approx 2.5 \times 10^{43}(m^2)$$

The distance between the two galaxies is $2.5 \times 10^{22}m$. The cross-sectional area at the nearest point between the dark matter bubbles of the two galaxies is

$$S_2 \approx (2.5 \times 10^{22} - 10^{21}) \times 10^{21} \approx 2.4 \times 10^{43}(m^2)$$

According to the law of continuity, it can be calculated

$$\frac{v_2}{v_1} = \frac{S_1}{S_2} \approx 1.04$$

It can be estimated that the attraction of the dark matter fluid between two galaxies due to the presence of the dark matter bubble of the two galaxies is

$$\Delta p = p_1 - p_2 = \frac{1}{2}\rho v_2^2 - \frac{1}{2}\rho v_1^2 \approx \frac{1}{2}\rho \times 0.082 v_1^2 \approx 0.041 \rho v_1^2$$

Then

$$\Delta F = |\Delta p S| = 0.041 \times \pi \times \left(\frac{10^{21}}{2}\right)^2 \rho v_1^2 \approx 3.22 \times 10^{40} \rho v_1^2 (N)$$

Considering that the speed of the galaxy is about 300 km/s, it can be estimated

$$v_1 \approx 3 \times 10^5 m/s$$

So

$$\Delta F \approx 3.22 \times 10^{40} \rho v_1^2 \approx 2.9 \times 10^{51} \rho(N)$$

If we assume that dark matter accounts for 80% of the matter in a galaxy and is evenly distributed across galaxies, we can estimate the density of dark matter to be approximate

$$\rho \approx \frac{1.2 \times 10^{43} \times 0.8}{\frac{4}{3}\pi\left(\frac{10^{21}}{2}\right)^3} \approx 2.87 \times 10^{-20}(kg/m^3\,)$$

In this formula, the total mass of a galaxy Bubble, including visible matter, is divided by the volume of the Bubble to obtain the density of the dark matter fluid. It is assumed that the density of dark matter in the galaxy is equal to the density of the dark matter fluid outside the galaxy. This can be calculated

$$\Delta F \approx 8.3 \times 10^{31}(N) \tag{4}$$

It can be seen that the Bernoulli force caused by the flow of dark matter fluids is of the same magnitude as the gravitational F_g calculated in equation (1) above. This is basically consistent with my previous calculations [4], which means that the effects of dark matter fluids are about the same as gravitational effects by orders of magnitude. This may illustrate: 1. Is gravity related to Bernoulli's force in dark matter fluids? Or is gravity the Bernoulli force of dark matter fluids? 2. The Bernoulli force produced by dark matter fluids is the same as the gravitational force, which means that we may easily ignore the Bernoulli force of this dark matter fluid and confuse it with gravity. But in any case, the Bernoulli force produced by dark matter fluids is not limited by the speed of light, so it can act instantaneously. So on a cosmic scale, at least we don't need to think about the delay effect on which gravitational interactions depend.

4 Conclusions

Through the analysis of this paper, we believe that the possible applicability of the theory of gravity on a very large cosmic scale is limited, that is, many phenomena of the universe may not be fully explained by the theory of gravity. In the very vast universe, gravity may be a microscopic interaction similar to what we see. This microscopic interaction is mainly limited by the fact that the propagation speed of gravity is only the speed of light, so that gravity may be a microscopic force on the scale of the universe. If the phenomena of the universe cannot be fully explained by the theory of gravity, then we may need a force that exceeds the speed of light of the gravitational force of the universe to explain the phenomena in the universe. The Bernoulli effect caused by dark matter fluids should explain to some extent many inexplicable cosmic phenomena in the past.

In the process of writing this paper, I had a very useful discussion with Jovica Vjestica, an aircraft maintenance engineer and aerodynamicist from Toronto, Canada, and I would like to thank him for the good inspiration.

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Appendix:

Several photos of multiple galaxies from the Hubble Telescope, etc.


NASA, ESA, Hubble
Compilation: Douglas Gardner

Use the dark matter Cherenkov effect to explain why galaxies form and the evidences

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Abstract

Based on the cosmic dark matter fluid model, this paper proposes that the visible matter of the cosmic galaxy is formed by various turbulences of the dark matter fluid. This perturbation may be caused by a huge dark matter entity moving faster than the speed of light, which in turn forms Cherenkov radiation of gravitational waves. This paper estimates the size of this dark matter entity, pointing out that this disturbance will form two regions of high and low pressure in the dark matter fluid. The pressure gradient generated around the turbulence can be estimated using the Fujita formula for tropical cyclones. Computational analysis shows that when it reaches the outer periphery of the galaxy, the pressure gradient becomes small, and the effect of the Corio force is not obvious, so the rotation speed of the galaxy material is mainly affected by the speed of the dark matter fluid itself. This can be confirmed by the fact that the peripheral material rotation speed of all galaxies in the local group is basically the same. In addition, because the dark matter entity may have a certain length, just like a jet that produces a sonic boom, a low-pressure region and a high-pressure region will be generated at both ends of the length, which also means that the same dark matter entity may produce multiple galaxies, and there should be at least two galaxies in multiple galaxies with the same structure. This can be confirmed by some observations. Examples include the Milky Way and Andromeda Galaxy (M31), as well as the Hickson Compact Group.

1 Introduction

The formation of galaxies is a perplexing question. There are currently multiple theories to explain it. The Big Bang theory describes that as the temperature of the universe cools, hydrogen condenses, eventually synthesizing various elements to form the galactic material we see today.

Based on the dark matter fluid model of the universe [1], this paper gives a new explanation for the formation of galaxies.

2 Formation of turbulence in dark matter fluids

When I first proposed the turbulence model of dark matter fluids [1], my assumption was that dark matter fluids would have uneven flow velocities during the flow process. Turbulence occurs at locations with fast flow velocities, forming visible material. But if visible matter is produced in this way, there is a question, why does the flow rate of dark matter fluid in different locations occur unevenly? Are there obstacles in the universe like coral reefs in the ocean? And how to explain why visible galaxies actually occupy a relatively small space in the universe, but the distance between galaxies can be very large. This can be confirmed in the photographs of the Webb Space Telescope in Fig. 1.

Fig. 1. Deep space universe photographed by the Webb Space Telescope (NASA)

Another question is in Fig. 1 We can also notice that different spiral galaxies rotate in different directions. After all, according to the Big Bang theory, if the direction of the Big Bang explodes from a point outward in the direction of spherical symmetry, then the direction of motion of these galaxy materials left after the explosion should have a certain regularity. In addition to the fact that all galactic matter is moving away from each other, we should also be able to see that most galaxies should rotate in roughly the same direction, but this is not the same as what we actually observe. Judging from the photos taken by the Hubble Space Telescope or the Webb Space Telescope, the direction of rotation of various galaxies actually has a large randomness. It is far-fetched to explain it just by gravitational interactions.

Therefore, I think it is more likely that there are entities in dark matter fluids due to the presence of various motions. Some of these moving entities exceed the speed of light, forming turbulent phenomena such as shock waves, which in turn form various galaxies. These shocks are like sonic booms produced by supersonic aircraft in the air when they break through the sound barrier. The different direction of galaxy rotation may be related to the direction of dark matter fluid flow. Just like wooden blocks floating in a river, they will tumble randomly depending on the state of the flowing water.

