Estimation of dark matter fluid parameters and their influence on galaxy motion

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Abstract

This paper explores the effects of dark matter fluids on galactic matter within the confines of the solar system. In this way, we can explore the possible effects of dark matter fluids on a smaller scale. The effect of this dark matter fluid in the solar system is mainly the tilt angle of the rotation of the planet or star. Because even in very large-scale cosmic scales, conservation of angular momentum can always be established, so the change of angular momentum has become the most sensitive parameter of galactic matter to external influences. Through the analysis and calculation results of this paper, it is shown that when there is a high-speed relative motion between galactic matter and dark matter fluid, the viscous force of dark matter fluid will cause changes in the orbital or rotational angular momentum of planets or stars like gyroscopes affected by gravity. This may be an important reason for the tilt of the eight planets in the solar system, as well as the sun itself. The calculation results according to the model in this paper show that the calculation results are basically consistent with the actual observed precession period of the major planets and the sun. A few inconsistencies can be corrected by external factors such as asteroid impacts. The significance of this study is to provide an important way to detect the existence of dark matter in a smaller galaxy range, and also estimate some important parameters of dark matter fluid, such as the flow speed of dark matter fluid and the viscosity coefficient of dark matter fluid.

1 Introduction

The concept of dark matter has been proposed for a long time, and more and more cosmic observation evidence has been obtained. This also means that there will be more and more exploration projects for dark matter. However, because the dark matter effect is mainly expressed on the scale of the universe, this brings certain difficulties to the direct verification of dark matter. So in the solar system where we humans live, is there a phenomenon that dark matter affects the movement of galactic matter? If it exists, it is believed that it will be very conducive to human exploration of the laws of dark matter. This paper attempts to explore the various observable effects of dark matter fluids from the perspective of the influence of dark matter on the motion of planets or stars. The analysis of these observable effects should provide us with some more direct evidence of the existence of dark matter, and some important parameters of dark matter fluids can be obtained.

This paper examines the tilt of the rotational axes of planets and stars in the solar system. We already know that for an object with angular momentum such as a gyroscope, if it is affected by gravity, its axis will tilt. The tilted shaft generates precession. But for stars or planets in the solar system, because they are floating in space and do not have a ground fulcrum like a gyroscope, why do these axes also tilt? This has always been a confusing question. There are also many different views on why the rotations of planets and stars in the solar system are tilted. This includes exploration from the perspective of conservation of angular momentum and collisions of asteroids.

This paper argues that if there is a dark matter fluid, and the dark matter fluid has a viscous force, the viscous force of the dark matter fluid is like the effect of gravity on the gyroscope, which will cause the angular momentum or rotation angular momentum of the planet or star to produce an increase in angular momentum in the vertical direction. This vertical increase in angular momentum is what causes the orbital or rotational momentum of a planet or star to deviate from its axis.

2 The effect of viscous force of dark matter fluid on planetary motion

The Earth's motion is mainly caused by gravitational interactions due to the greater gravitational interaction of the Sun. As the Earth orbits the Sun, it is also hindered by a viscous force of dark matter. The end result of this dark matter fluid's obstruction is to reduce Earth's orbital velocity. However, if this speed reduction is very small, it will not affect the movement of the Earth for billions of years.

We can calculate the effect of dark matter viscosity on the Earth's orbital velocity in this way. Let the radius of the Earth be r, then according to the Stokes formula for the force of the sphere moving in a fluid, we can find that the force on the Earth is

$$F = 6\pi\eta r v$$

where η is the viscosity coefficient of dark matter fluids, and v is the orbital velocity of the Earth.

Suppose the Earth decreases from its maximum orbital velocity to 0 and moves l distance, so the energy consumed by viscous friction to do work is

$$W = Fl = 6\pi\eta r v l$$

If the total kinetic energy of a planet is E, this energy is completely consumed by the viscous force of the dark matter fluid

$$E = W = 6\pi\eta r v l$$

So

$$l = \frac{E}{6\pi\eta r v}$$

Therefore

$$\tau = \frac{l}{v} = \frac{E}{6\pi\eta r v^2}$$

It can be seen that the change in the speed of the planet's motion is proportional to the energy viscosity coefficient ratio, and inversely proportional to the square of the velocity of the fluid.

Changes in the orbital velocity of the Earth can be estimated as follows.

