A fluid model of dark matter

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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.

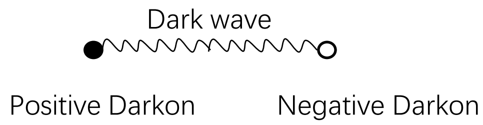

Figure 1. Interaction between Darkons

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.

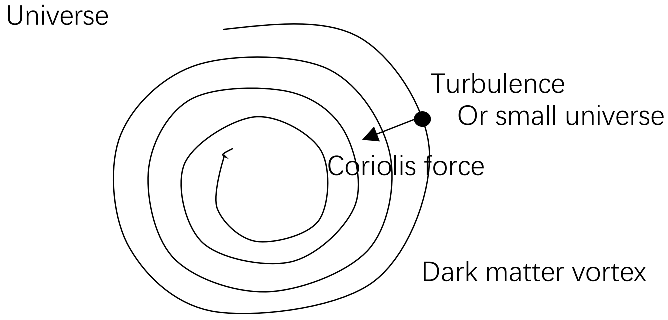

Figure 2. The Dark Flow and Turbulence

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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