3 Faster-than-light motion in dark matter fluids

We can assume that there are some continuously moving entities in the relatively uniform dark matter fluid, and these continuously moving entities cannot be observed by the visible matter world, because their interactions are unique to dark matter. These entities may be like creatures in Earth's oceans, moving in random directions.

Some dark matter entities are larger, others are smaller, but unlike the creatures in Earth's oceans, these entities in dark matter fluids can easily exceed the speed of light. The speed of life in the Earth's oceans does not exceed the speed of sound.

If these dark matter entities move faster than the speed of light, they will break through the light barrier in the dark matter fluid, forming shock waves similar to those in the air of the earth, where objects travel faster than the speed of sound [2]. This should be one reason for the turbulence in dark matter fluids.

Of course, to produce turbulence does not necessarily need to break through the limit of the speed of light, and the speed of some organisms in the Earth's oceans is not necessarily fast, but they can also produce turbulence in the ocean. Therefore, the generation of this dark matter turbulence has a great diversity.

We now focus on the turbulence formed by the movement of dark matter entities exceeding the speed of light, so the turbulence formed must be relatively regular. Like some very regular spiral galaxies, it may belong to this category of turbulence.

4 Estimation of the size of dark matter entities

From the diameter formed by the turbulence, it should be possible to roughly estimate the diameter of this dark matter entity moving beyond the speed of light.

There are two main types of shock waves that we know to form beyond a certain signal speed. One is the turbulence formed by breaking through the sound barrier. The other is Cherenkov radiation, which is formed faster than the speed of light.

From the perspective of Cherenkov radiation, the intensity of the radiation formed is mainly related to the speed of particles and the number of particles. The faster a particle travels faster than the speed of light, the greater the radiation intensity will be. The greater the number of particles, the greater the intensity of radiation formed.

Therefore, the turbulence formed by the disturbance of dark matter entities mainly depends on the mechanism of turbulence formation. Is the dark matter fluid similar to air or just an electromagnetic medium? If the dark matter fluid is only an electromagnetic medium, the size of galaxies formed in the cosmic fluid is mainly directly related to the speed and number of dark matter entities. The relationship with entity size is not clear.

However, we can still make an estimate of the size of dark matter entities by comparing the size of the blue whale, the largest animal in the ocean on Earth, with the volume of the ocean.

According to the average depth of the Earth's oceans of 3800m and the average area of $3.6 \times 10^8 km^2$, the total volume of the Earth's oceans is

$$3800 \times 3.6 \times 10^8 \times 10^6 = 1.4 \times 10^{18}(m^3)$$

The size of the world's largest blue whale is currently about $200m^3$

It can be seen that the ratio of blue whales to the total volume of the ocean is approximately

$$\frac{200}{1.4 \times 10^{18}} \approx 1.4 \times 10^{-16}$$

Now we calculate the size of the currently observed cosmic radius of about $1.4 \times 10^{10} ly$

$$\frac{4}{3}\pi \times (1.4 \times 10^{10})^3 \approx 3 \times 10^{31}(ly^3)$$

Then, referring to the ratio of blue whales to ocean volume, the maximum volume of possible dark matter entities can be estimated to be approximately

$$3 \times 10^{31} \times 1.4 \times 10^{-16} \approx 4 \times 10^{15}(ly^3)$$

That is, if the dark matter entity is a cylindrical shape with a base radius of $10^5 ly,$ its length is approximately

$$\frac{4 \times 10^{15}}{\pi \times 10^{10}} \approx 1.3 \times 10^5(ly)$$

That is, the maximum length of dark matter entities moving in the universe is about hundreds of thousands of light years, and the cross-sectional radius of about 100,000 light years or so.

The currently observed radius of the Milky Way is about 100,000 light-years. However, the Milky Way is only a medium-sized galaxy in the universe, and there are many larger galaxies in the universe. Therefore, the shock waves formed by Cherenkov radiation or breaking through the sound barrier in the air produced by such a large-scale dark matter entity are basically the same as the scale of the moving entity in the ocean. More entities should be much smaller than this scale.

5 The process of forming a shock wave

When a dark matter entity moves faster than the speed of light in a dark matter fluid, it will form a gravitational wave of Cherenkov radiation [2]. The result of this radiation is the formation of a relatively pronounced ring of matter. The formation of this ring of matter then leads to the formation of a low or higher pressure region at its center, and this low or higher pressure region produces the rotation of galactic matter due to the movement of dark matter fluids, forming spiral galaxies of various shapes.

After the formation of a low or high pressure region at the center of the galaxy, a pressure gradient is formed around it, which can be described by Fujita's formula

$$P = P_\infty - (P_\infty - P_l)\left[1 + 2\left(\frac{r}{R}\right)^2\right]^{-\frac{1}{2}} \tag{1}$$

By Newton's laws of motion, then

$$a = \frac{dP}{dm} \tag{2}$$

where m is the mass of the gas with the length of the unit radius. therefore

$$a = \frac{dP}{\rho dr} = \frac{2}{\rho R^2}(P_\infty - P_l)r\left[1 + 2\left(\frac{r}{R}\right)^2\right]^{-\frac{3}{2}} \tag{3}$$

If the velocity of a cyclone is v and can be approximated as a circular motion around the center, its acceleration is

$$\frac{v^2}{r} = \frac{2}{\rho R^2}(P_\infty - P_l)r\left[1 + 2\left(\frac{r}{R}\right)^2\right]^{-\frac{3}{2}} = Ar\left[1 + 2\left(\frac{r}{R}\right)^2\right]^{-\frac{3}{2}} \tag{4}$$

such

$$v^2 = Ar^2\left[1 + 2\left(\frac{r}{R}\right)^2\right]^{-\frac{3}{2}} \tag{5}$$

It can be seen that if $r \ll R$, then

$$v^2 \approx Ar^2$$

or

$$v \approx Br \tag{6}$$

That is, the speed is proportional to the radius. Of course, this is the gas velocity due to the centripetal force. However, galactic matter and atmospheric vortexes are different, and the center density of galactic material is very large, and the gravitational effect is very large. Therefore, the centripetal force of galactic matter is the combined force of gravity and cyclone pressure difference.

If r is large enough, i.e. $r \gg R$, then

$$v^2 \approx Ar^2\left[2\left(\frac{r}{R}\right)^2\right]^{-\frac{3}{2}} = \frac{AR^3r^2}{2^{\frac{2}{3}}r^3} \tag{7}$$

or

$$v \approx \frac{C}{\sqrt{r}} \tag{8}$$

At this time, the peripheral gravity of galactic matter has a similar relationship. But gravity is also very weak at this time. The effect produced by the combined force of cyclone pressure difference and gravity will become smaller and smaller. At this time, the speed of material in the outer galaxies of spiral galaxies is mainly determined by the laminar velocity of dark matter fluids. This also means that in the same dark matter fluid region, it is foreseeable that the speed of the dark matter fluid is roughly uniform. Therefore, this dark matter fluid region, the rotational speed of the outer part of all galactic matter, should be about the same.

The existing observation data show that in a number of galaxies adjacent to the Milky Way, the rotation speed of the material outside the galaxy is not much different, and basically maintains a relatively constant speed [3].