Thereinto

$$E = \frac{1}{2} m v^2$$

where *m* represents the mass of the Earth, approximately $m = 6 \times 10^{24}(kg)$

According to the estimation of paper [1], the viscosity coefficient of the dark matter fluid is

$$\eta = 4000 Pa \cdot s$$

The radius of earth is

$$r = 6400000(m)$$

The lifetime of the Earth's orbital movement can be estimated to be

$$\tau = \frac{m}{6\pi\eta r} = \frac{6 \times 10^{24}}{6 \times 3.14 \times 4000 \times 6400000} \approx 1.24 \times 10^{13}(s)$$

Converted to year, it is

$$\tau \approx 4 \times 10^5(year)$$

That is, only 400,000 years of life. This is clearly not consistent with what is already known. The reason for the problem is that paper [1] only estimates the upper limit of the viscosity coefficient of dark matter fluids. The viscosity coefficient of actual dark matter fluids may be much smaller.

If analyzed according to the current state of the Earth's movement, if the sun does not change, the Earth's current orbit movement time should reach more than ten billion years. After all, the Earth has been in this orbit for more than four billion years.

So if we reduce the viscosity coefficient of dark matter fluids, take

$$\eta = 0.1 Pa \cdot s$$

Then we can get

$$\tau \approx 1.6 \times 10^{10} (year)$$

That is, the orbital life of the Earth should reach 16 billion years. This makes sense. This also shows that if there is a dark matter fluid, and this dark matter fluid has a viscous force, its viscosity coefficient is about $0.1 Pa{\cdot}s$. We can take the upper limit to $0.2 Pa{\cdot}s$, ie

$$\eta \leq 0.2 Pa \cdot s$$

This is smaller than the viscosity coefficient of water, but greater than the viscosity coefficient of air.

However, moving in such a viscous liquid, the object does not seem to be subject to as much resistance as ordinary water or air, mainly because dark matter fluids do not participate in electromagnetic interactions, so there will be no fluid dynamics dominated by Bernoulli's principle due to the movement of matter. When matter moves in the dark matter fluid, it is only affected by the viscous force of the dark matter fluid. Such viscous forces are orders of magnitude much smaller than the pressure difference formed by the flow of fluids, and the final obstruction effect on the object is actually very small.

3 Effect of viscous force of dark matter fluid on planetary axis precession

From the point of view of the planet's rotation, the planet's axis of rotation should always remain in a fixed direction if no additional moment is applied. However, since the planets are also affected by the viscous force of a fluid while moving, a moment perpendicular to the direction of the planet's motion will be generated, which will affect the orbit or rotational momentum of the planet.

Fig. 1 shows the effect of such a moment.

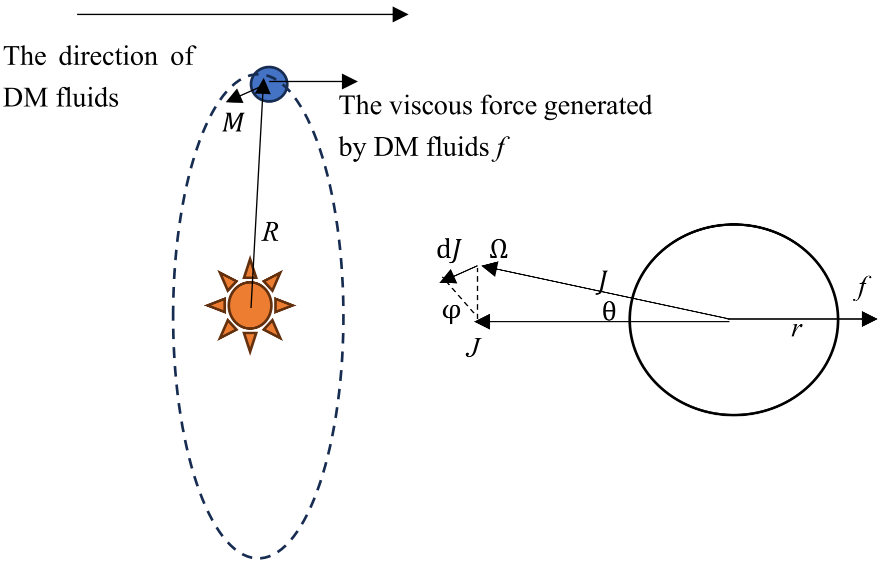

Fig. 1 The viscous force to which the planet or star is subjected

In Fig. 1, r is the radius of the planet, R is the orbital radius of the planet, J is the orbital angular momentum of the planet, and f is the viscous resistance of the dark matter fluid. M is the moment generated by the viscous force of the dark matter fluid on the planet's surface. φ is the angle at which the angular momentum precession.

