A New Interpretation of Dark Matter by ASD

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1. Abstract

This paper proposes a hypothesis regarding the essence of dark matter, interpreting it as Additional Space-time Distortion (ASD). ASD is defined as a (nonlinear) superposition of spacetime distortion fields. We suggest that dark matter phenomena may be consistently explained within this ASD framework. This approach offers potential insights into the nature of dark matter

keyword: Dark matter, cosmology, physics, science, astrophysics

2. Introduction

In modern astrophysics, dark matter [1] is generally considered to be an undiscovered form of matter, It is often assumed to be a new particle. But despite decades of experimentation and exploration, These particles have never been directly detected yet. These situations suggest the possibility that the nature of dark matter lies outside the particle model. In this work, we propose an alternative interpretation of dark matter and interprets dark matter as an effect formed by superpositions of space-time distortions. This could be a clue to explain the Dark Matter.

ASD is not a new gravitational source, but rather a description of the cumulative effect of the space-time distortion fields created by multiple mass sources. as the curvature of space-time produced by the superpositions of two or more sources of gravity fields, the degree of curvature becomes more severe within a region. the spatio-temporal distortion rate is more concentrated locally.

This essentially makes a difference in terms of gravitational effects when concentrated in one place and forming a strong gravitational force, rather than spreading into space and being weakly affected several times. It provides a hypothetical basis that the distribution and concentration have a influence gravitational phenomenon.

And nonlinear terms in field equations may also have to be considered for accurate interpretation. However, in the weak field approximation we typically use, these equations are treated linearly, (in reality nonlinearity is intrinsically implied)

The dark matter phenomenon mentioned in this paper is very likely to be a gravitational effect caused by superpositions of the spacetime curvatures generated from the existing mass distribution. And in particular, the superposition of the space-time distortion fields created by the mass is generally not observed as a clear gravitational lens effect [2]. Instead, when observed from a long distance, these distortions may be statistically revealed in the manner of brightness change, shape distortion, variation of the distortion pattern, and the like.

In summary, a local increase in spacetime curvature does not mean that a new gravitational source has been added to the space. Rather, different spacetime distortion fields made by existing mass sources are superposed in a region, resulting in a linear (or non-linear) addition of the curvature at the corresponding position. This paper suggests that this local curvature increase due to superposition is the very nature of dark matter.

(Density refers to general matter Density and Naturally it includes particulate elements such as gas, molecular clouds, nebulae, interstellar matter, plasma etc.)

3. linearity and Nonlinearity of ASD

In weak spacetime distortions, the linear superposition of metric perturbations is valid under the condition that the cumulative perturbation satisfies $|h_{\mu\nu}| \ll 1$. However, when $|h_{\mu\nu}|$ approaches 10^{-2}, non-linear contributions may become significant, and the validity of the linear approximation should be reexamined.

The field equations of general relativity are as follows:

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}$$

This equation is nonlinear in nature. But in the case of weak gravity, The metric tensor can be approximated as follows:

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu}, \quad |h_{\mu\nu}| \ll 1$$

$h_{\mu\nu} \propto T_{\mu\nu}$, The gravitational fields created by the two mass source when A, B are superposed:

$$h_{\mu\nu}^{\text{total}} = h_{\mu\nu}^{(A)} + h_{\mu\nu}^{(B)}$$

However, in practice, due to the nonlinearity of the field equations, a more accurate representation is as follows:

$$h_{\mu\nu}^{\text{total}} = h_{\mu\nu}^{(A)} + h_{\mu\nu}^{(B)} + N_{\mu\nu}(h^{(A)}, h^{(B)})$$

where $N_{\mu\nu}$ is the terms representing the nonlinear interaction of two gravitational fields, It includes complex components such as h^2, $h\partial h$, and inverse metric terms.

Therefore:

- In the weak field approximation, the gravitational field simply superposes linearly. It's not because there's no nonlinearity terms. But It's so small that you can ignore it
- A strong field requires a sum including even nonlinear interactions.