From these observations, if the speed of material moving in the outer reaches of the galaxy is lower than 200 *km/s*, the speed of rotation of material in the outer galaxy increases with distance. For example, NGC2403, NGC3621, NGC2574 and so on. Among them, NGC 2574 is more obvious. Its peripheral galaxy rotation speed is less than 100, so the rotation speed of material in the outer galactic galaxy increases significantly with distance. If galactic matter moves faster than 200 *km/s*, the speed of rotation of outer galactic matter decreases with distance. For example, the Milky Way, NGC 2841, NGC2903, NGC7331 and so on.

It can be seen that when the speed of rotation of the material in the outer regions of the galaxy exceeds a certain value, it will be slowed down. Below a certain value, it will be accelerated. Therefore, it can be expected that without the influence of galactic material, these galactic materials may all have a fixed speed. It's like a wooden block floating in a steady stream of water.

After using Fujita's formula, another effect is that the positive and negative central pressure difference is closely related to the rotational shape of the galaxy. If the central pressure in the formula is negative, i.e. $P_0 < P_\infty$, then the pressure difference calculated by Fujita's formula will strengthen the gravitational interaction, and the galactic material is closer to the center of the galaxy. The observation is that the radius of the galaxy will be relatively small.

Conversely, if the central pressure in the formula is positive, i.e. $P_0 > P_\infty$, then the pressure difference calculated by Fujita's formula will weaken the gravitational interaction and make the galactic material farther away from the center of the galaxy. The observation is that the radius of galaxies is relatively large.

6 Galaxies formed at the same time

In the process of breaking the sound barrier, high-pressure areas and low-pressure areas are formed in the front and rear ends of the aircraft. Therefore, there are generally two more obvious turbulent areas. However, this is due to the fact that the aircraft itself has a certain length. For Cherenkov radiation of electromagnetic waves, because the particles traveling at high speed are very small, and the electromagnetic wave radiation formed reaches the macroscopic scale, there is generally only one aperture detected in the Super Kamiokande detector.

However, for the Cherenkov radiation of gravitational waves [2], like the supernova 1987A, the released material has a certain volume, which forms multiple rings of material. Two of them are relatively large in diameter and the same shape of the ring substance is more obvious.

High-speed moving entities in dark matter fluids, if they have volume, should also be able to form two symmetrical turbulent regions. The material turbulence of these two galaxies may correspond to two galaxies that look very similar in shape.

In the Local Group, the Andromeda Galaxy (M31) as we know it is very similar to our Milky Way structure. So are these two galaxies symmetrical galactic material turbulence produced when a certain volume of dark matter entities break through the speed of light?

Of course, although M31 and the Milky Way are the same shape, the rotational normal is currently not on the same axis. This may have something to do with the fact that galactic matter vortices may also flow in dark matter fluids. This flow of galaxies causes its normal direction to be changed.

The symmetry of galaxy structure in this group can also be found in other groups. For example, in the Stephen Quintet galaxy group photographed by the Harper Space Telescope, two pairs of galaxies with basically the same structure can be found. As shown in Fig.3.

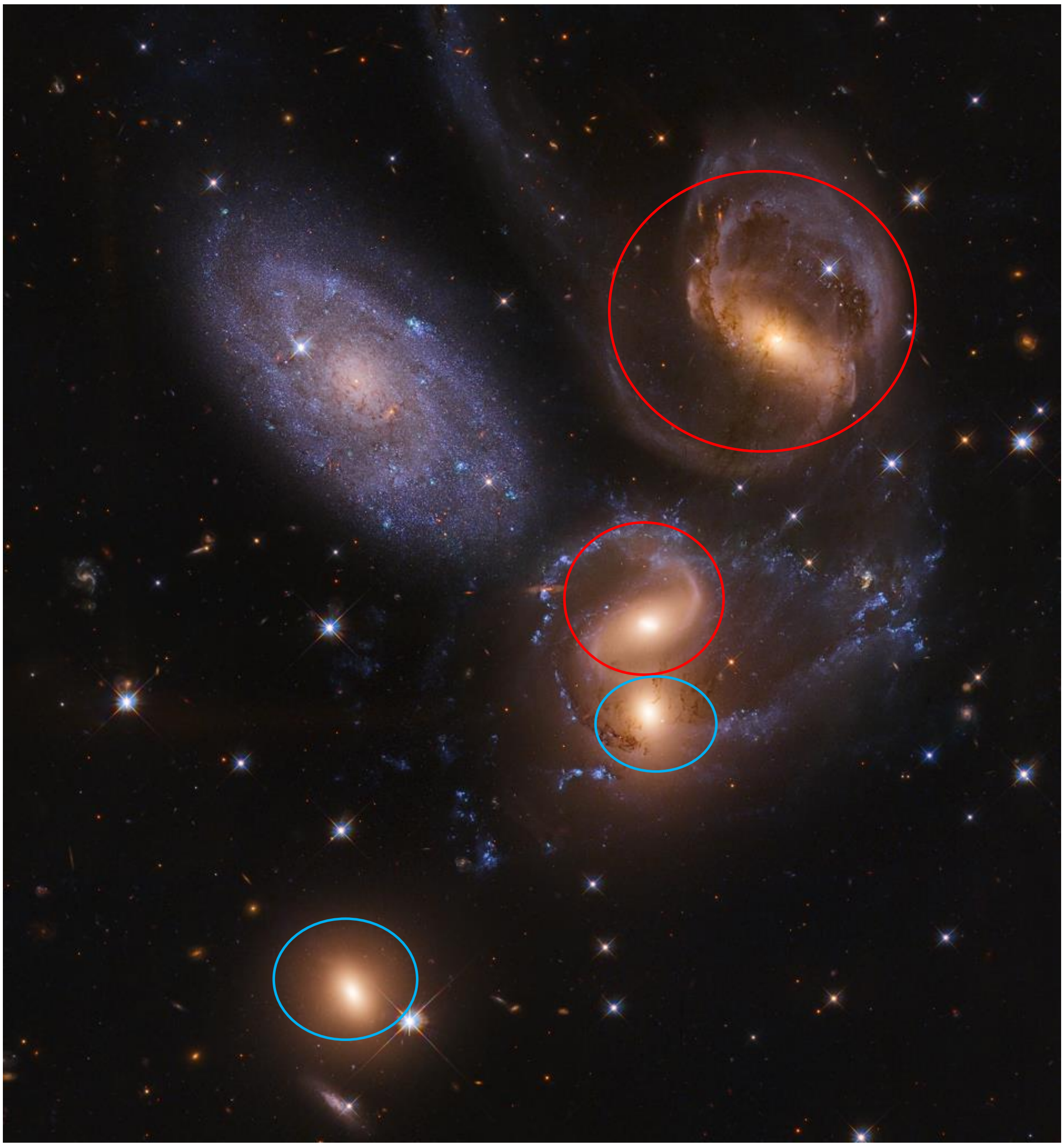

Fig.2 Stephan's Quintet was taken by Hubble Space Telescope (NASA)

It can be seen that in Fig.2, the structure of the galaxy in the two red circles and the two blue circles is the same. It can be noted that the two galaxies in the red circle rotate in opposite directions. According to the analysis in Section 5, large spiral galaxy centers should be positive pressure, while small spiral galaxy centers should be negative pressure.

The symmetry of this structure can be seen more clearly in the infrared photographs of the Webb Space Telescope (Fig. 3).

