On the dark matter fluid model

Zhi Cheng

gzchengzhi@hotmail.com

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.

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.

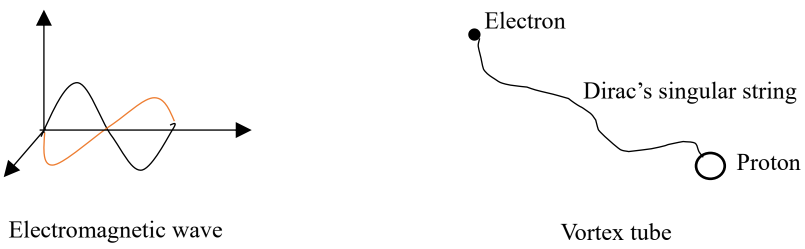

Fig. 1. EM wave and turbulence of dark matter fluids

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.

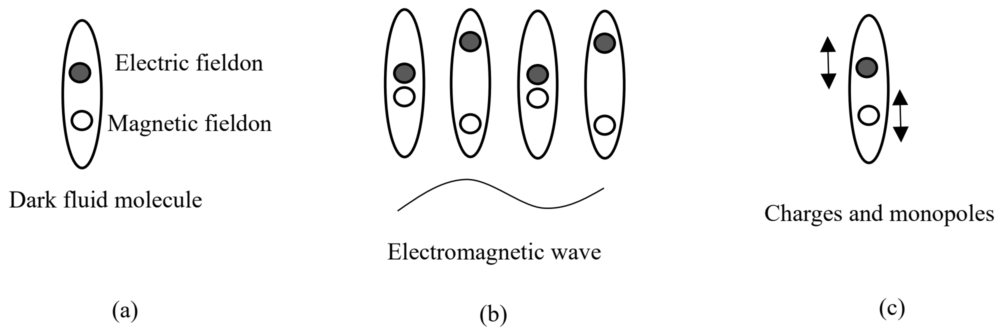

Fig. 2. Dark fluid molecule and energy

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.

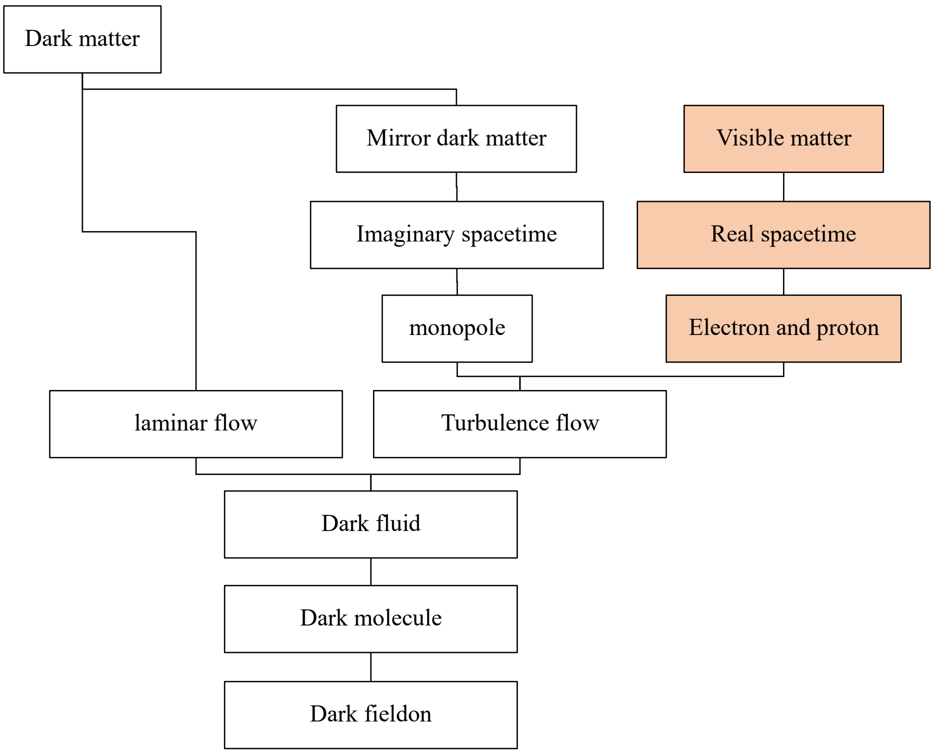

Fig. 3. The level of matter structures of the universe

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

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

whereas

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

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

$$r = \sqrt{\frac{2G\hbar}{c^3}} \tag{12}$$

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

$$J = mrv \tag{13}$$

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

$$p = mv$$

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

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

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:

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

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)**
$\boldsymbol{r_c}$	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

$$g r_p \approx 1.4089924 \times 10^{-15}(m)$$

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

$$m_{pf} \approx 0.5962 m_p$$

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.

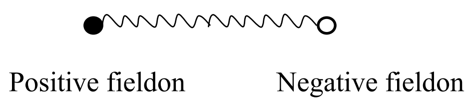

Figure 4. Interaction between fieldons

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.

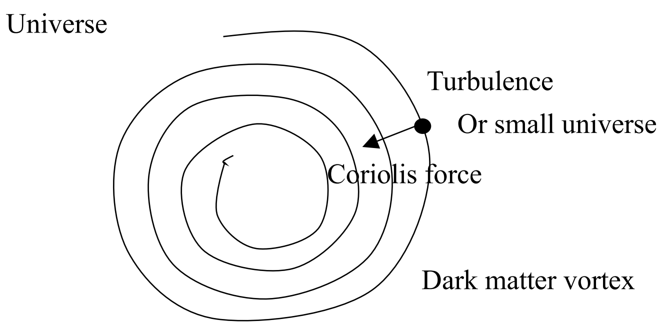

Fig. 5. The Dark flow and Turbulence

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

$$V = V_q + V_T \qquad (25)$$

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 $\mu \approx 4200$ (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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