4. The Exact Same Characteristics of Dark matter and ASD

ASD and Dark Matter don't interact with light.

ASD can't also exist and move completely independently By definition. This is Exactly the same as dark matter. existing theories assume that dark matter is an virtual particle. But absolutely alone or independent motion like matter or particles has never been observed.

ASD and Dark Matter have gravitational effects on the outside. but It is not affected by gravity. (There is only indirect speculation that dark matter will be affected by gravity.)

By definition, ASD, Dark Matter goes by without colliding with anything.(still in the theoretical stage that dark matter can collide with other matter.)

5. relationship between ASD and Matter density

Since ASD is the result of superposition spacetime distortions caused by the presence of matter, the amount eventually depends on the number of distortions that can be superposed at that location. This means that ASD is formed when there is sufficient general matter around that underlying the superpositionable distortion fields. Therefore, the superposition of distortion fields occurs actively at high material densities, increasing ASD, and at low densities, the superposition itself is limited, forcing ASD to decrease. In other words, the distribution of ASD is based on the following premise:

- ASD is a superposition of distortion fields caused by matter with mass.
- Therefore, for ASD to exist, superpositionable matter density must precede.

According to this premise, ASD can be expressed as a function of material density

$$D(x) = \alpha \cdot \rho(x) \tag{1}$$

Where $D(x)$ is the strength, frequency of the ASD at position x, $\rho(x)$ is the material density at that position, and α is the coefficient representing the superposition strength and may vary depending on the environment or conditions. ASD increases or decreases with surrounding density, excluding extreme high density situations

6. Interpretation of ASD Perspectives on Dark Matter-Related Phenomena

6.1 Explanation of Galaxy's rotational speed & Halo

The gravitational force (F_g) acting on an object in a circular orbit equals the centripetal force (F_c).

$$F_g = F_c$$

$$G\frac{M(r)m}{r^2} = \frac{mv(r)^2}{r}$$

Where G is the gravitational constant, $M(r)$ is the total mass within the radius r, m is the mass of an object in orbit, and $v(r)$ is the orbital velocity. If you clear one m and r from both sides:

$$G\frac{M(r)}{r} = v(r)^2$$

So to summarize for $v(r)$:

$$v(r) = \sqrt{\frac{GM(r)}{r}}$$

Since G is a constant here, the proportional relationship is as follows.

$$v(r) \propto \sqrt{\frac{M(r)}{r}}$$

Numerical examples (based on our galaxy):

0 kpc: 0 km/s (it's center)

1 to 2 kpc: rapidly increasing above 100 km/s

3-5 kpc: Increase to around 200 km/s,

8.5 kpc (the Sun's position): approximately 220 km/s (our Sun's orbital velocity).

10 to 20 kpc (optical outskirts): little change before and after 220 km/s (must be reduced in theory, but retained thanks to dark matter)

20-50 kpc (dark matter halo area): still constant around 220 km/s

First of all, The core of the galaxy's rotational speed problem [3]is that the rotational velocity of ordinary matters remain nearly constant regardless of the distance from the galactic center. To explain the flattening of the speed, M(r) must increase as it moves away.

In other words, The total mass M(r) contained inside the orbit must increase linearly in proportion to the distance. but the volume of space increases much more rapidly as the cube of the distance. so the distribution of the internal mass must become thinner as it moves away from the center. NFW [4] have shown that the density decreases to inversely proportional

$$\rho(r) \propto \begin{cases} \dfrac{1}{r} & \text{as } r \to 0 \quad \text{(central region)} \\ \dfrac{1}{r^2} & \text{at intermediate } r \quad \text{(halo body)} \\ \dfrac{1}{r^3} & \text{as } r \to \infty \quad \text{(outer region)} \end{cases}$$

General matter is most concentrated in the center of the galaxy, and its density gradually decreases toward the outskirts. However, the distribution of such ordinary matter alone is difficult to explain the rotational speed at which stars or gases are observed in galaxies. In other words, the existence of an additional gravitational source is necessary, and the concept of "Dark Matter Halo" has been proposed in this background.