Fig.3. Stephan's Quintet was taken by Webb Space Telescope

The same structure is true for other Hickson Compact Groups galaxies.

In addition, in the local group, we can also note that the Andromeda Galaxy has a larger radius than the Milky Way, which means that the center of the Andromeda Galaxy may be positive pressure, while the center of the Milky Way may form negative pressure.

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What kind of device can measure the viscosity of dark matter fluids

Abstract

This paper explores how to detect the viscous force of dark matter fluids. In a microscopic environment like the Earth, the ideal measuring device is the gravitational constant measuring device. However, although the order of magnitude of the viscosity force of dark matter fluid is equivalent to the gravitational constant, due to the symmetry arrangement of the gravitational constant Measuring device itself, the influence of various external factors including the viscous force of dark matter fluids has also been eliminated. Of course, The gravitational constant measuring device used in a general physics laboratory may not be accurate. It requires sophisticated professional equipment to complete. In addition, the direct measurement with other devices is not very good. The main thing is that the accuracy requirements are higher. In the interstellar range, the use of artificial satellites and spacecraft to make measurements may also be affected by gravity, and there are also some key problems to solve. In order to solve the above problems, this paper proposes a method that uses the principle of superconducting diamagnetism to balance pendulum, effectively eliminating the problem of symmetric placement of pendulum.

1 Introduction

To measure the effect of the viscous force of dark matter on visible matter, it can be analyzed by Newton's formula for gravity. The viscous force of dark matter fluid superimposed on gravity is equivalent to a slight increase in the gravitational constant. That is

$$F = \frac{GMm}{r^2}$$

where m is the mass of the pendulum that drives the fiber to turn. While M is the mass of the attraction ball, r is the distance between the attraction ball and the pendulum. F is gravity. G is the gravitational constant. In this way, the resultant force after adding the viscous force of the dark matter fluid is

$$F + f = \frac{(G + \delta G)Mm}{r^2} = F + \frac{\delta GMm}{r^2}$$

where f is the viscous force of the dark matter fluid.

So

$$f = \frac{\delta GMm}{r^2}$$

Or

$$\delta G = \frac{fr^2}{Mm} = \frac{f_{1kg}r^2}{M}$$

Where

$$f_{1kg} = 6.71 \times 10^{-11}(N)$$

If

$$r = 0.16m$$

$$M = 0.78kg$$

Then

$$\delta G = \frac{f_{1kg}r^2}{M} \approx 6.71 \times 10^{-11} \times \frac{0.16^2}{0.78} \approx 2.2 \times 10^{-12}(\mathrm{m^3kg^{-1}s^{-2}})$$

Of course, the direction of the viscous force of the dark matter fluid will deviate from the direction of gravity measured in the experimental device, but even if you consider this, it can be seen that the change in the gravitational constant is still considerable. By measuring over different time periods, it should be possible to obtain large differences in gravitational constants.

For example, in Wuhan, the minimum angle between the viscosity direction of dark matter fluid and the perpendicular direction of the experimental plane is -36.6 degrees. The maximum angle is 83.4 degrees. That is, if the gravitational constant is measured during the day, the measured gravitational constant will be reduced. That is

$$\delta G = -2.2 \times 10^{-12} \times sin36.6 \approx -1.31 \times 10^{-12}(\mathrm{m^3kg^{-1}s^{-2}})$$

After 12 hours of measurement, the gravitational constant was measured. That is

$$\delta G = 2.2 \times 10^{-12} \times sin83.4 \approx 2.19 \times 10^{-12}(\mathrm{m^3kg^{-1}s^{-2}}) \qquad (1)$$

From the calculation results, as long as the accuracy of more than 2% of the experimental device can complete this experiment. In addition, if the mass of the attraction ball is reduced or the distance between the attraction ball and the pendulum center of mass is increased, the accuracy requirements of the experiment can also be reduced.

So which of the current devices used to measure the gravitational constant can measure this change in the gravitational constant? Let's first take a look at some parameters of the gravitational constant measuring devices that are currently commonly used in college physics laboratories. One of the typical devices has a distance of about 3cm between the attraction ball and the ball on the pendulum, and the mass of the attration ball is about 1.5kg. Substituting these parameters into Equation (1) allows us to find out the variation in the measurement of the gravitational constant caused by such parameters

$$\delta G \approx 4 \times 10^{-16} (\mathrm{m^3 kg^{-1} s^{-2}})$$

It can be seen that the error of this experimental device is too large to measure the effect of the viscous force of dark matter fluid on the gravitational constant.

Therefore, to measure the influence of the viscous force of dark matter fluid on the gravitational constant, it may still require more professional and high-precision measurement equipment. And these devices should be more expensive. However, these professional and high-precision equipment have a symmetry problem that is difficult to solve. Therefore, it may eventually be necessary to design a completely new set of equipment to complete such experiments.

2 Comparison of devices for measuring gravitational constants

2.1 Two commonly used methods for measuring gravitational constants

Although the viscous force of dark fluid is a very macroscopic force, we can still measure it on Earth through very precise experiments. From the calculation results of the viscous force of dark matter fluid [1], its order of magnitude is actually about the same as the order of gravity. It's just that because gravity has a cumulative effect, that is, when the mass is relatively small, it is difficult for us to feel the existence of gravity. But if the mass is very large, this gravitational force produces a very considerable macroscopic effect. But this is not the case with the viscous force of dark matter fluids. Whether the mass is large or the mass is small, the effect of the force it produces is basically the same. That is to say, although the greater the mass, the greater the viscous force of the dark matter fluid, but by dividing the viscosity force by the mass, we can find that it is a constant value. It does not affect the acceleration effect of the viscous force of dark matter because of the size of the visible matter.

On Earth, it is now possible to measure the effects of gravity in the laboratory. This is mainly done through very precise gravitational constant measurement experiments. Since other factors, including electrostatic forces, the magnitude of the force far exceeds the gravitational force, a very symmetrical structure is used in the experiment of measuring the gravitational constant in order to eliminate the influence of these other factors on the measurement results. For example, two equal mass attraction balls are used, and the masses at both ends of the pendulum are symmetrical and equal. This makes it very effective to shield against the effects of various external forces. Of course, this can also shield the viscous force of dark matter fluids.

However, unlike the effects of other factors, the direction of the viscous force of the dark matter fluid is related to the movement of the earth and even the movement of the solar system, so if the gravitational constant measurement time is long enough, then this change in the direction of the dark matter fluid caused by the Earth's rotation will bring great uncertainty to the measurement results. Therefore, relatively speaking, the time-of-swing method is relatively less affected by the uncertainty of the direction of the viscous force of dark matter fluids. However, for the angular-acceleration-feedback method, due to the very long measurement time, the viscosity of the dark matter fluid may have a larger impact in this case, resulting in a larger deviation in the measurement results.

Therefore, in order to be able to measure the effect of the viscosity force of dark matter fluid on visible matter, we can do the following work:

The first is to reduce the symmetry of the gravitational constant measuring device. That means we can do without two or four balls. Let's just use one attraction ball to do the experiment. In this way, when the direction of dark matter fluid flow changes, we can accurately predict the effect of dark matter fluid viscosity on the experimental results. Then we measure according to the different positions of the Earth's rotation, which can be used to compare the difference in the measured results when the viscosity direction of the dark matter fluid is different.