As can be seen from the above figure, when the planet moves at a velocity v with respect to the dark matter fluid, the resistance of the dark matter fluid can be calculated by the Stokes formula

$$f = 6\pi\mu r v$$

The moment generated by this force on the planetary body is

$$M = Rf$$

Here R is the orbital radius of the planet. This moment is always perpendicular to the direction of the star's angular momentum of rotation. If the change in the momentum of the star's rotation angle generated by this moment is dJ, then

$$dJ = Mdt$$

Since the moment M is perpendicular to the orbital angular momentum, the change of the angular momentum will not affect the magnitude of the orbital angular momentum on the one hand, but will cause the orbital angular momentum to deviate from the axis, resulting in an inclination angle θ, which changes the direction of the rotation angular momentum. Thus creating a precession along the axis of motion around the planet. This is like a gravitational gyroscope precessioning around an axis. The angular velocity of its precession is

$$\Omega = \frac{d\varphi}{dt} = \frac{dJ}{Jsin\theta dt} = \frac{M}{Jsin\theta}$$

It can be seen that the angular velocity of the planetary axis precession is proportional to the viscous force moment received, and is inversely proportional to the rotational angular momentum of the planet. We can also express the angular velocity in terms of period *T*.

$$\Omega = \frac{2\pi}{T} = \frac{M}{Jsin\theta}$$

That is

$$T = \frac{2\pi Jsin\theta}{M}$$

Then

$$T = \frac{Jsin\theta}{3\pi\mu rRv} \tag{1}$$

4 The influence of the Moon on the momentum of the Earth's rotation angle

Unlike other planets, the Moon's rotation around the Earth is at an angle to the inclination of the Earth's axis of rotation. The Moon orbit itself has a 5-degree inclination angle to the plane of the perpendicular planetary orbit. The Earth's axis of rotation has an inclination of 23.44 degrees in the other direction. Therefore, when considering the tilt of the Earth's axis of rotation, the influence of the Moon must also be taken into account.

Take it here

$$m = 6.00 \times 10^{24} kg$$

$$\mu = 0.1 Pa \cdot s$$

$$r = 6400000m$$

$$v = 30000\, m/s$$

$$\omega = 7.27221 \times 10^{-5} (rad/s)$$

It can be calculated that the rotational momentum of the Earth is

$$L = \frac{2}{5}mr^2\omega = 7.2 \times 10^{33}(kgm^2s^{-1})$$

Taking into account the influence of the movement of the Moon, the average inclination of the lunar orbit

$$\alpha = 5°$$

And the tilt of the Earth's axis of rotation is

$$\beta = 23.44°$$

The orbital angular momentum of the Moon

$$L_e = 7.2 \times 10^{33}(kgm^2s^{-1})$$

$$L_m = 2.9 \times 10^{34}(kgm^2s^{-1})$$

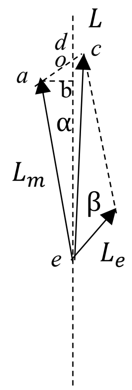

Fig. 2 The effect of the angular momentum of the Moon's orbit on the angular momentum of the Earth's rotation

The geometric relationships in Fig. 2 are as follows

$$ab = L_m sin\alpha$$

$$ao = \frac{ab}{sin\beta} = \frac{L_m sin\alpha}{sin\beta}$$

$$oc = L_e - ao = L_e - \frac{L_m sin\alpha}{sin\beta}$$

Make a perpendicular line *cd* perpendicular to the axis at point C, then

$$cd = oc \cdot sin\beta = \left(L_e - \frac{L_m sin\alpha}{sin\beta}\right) sin\beta = L_e sin\beta - L_m sin\alpha$$

In this way, we can find the angle between the total angular momentum *ec* and the axis *eo*

$$sin\theta = \frac{L_e sin\beta - L_m sin\alpha}{L}$$

Where

$$L^2 = L_e^2 + L_m^2 - 2L_e L_m \cos(\alpha + \beta)$$

It can be found that the rotational tilt angle produced by the total angular momentum of the Earth and Moon is

$$\theta = 0.84° = 0.0147rad$$

In addition to Earth, the satellites of other planets are either too small in mass and the orbital angular momentum does not have much effect on the planet's rotational momentum, or the orbital plane of the satellite is consistent with the direction of the planet's rotational momentum, so it does not significantly affect the planet's rotational momentum tilt. Therefore, the rotation axis inclination data of these planets can be used directly.