The dark matter halo surrounds the entire galaxy much more widely and covers hundreds of thousands of light years. Even inside the halo, by definition, the ASD produced by various mass distributions also gradually weakens as it goes toward the outer periphery compared to the center. It is as if the distribution of a gravitational source decreases. This tendency is very similar to the distribution of a gravitational source in dark matter, which gradually dilutes from the center to the outer periphery.

it is generally accepted that the halo's edge approximately matches the average conditions of the universe. There can be no ASD either by definition. In other words, ASD is distributed from the center of the dark matter halo to the end of it with the same distribution of Dark Matter. Both ASD and Dark Matter become less dense when going to the outskirts, and the area without Dark Matter is the area without ASD.

The mathematical approach of galaxy rotation curves and ASD models The galaxy rotation curve describes the orbital velocity of visible stars or gas within a galaxy as a function of their distance from the galactic center.

Model 1: Baryonic Matter Only

Based on Newtonian gravity, considering only the visible baryonic mass (M_{vis}), the velocity is given by:

$$v_{\text{vis}}(r) = \sqrt{\frac{GM_{\text{vis}}}{r}} \tag{2}$$

This model predicts that the rotational velocity should decrease as the distance r increases.

Model 2: Including the ASD Effect

To account for the flat rotation curves observed in reality, we introduce an additional mass component, $M_{\text{ASD}}(r)$, which accumulates linearly with distance, where α is the accumulation slope.

$$M_{\text{ASD}}(r) = \alpha \cdot r \tag{3}$$

The total mass within radius r is then $M_{\text{total}}(r) = M_{\text{vis}} + \alpha r$. This leads to a modified velocity equation:

$$v(r) = \sqrt{\frac{G}{r}\left(M_{\text{vis}} + \alpha r\right)} = \sqrt{\frac{GM_{\text{vis}}}{r} + G\alpha} \tag{4}$$

As r becomes large, the first term $\frac{GM_{\text{vis}}}{r}$ approaches zero, and the velocity $v(r)$ approaches a constant value $\sqrt{G\alpha}$, resulting in a flat rotation curve.

Where:

- G: Gravitational constant
- M_{vis}: Visible (baryonic) mass
- α: ASD accumulation slope (mass/distance)
- r: Distance from the galactic center

6.2 Bullet galaxy Cluster Collision

One of the most important events suggesting the existence of dark matter is the bullet Bullet galaxy Cluster Collision.[5] (Collision at speeds between 4500 and 6000 km/s) First of all, hot gas strongly collides with galaxies due to the action of electromagnetic force. while stars do not collide because the empty space is too huge. after the collision, the hot gas remained around at the point of collision. but the center of mass was laid out by galaxies and stars. This means that a gravitational source, which cannot be explained by visible matter has traveled with the star and galaxies. This suggests that invisible dark matter exists.

Exactly the same as the properties of ASD, In the event of a collision, ASD goes through everything. That is, distorted spacetime itself and has no interaction with electromagnetic force at all. also It doesn't collide with anything. From ASD's point of view, the stars passed without impact(It is safe to say that the distance between the stars are so far away that there is virtually no direct collision.). ASD just continued to goes with the stars without affected. ASD has never collided.

6.3 Core–Cusp Problem

The issue of the Core-cusp problem [6] is that the actual distribution is different from the prediction of the distribution of dark matter. Along with the general material density, the density of dark matter also rapidly increased, that is, the Cusp shape, was predicted, but it was actually confirmed in the form of Core.
From the ASD point of view, ASD cannot be generated in a high-density general substance distribution, so the generation of ASD in the Core form stops.