The second is to choose different times to measure. In a relatively short period of time, the influence on the viscosity direction of dark matter fluid is mainly the direction of the Earth's rotation. From the analysis results of the paper [2], we can see that the direction of the viscous force of dark matter fluid is the most different between the two times of day and night. Therefore, a more varied gravitational constant should be obtained.

In this way, after the improved experimental device, we can choose the time-of-swing method to measure the single attraction ball. The experimental measurement device is shown in Figure 1. The two types of the placement position of pendulum is different according to the distance from the attraction ball, which is called near configuration and far configuration.

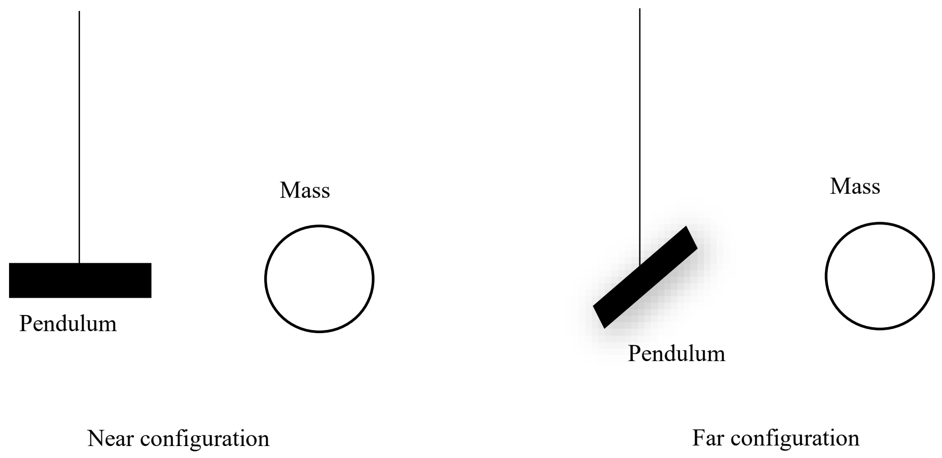

Fig. 1 The time-of-swing method with only one attraction ball

As can be seen from Figure 1, the two methods are consistent with the orientation of the time-of-swing method's device for measuring gravitational constants. Just reduce the attraction ball from symmetrical two to one. In this way, the two angular frequencies of the near configuration and the far configuration of the pendulum are measured, which are ω_n and ω_f

$$\omega_n^2 = \frac{k_n + GC_{gn}}{I}$$

$$\omega_f^2 = \frac{k_f + GC_{gf}}{I}$$

where k is the elastic coefficient of the pendulum hanging fiber and C is a coupling coefficient related to the attraction mass and the measured mass distribution. These two parameters are different in the two configurations. I is the moment of inertia of the pendulum.

The gravitational constant thus measured is

$$G = \frac{I\left(\omega_n^2 - \omega_f^2\right) - (k_n - k_f)}{C_{gn} - C_{gf}}$$

However, despite this, we can find that although there is only one attraction ball and there is no symmetry of attraction ball, the force of the dark matter fluid on the pendulum is still symmetrical. Therefore, it will not be possible to generate a torsional moment on the pendulum, and naturally it will not be possible to measure the viscous force of the dark matter fluid in the device. Therefore, other approaches are needed to solve this problem.

If you want to affect the measurement results simply by changing the symmetry of the attraction ball, you may still need the angular acceleration feedback (AAF) method to measure. The influence of the viscous force of dark matter on the measurement of the gravitational constant by the AAF method has been analyzed in detail in the paper [2].

In the AAF method, if an asymmetrical structure is used, i.e. only two attraction balls are installed on one side on the rotating disc and the two attraction balls on the other side are canceled. This should help increase the error in the gravitational constant measurement. However, this error may come from other non dark matter fluid viscosity factors. Therefore, it is not a very good method either. And although the symmetry of the attraction ball is canceled, the symmetry of the pendulum cannot be eliminated, so the uncertainty of the experimental results becomes very large.

3.2 Use the cold atom interferometry

Unlike measuring the gravitational constant using pendulum, the use of cold atom interference is an absolute gravitational acceleration measurement method that can measure the gravitational acceleration *g* of the Earth with very high accuracy. At present, very high accuracy can be achieved using cold atomic interferometry method, and of course it can also be used to measure gravitational constants [3].

If the viscous force direction of the dark matter fluid is towards the atom, the result is to increase the acceleration of the atom, that is

$$F = m(g + \delta g) = mg + f$$

where *m* is the atomic mass, *g* is the acceleration due to gravity of the atom, and *f* is the viscous force of dark matter experienced by the atom.

So

$$f = m\delta g$$

Or

$$mf_{1kg} = m\delta g$$

So

$$\delta g = f_{1kg} = 6.71 \times 10^{-11}(ms^{-2})$$

Of course, the direction of the viscous force of the dark matter fluid will deviate from the direction of gravity measured in the experimental device, but even if you consider this, it can be seen that the change in the acceleration of gravity is still considerable. By measuring over different time periods, it should be possible to obtain differences in gravitational acceleration.

Of course, this has relatively high requirements for the accuracy of cold atom interferometry that measures the gradient of gravitational acceleration. As far as the current development of cold atom interferometry equipment is concerned, it is still difficult to achieve such accuracy.

3 Other methods

3.1 Only pendulum

Only use pendulum directly to make measurements. The main thing is to measure the magnitude of this pendulum shift to equilibrium position under the action of the viscous force of dark matter fluid. Since this deviation is very small, more sophisticated distance measurement tools may be required, and we can roughly estimate the distance traveled.

If the length of the pendulum's suspension fiber is $1m$, the gravity of the pendulum is mg. If the pendulum is simultaneously subjected to a dark matter viscosity force f perpendicular to the direction of gravity, then at this time we can calculate the angle of the pendulum fiber to deviate from the equilibrium position

$$x = \frac{f}{mg} \approx 6.71 \times 10^{-12}(m)$$

It can be seen that this deviation distance is very short. That's about 0.007 nanometers. Such a short distance is very difficult to measure even with today's very sophisticated laser interferometric instruments. So the only way to solve this problem is to extend the length of the pendulum line. But the longer the pendulum line, the longer it is, the more disturbed by the surrounding environment. So this approach is not very applicable on Earth.

3.2 Satellites

If we can manage to lengthen the length of the pendulum line to a very long length, this should alleviate the problem of measurement accuracy to some extent. So if we measure through satellites in space, this length can become very long. In addition, because the satellite is in a microgravity environment, the acceleration of gravity is very small, and the force of the entire satellite at this time is mainly the viscous force of the dark matter fluid. Then we can measure the distance of the satellite from the equilibrium position by laser interference, which should be able to obtain the observable effect of the viscous force of dark matter on the satellite.

We can calculate the acceleration of satellites due to the viscous force of dark matter. This acceleration is

$$a = \frac{mf_{1kg}}{m} = f_{1kg} = 6.71 \times 10^{-11}(m/s^2)$$

This acceleration is small, but if it is long enough, it can make the satellite's speed observable.

For example, if it can last for such a long period of four months, the speed generated by the moon due to the viscous force of dark matter can be reached

$$v = at = 6.71 \times 10^{-3} ms^{-1}$$

That is, a speed of 6*mm* per second, which is still easy to observe.