5 Comparison of theoretical calculations and practical observations

By substituting the actual data into Equation (1), we can calculate the period of the planetary axial precession caused by the influence of the viscous force of the dark matter fluid. The second column in the table, "Precession Period", is the actual observed axis precession period for each planet. The third column, "Calculation Period", is the result of calculations based on the model in this article. Other columns are additional parameters。

Table 1. Comparison of theoretical and observational data on the precession period of planetary rotations

Planets	Precession Period	Calculation Period	Mass	Radius	Orbital	Radius Velocity	Inclination
Mars	170000	131000	6.42E+23	3E+06	2.29E+11	24130	25.19
Venus	29000	87400	4.87E+24	6E+06	1.08E+11	35030	2.64
Jupiter	4.30E+05	1.30E+06	1.90E+27	7E+07	7.81E+11	13060	3.13
earth	26000	27700	6.00E+24	6E+06	1.50E+11	30000	0.84
Saturn	1.77E+06	2.76E+06	5.68E+26	6E+07	1.44E+12	9690	26.7
Uranus	1.69E+08	1.54E+06	8.68E+25	3E+07	2.85E+12	6810	82
Neptune	1.77E+06	7.61E+05	1.03E+26	2E+07	4.51E+12	5430	30

As can be seen from Table 1, except for Uranus, the size of the calculation results of the precession period of the planets is basically consistent with the actual observations. For example, the precession period of Mars is greater than that of Venus and larger than that of Earth. However, the data varies widely, which may be related to the fact that Venus' rotation is tidally locked by the Sun. Since the rotation of Venus is tidally locked by the Sun, it means that the gyroscopic effect of Venus' rotation will be relatively small, and it will be easily disturbed by external movements. For example, an asteroid impact can easily change the angle of tilt of Venus' axis of rotation.

All four gaseous planets have greater precession periods than rocky planets. Of the four gaseous planets, Jupiter has the smallest precession period. Uranus calculations differ greatly from actual observations, which may be related to other factors. Such as tidal locking, asteroid impacts, and so on.

6 The axis of the sun precession

It can be seen from paper [2] that the current planetary orbital plane of the solar system is at an angle of 60 degrees to the direction of the movement of the solar system, and this angle is still showing periodic changes, with a period of about 60 million years. In other words, the axis of the sun has an angle of 30 degrees relative to its direction of motion. If we consider that this tilt of the sun's axis relative to its direction of motion is also related to the viscous force generated by dark matter fluids, then we can assume that the sun's axis of rotation has a 30-degree tilt, and the sun's axis of rotation presents a precession with a period of 60 million years around its direction of motion.

First, we calculate that the rotational momentum of the Sun is

$$L_s = \frac{2}{5} M r^2 \omega = 1.13 \times 10^{42}$$

By use formula (1), we substitute the data of the sun, obtained

$$T = \frac{L_s sin\theta}{3\pi\mu r^2 v} = \frac{1.13 \times 10^{42} sin30°}{3\pi \times 0.2 \times 696300000^2 \times 2.5 \times 10^8}(s) \approx 7.83 \times 10^7 (year)$$

This cycle is basically consistent with the oscillation period of the solar system estimated in paper [2]. It also shows that the angle between the orbital plane of the solar system and the direction of the solar system's motion may be reflected because of the precession of the sun's axis.

7 Force analysis of galactic matter

The flow velocity of dark matter fluid reaches $2.5 \times 10^8\ m/s$ is indeed very large, already close to the speed of light. Therefore, even considering that the viscosity of the dark matter fluid is only $0.2 Pa{\cdot}s$, the resistance of galactic matter is very large. Therefore, the motion of the entire galaxy is prone to slowing down or accelerating. This can be seen in the relative positions between some of the already observed galaxies. For example, the Milky Way and Andromeda, these two galaxies should be symmetrical. According to the theory of shock turbulence formation [3], the two galaxies should be arranged in parallel. But what we're seeing now is that the two galaxies seem to be approaching rapidly and colliding. This reflects the instability of the turbulence formed in dark matter fluids.

However, because the material in the Milky Way galaxy is mainly gathered together by gravitational interactions, the viscous resistance generated by dark matter fluids is still very small relative to gravitational interactions, and will not affect the overall structure of the planet or the relative motion between the materials inside.

For example, according to the radius of the Earth to calculate, the Earth moves with the Milky Way at a speed of 250,000 km/s relative to the dark matter fluid, and the viscous resistance of the dark matter fluid is

$$f_e = 6\pi\mu r v = 6\pi \times 0.2 \times 6.4 \times 10^6 \times 2.5 \times 10^8 = 6.03 \times 10^{15}(N)$$

And the gravitational force between the Earth and the Sun is

$$F_{se} = \frac{GMm}{R^2} = 3.56 \times 10^{22}(N)$$

The difference between the two is nearly 10 million times. Therefore, relative to gravitational interactions, the viscous force generated by dark matter fluids is negligible.