In fact, the density of ordinary matter increases explosively and exponentially as it moves toward the Galactic center. This region is severely dense in ordinary matter, and the ASD's destructive force has become stronger, so Dark Matter is no longer produced at a high density, and it appears to have stopped in the Core state.

6.4 ASD Post Big Bang

After Big Bang [7] In the early Universe there was a microscopic density non-uniformity due to quantum fluctuations that extended throughout the Universe under an inflationary process. These density fluctuations subsequently became the seeds for the formation of spacetime structures and are also confirmed observationally by temperature fluctuations in the cosmic microwave background radiation (CMB) [8]. Additional space-time distortion (ASD) is a geometric phenomenon that reacts directly to the density distribution, as it is an superposition effect of the space-time curvature field. Therefore, the regional deviation of the initial density soon led to the spatial non-uniformity of the ASD, and the fact that initial density fluctuations existed naturally supports the fact that ASD was also unable to act uniformly throughout the universe.

7. Statistical Convergence of ASD and Gravitational Lensing and its Observational Challenges

In the region with a density, ASD seems to maintain a stable value through statistical convergence. At this time, the number and intensity of superposition are concepts independent of each other and each have statistically fixed values. The superpositions can be created locally or resolved by positional change, but this process itself is not directly observed with current techniques. while an individual contribution may not produce a detectable lensing effect. when observed from a distance, the overall collective superposition contributes to the average shape or position, mean distortion and point light source etc.

Table 1: Detectability of lensing signatures by mass and distance

Mass $M(M_\odot)$	**Distance** D_L **(Mpc)**	**Expected** θ_E
10^{11} (Galactic Scale)	100	$\sim$ 1 UltraVisual
3×10^{10}	3×100	$\sim$ 0.3 First-second
10^9	100	$\sim$ 0.1 Ultra-angle
10^8	10	$\sim$ 0.01 Ultra-angle
10^7	1	$\sim$ 0.003 Ultra-angle

The basic lensing equation relates the observed image position $\vec{\theta}$, the true source position $\vec{\beta}$, and the deflection angle $\vec{\alpha}(\vec{\theta})$ as:

$$\vec{\beta} = \vec{\theta} - \vec{\alpha}(\vec{\theta}) \cdot \frac{D_{LS}}{D_S} \tag{5}$$

Here, D_{LS} is the angular diameter distance between the lens and the source, and D_S is the angular diameter distance between the observer and the source. For weak lensing by dark matter halos, the deflection angle $\vec{\alpha}(\vec{\theta})$ becomes exceedingly small. Consequently, the observed image position $\vec{\theta}$ is only minutely displaced from the true source position $\vec{\beta}$, leading to $\vec{\theta} \approx \vec{\beta}$. This tiny difference, often referred to as a subtle distortion, frequently falls below the detection limits of current instrumental resolution, making the direct measurement of weak lensing effects particularly challenging.

Interpretation of Observational Challenges As illustrated in Table 1, small or distant masses significantly reduce the Einstein radius (θ_E), making the detection of lensing signatures extremely challenging. For instance, even a $10^9 M_\odot$ dark matter halo acting as a lens at a distance of 100 Mpc would produce an Einstein radius of approximately 0.1 arcsecond. This value is critically close to, or often below, the typical angular resolution limit of the Hubble Space Telescope (around 0.05 arcseconds), making it profoundly difficult to observe such a faint distortion as a distinct entity. For even smaller mass or more distant lenses, the deflection angles (and thus θ_E)

diminish further into the milliarcsecond (mas) range. Such minute bending angles render them undetectable by optical telescopes like HST, often requiring specialized instruments such as very high-resolution radio telescopes (e.g., VLBI) for any potential detection, or making them undetectable altogether.

9. Conclusion

Currently, attempts to interpret dark matter by assuming virtual particles are ongoing, but not a single virtual particle has been found or detected. This implies that another interpretation, concept is needed for it. This paper proposed the ASD framework as a new persuasive alternative, and this concept will serve as an opportunity to match and successfully know the identity of dark matter.

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