However, this method also has a problem, that is, the solar system and artificial satellites are actually in the same dark matter fluid. The viscous force of dark matter fluids causes artificial satellites to accelerate, and the same acceleration will occur throughout the solar system. Therefore, if we use the solar system, or any planet in the solar system, as a frame of reference, we should probably not be able to observe the acceleration effect of this dark matter fluid in general.

3.3 Instability of dark matter fluids

Considering that dark matter fluids may be unstable fluids, for example, we can see several galaxies like the Stephen Quintet galaxy group, whose rotation directions are different, it is believed that it should be due to the unstable flow of dark matter fluids caused by changes in the direction of galaxy rotation. Therefore, we can also try to use the instability of this dark matter fluid to detect the viscosity of the dark matter fluid.

However, this instability can occur at a more macroscopic scale. It is mainly manifested in the large spatial span and the long time span. Therefore, in a local environment like Earth, it may be difficult to detect the instability of this dark matter fluid. So we can look at a slightly larger environment to detect. For example, throughout the solar system, there should be some instability of dark matter fluids.

In this relatively macroscopic environment, if an artificial satellite is separated from the gravitational pull of the sun, it may bring different behaviors from the dynamic mechanism of the entire solar system due to the instability of dark matter fluids. For example, the current Voyager spacecraft is believed to have been separated from the gravity of the solar system. In this case, some of the Voyager behaviors may be different from those of planets in the solar system.

4 A device based on superconducting diamagnetism

From the above analysis, it can be seen that the biggest problem for existing gravitational constant measurement devices is how to eliminate the symmetry of experimental equipment. One of the most difficult to eliminate is the symmetry problem of pendulum. Because if the pendulum uses an asymmetrical structure, it cannot be stably suspended by fiber, let alone obtain an accurate value of the gravitational constant. To solve this problem, superconducting magnetic levitation can be used for equilibrium. The device is shown in Figure 2.

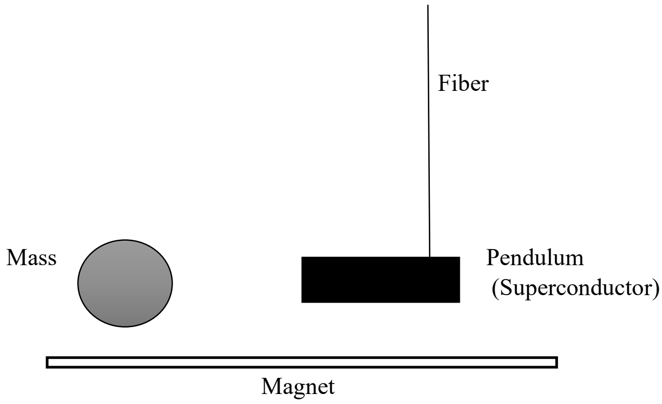

Fig. 2 A gravitational constant measuring device for detecting

In Figure 2, since the pendulum is a superconductor, it levitates under the action of the magnet below because of diamagnetism. In this way, even if the hanging fiber is not fixed in the center of mass position of the pendulum, it will not cause the tilt problem of the pendulum. The fiber is not completely fixed at the end of the pendulum, which can also give the fiber a certain tensile force to obtain torsional stress.

In this way, the symmetry problem of pendulum in traditional gravitational constant measurement devices can be effectively solved. And on the other side of the pendulum is installed a attraction ball. If the attraction ball deviates from the direction of the pendulum, it will cause the pendulum to shift due to gravity, which in turn will cause the fiber to twist. By measuring the torsional angle of the fiber, the gravitational constant can be measured.

And if the pendulum made of superconducting materials is subjected to the viscous force of the dark matter fluid, it will change the interaction force between the attraction ball and the pendulum. The angle that causes the fiber to twist changes. From the above formula (1), we can determine the size of the viscous force of the dark matter fluid by calculating the change in the gravitational constant.

Although superconducting diamagnetism is very complex nonlinear interactions. But fortunately, gravity is a very weak interaction force. Therefore, in the experimental device, as long as the superconducting material pendulum is in a stable suspension state, because the displacement caused by gravity and the viscous force of dark matter fluid is very small. With such a small displacement, we can approximately treat all of these interactions as linear.

5 Conclusions

If the viscous force of dark matter is orders of magnitude consistent with gravity, this will allow us to measure the viscosity of dark matter fluid using an improved gravitational constant measuring device. This also provides us with the possibility of detecting the presence or absence of dark matter in Earth's ground laboratory. From the analysis of this paper, due to the symmetry and accuracy of the experimental equipment, the existing gravitational constant measurement devices are not suitable to use to detect the viscosity of dark matter fluids. This paper proposes a method to balance pendulum using the principle of superconducting diamagnetism, which well eliminates the problem of pendulum symmetry in traditional gravity laboratories. In this way, the viscous force of the dark matter fluid acts on the experimental device, which can produce a more obvious effect. At the same time, after simplifying the experimental device, the size of the viscous force of dark matter can also be measured more accurately.

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Dark matter fluid interpretation of quantum entanglement

Abstract

This paper explains the transmission of quantum entanglement information by establishing a completely new theoretical model of quantum entanglement. This model is based on the cosmic dark matter fluid model. In this model, we consider that the vortex tube that forms positive and negative magnetic monopoles or positive and negative charges is not limited by electromagnetic interaction. This will cause the exchange and movement of the vortex tubes to reach 1 million times the speed of light. The transmission of quantum entanglement information is based on the high-speed exchange and movement of this vortex tubes. The contribution of this paper is to construct a completely new theory that can be used to explain the phenomenon of quantum entanglement, and this theory can be used to replace the previous theory of hidden variables.

1 Introduction

According to the dark matter fluid model, the entire universe is filled with dark matter fluids. Dark matter fluids have a viscosity coefficient, which leads to turbulence during the flow of dark matter fluids. The emergence of this turbulence phenomenon means that a dissipative structure of energy appears in dark matter fluids. This energy dissipation structure is a direct result of the emergence of countless vortex tubes. Each Vortex tube is connected with positive and negative charges or positive and negative magnetic monopoles. In Real Spacetime, the Vortex tube connects positive and negative charges, corresponding to proton-electron pairs. Positive and negative magnetic monopoles appear in imaginary spacetime.

Due to the limitations of Dirac's quantization conditions, this means that the Vortex tube does not produce observable physical effects in either Real Spacetime or Imaginary Spacetime. This means that the rotation, movement, etc. of the vortex tube will not cause energy absorption and consumption. This also means that the motion of the Vortex tube is a phenomenon unique to dark matter fluids. Its interaction is not related to electromagnetic interactions, but to dark matter interactions. If the intermediary of the interaction of the vortex tube is dark matter waves, the motion speed of this vortex tube will reach very high speeds. According to my other research results [1], this dark matter wave may travel up to a million times faster than electromagnetic waves. Such a high speed means that the vortex tube of the dark matter fluid may also move a million times faster than the speed of light.

The reason why the Vortex tube can move so fast is because the Vortex tube is not directly involved in electromagnetic interactions. The vortex at both ends of the vortex tube will participate in electromagnetic interactions, so the speed of the vortex will be limited by the speed of light.