8 Conclusions

From the above analysis, we can see that the motion of dark matter fluid relative to galactic matter is an important factor that causes galactic matter to be subjected to viscous forces. The viscous resistance generated by this dark matter fluid, combined with the circular motion of galactic matter, can produce the tilt of the axis like a gyroscope. The tilted rotating shaft creates a corresponding precession. Then, by analyzing the angle of rotation of the axis of rotation and the period of precession, we can verify the existence of the viscous force of the dark matter fluid.

The rotation of galactic matter can be around a specific orbit, such as the angular momentum generated by the orbit of planets such as Earth around the Sun. The action of dark matter fluids can cause changes in this angular momentum. Of course, planets like Earth also have rotation, and the action of dark matter fluids should also tilt this axis of rotation. The precession of the rotation axis is generated due to the change of rotation angular momentum, but because the speed of planetary rotation is relatively slow, the tilt effect of the rotation axis caused by the viscous resistance generated by this dark matter fluid is not obvious. In the analysis of this paper, we mainly analyze the change in the angular momentum of the planet's orbit around the sun, and determine the degree of tilt of the planet's rotation axis by analyzing the change in the angular momentum of this orbit. But for a star as large as the Sun, its rotation speed is easily affected by the viscous force of dark matter fluids, which in turn causes the rotation axis to tilt.

During the entire analysis, we can note that among all 8 planets, Mercury's rotation axis itself is very weakly tilted, and the relevant data is incomplete, so this paper does not analyze. For the Earth, because there is a lunar orbital angular momentum orbiting the earth, its direction is very different from the direction of the Earth's rotation angular momentum, so the inclination of the Earth's rotation axis also takes into account the influence of the moon. Through detailed analysis, we can see that if the influence of the Moon is considered, then the axis tilt angle of the entire Earth-Moon system is actually very small. In the calculations in this article, it can be seen that it is only 0.84 degrees, which is a very small rotational tilt. Then for other planets, including Uranus, Neptune, and so on, their moons are consistent with the direction of the rotational momentum of these planets. That is to say, even if their satellites are very large, but because the direction of the angular momentum of the satellite's orbit is consistent with the angular momentum direction of the planet's rotation, the tilt of the rotation axis of these planets will not or rarely be affected by the angular momentum of the orbit of these satellites, so only the influence of the moon on the Earth's rotation angle is analyzed in this article.

From the results of the calculation, if the viscosity coefficient of the dark matter fluid we consider is only $0.2 Pa \cdot s$ and the movement speed of galactic matter, that is, the solar system relative to the dark matter fluid, reaches 250,000 km per second, then the rotation axis tilt angle of the seven planets we calculated except Mercury is basically the same as the rotation axis tilt angle of the actually observed planets by orders of magnitude.

In addition, the inclination of the sun's rotation axis is calculated. If the angle between the sun's axis of rotation and the direction of the sun's motion is regarded as the tilt angle of the sun's axis of rotation, we can find that the tilt angle of the sun's axis of rotation reaches 30 degrees, and the precession period of its axis can reach more than 70 million years. The calculation results are basically consistent with the data predicted in some paper [2].

In our analysis of this article, we can also see a very interesting phenomenon, that is, if the speed of dark matter fluid relative to the speed of matter in the solar system galaxy reaches 250,000 kilometers per second, this is very close to the speed of 300,000 kilometers per second at the speed of light. It can be seen that the flow speed of dark matter fluids is very fast. However, because dark matter fluids do not participate in electromagnetic interactions, theoretically, even if the speed of dark matter fluids has an upper limit, this upper limit should far exceed the upper limit of the speed of light. Just as in our Earth's matter system, many objects can easily exceed the speed of sound.

Of course, because the dark matter fluid is very fast relative to the galactic matter, this also causes a huge galaxy in the dark matter fluid, it will continue to drift. The speed and magnitude of this drift can also be considerable, and it can be the entire galaxy moving at a very high speed, spinning, or even flipping, just like we see the Milky Way and its sister galaxy, the Andromeda Galaxy. The two galaxies are currently approaching at a very fast speed and will collide soon.

References

[1] Cheng, Z. (2023). On the Dark Matter Fluid Model. https://vixra.org/abs/2303.0134

[2] Astronomy Staff. In which direction does the Sun move through the Milky Way? Astronomy. July 6, 2020. (Available in https://www.astronomy.com/science/in-which-direction-does-the-sun-move-through-the-milky-way/)

[3] Cheng, Z. (2023). Using Dark Matter Cherenkov Effect to Explain Why Galaxies Form. https://vixra.org/abs/2307.0042