To form positive and negative charges or positive and negative magnetic monopoles at both ends of the vortex tube, there must be a special interface to form. This is like a vortex in a fluid, and only on the surface or at the bottom of the water interface will a special vortex structure be formed. In dark matter fluids, in order to obtain vortex structures at both ends of the vortex tube, there must be a relatively special interface. This interface may be the interface of the container in which the dark matter fluid is located, or it may be formed by the interaction of photons or other electrons or protons. This could explain why there is a problem of wave function collapse in quantum mechanics. That is, once the measurement occurs, the wave function collapses and the position of the particle is determined. If the vortex tube encounters photons or other particles that interact, the vortex tube of the dark matter fluid forms a vortex structure. This vortex structure is a particle.

2 Interactions between Vortex tubes

2.1 vortex tube exchange

The Vortex tube is combined with positive and negative charges or positive and negative magnetic monopoles. Figure 1(a) shows a pair of electron proton. The electron proton pair is ended by an electron vortex and a proton vortex. In the middle is the vortex tube that connects electron to proton vortices. Since they are connected to both ends of a tube, the spins of electron and proton are observed from different directions, and the spin directions of the two particles may be opposite. However, if you find it inconvenient to assume that such an assumption, you can also assume that the spin direction of the two particles should be the same. This is mainly due to the difference in the method of choosing the reference frame of different particles.

Figure 1(b) shows two pairs of electron proton. One of the pairs is electron proton pair 12 formed by electron 1 and proton 2, where the vortex tube is called the 12 vortex tube. The other electron proton pair is 34. The spins of electrons 1 and 3 are the same, so the spins of protons 2 and 4 must also be the same. When the vortex tube is connected between them, two pairs of electron protons are formed, as shown in Figure 1(c), two vortex tubes, 14 and 32, respectively. In Figure 1(c), the positions of electrons 1,3 and protons 2,4 do not change, but the vortex tube is exchanged to become 14 vortex tube and 32 vortex tube. But since the vortex tube does not produce observable physical effects, this exchange of the vortex tube does not cause a change in the physical state of the two pairs of electron proton. Of course, Vortex tubes 14 and 32 can continue to separate, which becomes the state of Figure 1(d). At this point, the 14 and 32 vortex tubes no longer cross together.

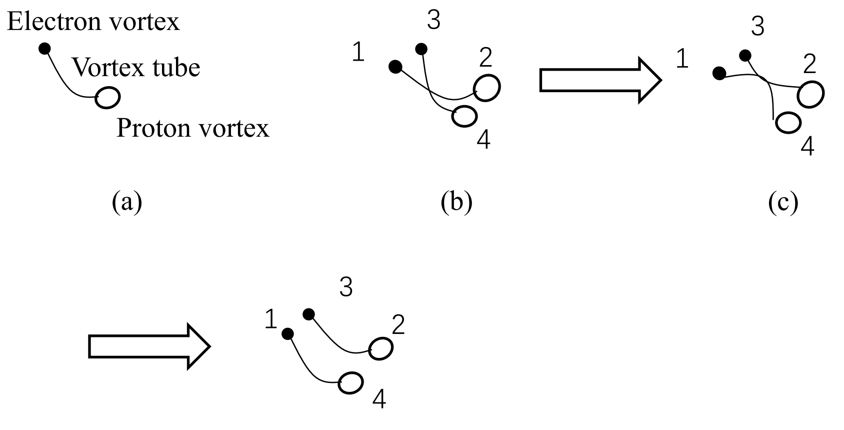
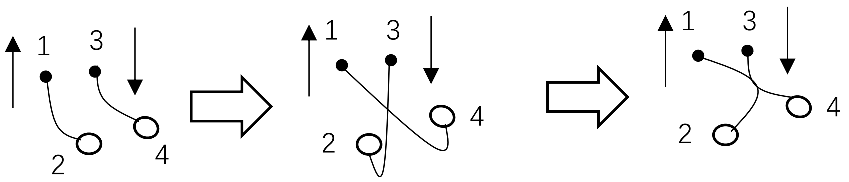


Fig. 1 The exchange of vortex tube

In Figure 1(c), we can also think that because the conduction speed of the Vortex tube exchange is very fast, electron 1 moves to position 3. Although such particle position exchange consumes energy in a macroscopic sense and produces observable physical effects, but at the microscopic scale, since electrons 1 and 3 are identical in state and are homogeneous particles, the exchange of positions between them does not produce observable physical effects.

If the spin direction of the two electrons is different, the vortex tubes can also be exchanged with each other in the same way as shown in Figure 2.



(a) (b) (c)

Freedom state Entangled state Entangled state

Fig. 2 The exchange of vortex tube with different particle spin

Figure 2(a) shows two pairs of electron proton, but the spin direction of the electrons is different, and of course the spin direction of the corresponding protons is also different.

If the two Vortex tubes want to exchange with each other, they only need to connect the Vortex Tube from the other end of the proton. This is shown in Figure 2(b). This is because if the vortex is seen as a ring, the spin direction seen from above and below the ring is exactly the opposite.

After forming the state of Figure 2(b), the vortex tube can be further exchanged to form the state of Figure 2(c). In the state of Figure 2(c), the vortex tube reconnects the upper end of the proton, ensuring that the spin direction of the electron proton pair is reversed.

The time required for the exchange of the Vortex tube is very short. Therefore, we can also think that electrons or protons move teleportarily to another location with the exchange of the vortex tube. But because the Vortex tube itself does not produce an observable effect, this movement makes it appear as if it moves from one position to another in an instant. This instantaneous effect can be used to provide a theoretical basis for the interpretation of the probability of the wave function. Because the movement and exchange of the vortex tube has a lot of randomness, and the position is not deterministic, the position results of the particles measured at different times are also uncertain.

2.2 Entangled state

If two Vortex tubes cross each other. For this state of vortex tube crossing, we can call it the entangled state. In the entangled state, the state of the two electrons can be described by a wave function:

$$|\psi> = \sum A_{ij}\left|\psi_i\,\psi_j\right.>$$

ψ_i or ψ_j is the wave function of two independent electrons.

If two electrons are entangled, the states of the two electrons will be related to each other, for example, if two electrons have the same spin, then the two electrons can be in the state of all spins up $|00>$ or the state of all spins down $|11>$.

Thus the wave function of the electrons in these two entangled states can be described

$$|\psi> = A_{00}|00> + A_{11}|11>$$

where 0 and 1 represent the spin direction up and down, respectively. Considering that the probability of spin up and spin down is the same, the above equation can also be written

$$|\psi> = \frac{1}{\sqrt{2}}(|00> + |11>)$$

In Figure 2(a), since the two Vortex tubes do not cross each other, this also means that the two Vortex tubes can be distinguished from each other. This is called the free state.

In Figure 2 (b) and (c), the vortex tube can be freely exchanged without affecting the state of the particle, so this state is called the entangled state.

Of course, even if the two Vortex tubes do not cross each other, it is possible that with the movement of the particles, the Vortex tubes will cross together at a certain moment, which can also form an entangled state. That is, the change from Figure 2(a) to Figure 2(b) or (c).

For two electrons with different spins in an entangled state, if the vortex tube corresponding to one electron is transferred to the other electron, then the other end of the vortex tube must be transferred from the corresponding proton to the other proton. For another vortex tube, the same effect. In this way, after the exchange of the vortex tube, it means that the state of the two electrons remains unchanged without observable physical effects.

3 Quantum entanglement

From the above analysis, we can see that in an entangled system, two electrons can be described by a wave function. So when the state of one electron changes, we can predict the change in the state of another electron.

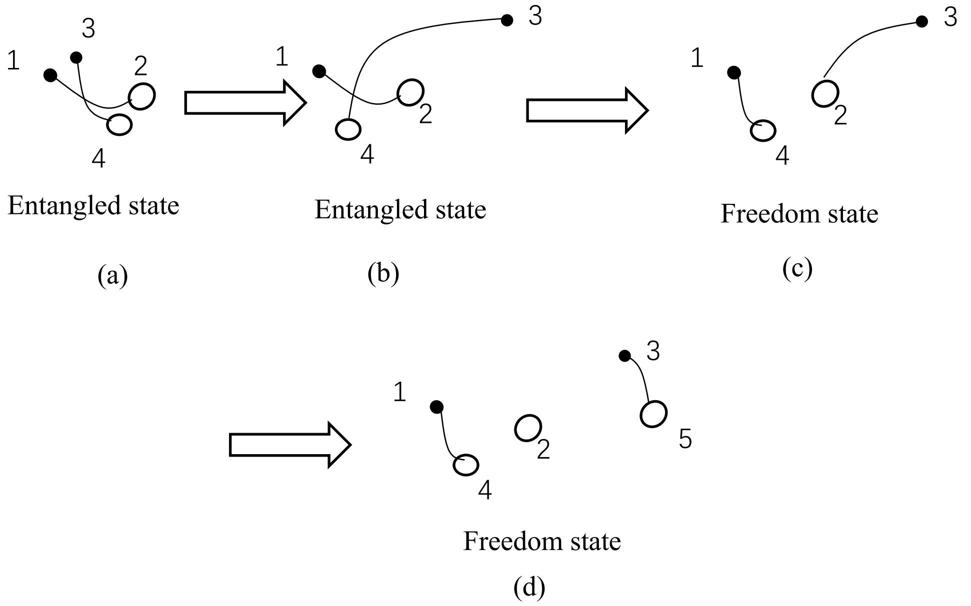


Fig. 3 Communication principle of quantum entanglement

In Figure 3(a), where the electron-proton pairs 1-2 and 3-4 are entangled, electrons 1 and 3 can be described by a wave function. Figure 3(b) shows electron 3 moving away from electron 1, and remaining in this entangled state if the vortex tube is not exchanged. The motion of electron 3 is limited by the speed of light. But the state of electrons 1 and 3 is determined by the connected vortex tubes 12 and 34. That is, a change in the state of electron 1 necessarily leads to a change in the state of electron 3.

Figure 3(c) shows that the two vortex tubes, 12 and 34, begin to exchange to the 14 and 32 vortex tubes and the entangled state disappears. In this way, the two vortex tubes no longer cross or become entangled, and the two electrons 1 and 3 enter a free state. Figure 3(d) shows that if there are other extra protons 5 near electron 3, electron 3 can also connect this new proton 5 by establishing a new vortex tube. This new Vortex tube is shorter in length.

This exchange of vortex tubes takes place in dark matter fluids, and the speed is mainly affected by dark matter waves, so the speed is very fast.

4 Manipulation and communication of entangled states

4.1 Distribution of entangled particles

When two elementary particles, such as electrons or photons, are entangled, the uncertainty of the Vortex tube exchange causes each particle to be in a random state. Therefore, if it is in the state of

Figure 3(b), it means that although the two particles have been distributed, they are still entangled. At this time, we only need to manipulate particle 1 so that it is in a certain state, and the state of particle 3 will be determined immediately, and the exchange process between the two vortex tubes will stop. Thus, information is instantly transmitted from particle 1 to particle 3 at the speed of dark matter interaction.

4.2 Speed of Information Dissemination

Because it is in an entangled state, the whole process does not involve the propagation of electromagnetic waves, so the propagation of state information is completely determined by the propagation speed of dark matter waves. This dark matter wave interaction can transmit the state change of one particle to another particle at a speed far faster than the speed of light, so that the information can arrive "instantaneously".

4.3 Time to propagate of quantum entangled information

If the speed of the information transmitted by quantum entanglement is fixed, propagating at the speed of dark matter waves, then it is roughly estimated that its speed may reach 1 million times the propagation speed of electromagnetic waves [1].

According to the propagation path in Figure 3(b), the entire state change involves four particles, so its propagation path includes two vortex tubes. Therefore, the length of the entire propagation is the length of two vortex tubes.

Divide the sum of the lengths of the two Vortex tubes by the propagation speed of the dark matter wave, and we can get the time it takes for the entangled signal to propagate.

However, if the distance between the two particles distributed is relatively long, then this distance will be much greater than the length of the first two vortex tubes distributed, so we can approximate the distance between the two particles to represent the distance of quantum entanglement information propagation.

For example, in the quantum entanglement experiment conducted by the Micius satellite [2], two photons were distributed over a distance of 1,000 kilometers. This also reflects the distance of information transmission of 1,000 kilometers. Then we divide this distance by the speed of dark matter wave propagation $v_d \approx 3 \times 10^{14}\, m/s$ [1], we can get the entire quantum information propagation time.

$$t = \frac{1000 \times 10^3}{3 \times 10^{14}} \approx 3.3 \times 10^{-9} (s)$$

This information transmission time should be very short. If it is the propagation of electromagnetic waves, such a long distance takes 3.3 milliseconds.

Therefore, from the results of this calculation, it can be seen that the time for quantum information to propagate is very short, and it can basically be said that it can be completed “instantly”. This speed is 1 million times the speed at which electromagnetic waves propagate.

Therefore, it is difficult to measure the time of this information propagation using current experimental techniques on Earth. Such a delay can only be measured on the scale of the universe.

5 Conclusions

Quantum entanglement has always been a very controversial topic, but in recent years, due to more and more evidence support, quantum entanglement related research has become more and more in-depth.

However, for such a phenomenon as quantum entanglement, there is still a lack of relevant theories to satisfactorily explain. Physicists, including Einstein, Bohm and others, have also tried to build hidden variable theories, but these theories are more or less flawed in one way or another.

From the results of this paper, if we adopt the idea of Dirac’s charge quantization and build a model of dark matter fluids, the matter in real and imaginary Spacetime is formed by the turbulence of dark matter fluids, then due to the special properties of the vortex tube connecting electron and proton or positive and negative magnetic monopoles, which leads to quantum entanglement can be explained by a new theory of dark matter fluids.

From the analysis results of this paper, because we use the unobservable property of the vortex tube in the idea of Dirac’s charge quantization, it is shown that the vortex tube connecting positive and negative charges does not interact with the electromagnetic waves of the visible matter world, so that it can escape the speed limit of light in relativity. That is to say, the movement of the vortex tube connecting positive and negative charges or positive and negative magnetic monopoles can break through the speed of light. Perhaps it is this superluminal signal that can be transmitted in dark matter that leads to the existence of what Einstein thought was a ghostly action at a distance.

According to this paper and the author’s previous research, this quantum entanglement information can be transmitted at a speed of 1 million times the speed of light, which is enough to make the observed particle state information in the matter world achieve the effect of instantaneous transmission.

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