Model of the Universe without Dark Matter

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Abstract

Are Dark Matter the result of uncalculated addition derivatives? The need to introduce dark matter dark becomes unnecessary if we consider that, the phenomenon of dark matter is a result of not computing the additional derivatives of the equation of motion. For this purpose, we use higher derivatives in the form of non-local variables, known as the Ostrogradsky formalism. As a mathematician, Ostrogradsky considered the dependence of the Lagrange function on acceleration and its higher derivatives with respect to time. This is the case that fully correspond with the real frame of reference, and that can be both inertial and non-inertial frames. The problem of dark matter and dark energy presented starting from basic observations to explain the different results in theory and experiment. The study of galactic motion, especially the rotation curves, showed that a large amount of dark matter can be found mainly in galactic halos. The search for dark matter and dark energy has not confirmed with the experimental discovery of it, so we use Ostrogradsky formalities to explain the effects described above, so that the need to introduce dark matter and dark energy disappears.

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1. INTRODUCTION

Dark matter, presence was first postulate in the early 20th century as a means to explain discrepancies between observed gravitational effects and the visible matter in the universe. The history of its discovery traces back to Swiss astronomer Fritz Zwicky in the 1930s, who noticed the anomalous motion of galaxies within the Coma Cluster [1]. Until the 1970s that further evidence emerged from astronomer Vera Rubin's groundbreaking observations of galaxies rotation curves. These findings suggested that galaxies were held together by unseen matter with gravitational influence, now commonly referred to as dark matter.

The true nature of dark matter remains enigmatic. Various methods have been devise to detect and understand this elusive substance. One prominent approach involves direct detection experiments, which aim to capture rare interactions between dark matter particles and ordinary matter. These experiments often utilize highly sensitive detectors buried deep underground to shield from cosmic ray interference. Additionally, particle colliders such as the Large Hadron Collider (LHC) have been used to indirectly search for dark matter particles by attempting to produce them in controlled collisions [2].

Modified Newtonian Dynamics (MOND) [3] emerged to explain the apparent discrepancy between observed galactic rotation curves (how stars move in galaxies) and predictions based only on visible matter. MOND suggests that the need for dark matter could be avoided if this modified acceleration law were taken into account. However, it is important to note that while MOND offers an interesting alternative perspective, it faces challenges in interpreting a wide range of astrophysical observations, including those at larger or smaller cosmic scales. The standard dark matter hypothesis is still the dominant explanation for many phenomena, but both MOND and dark matter research continue to advance our understanding of the fundamental nature of the Universe. MOND also lacks a strong theoretical basis to explain its proposed modifications of gravity. As of the knowledge's last update in September 2021, MOND remains the subject of debate and scrutiny in the scientific community due to these and other limitations.

2. QUANTUM CORRECTION TO NEWTON'S SECOND LAW

From Ostrogradsky formalism using a Lagrange function is

$$L = L(q, \dot{q}, \ddot{q}, ..., q^{(n)}). \tag{1}$$

but not

$$L = L(q, \dot{q}). \tag{2}$$

The Euler-Lagrange equation with high-order addition variables follows from the least-action principle:

$$\delta S = \delta \int L(q, \dot{q}, \ddot{q}, ..., q^{(n)})dt = \int \sum_{n=0}^{N} (-1)^n \frac{\partial^n}{\partial t^n} \left(\frac{\partial L}{\partial q^{(n)}} \right) \delta q^{(n)} dt = 0 \tag{3}$$

This equation can be written in the form of a corrected Newton's second law of motion in non-inertial reference frames [4]:

$$F - ma + f_0 = 0 \tag{4}$$

Here,

$$f_0 = mw = w(t) + \dot{w}(t)\tau + \sum_{k=2}^{n} (-1)^k \frac{1}{k!} \tau^k w^{(n)}(t) \tag{5}$$

is a random inertial force [4] that can be represented by Taylor expansion with high-order derivatives coordinates on time

$$F - ma + \tau m\dot{a} - \frac{1}{2}\tau m a^2 + ... + \frac{1}{n!}(-1)^n \tau^n m a^{(n)} + ... = 0 \tag{6}$$

in inertial reference frame $w = 0$. In Newtonian case

$$F = G\frac{mM}{r^2} \tag{7}$$

It follows from the equivalence principle of gravity and inertia that Newton's second law extended to random non-inertial frames of reference should also add additional variables to the law of gravitational interaction. On the other hand, it follows from the ergodic hypothesis that the time averages are equal to their average statistical values r [4]. Therefore

$$ma - \tau m\dot{a} + \frac{1}{2}\tau m a^2 - ... + \frac{1}{n!}(-1)^n \tau^n m a^{(n)} + ... = \tag{8}$$

$$= m\frac{GM}{r^2}\left(1 - \frac{\lambda}{r} + \frac{\lambda^2}{r^2} - ...\right) = m\frac{GM}{r^2}\exp^{\left(-\frac{\lambda}{r}\right)}, \tag{9}$$

here λ is measure of r.

3. DARK METRIC FOR DARK MATTER

It follows that the phase space of coordinates and high-order derivatives gives the corrected Newton's formula for gravitational potential [5]

$$\phi = \phi_0 \exp^{-\frac{\lambda}{r}} \tag{10}$$

where $\phi_0 = \dfrac{GM_g}{r_g}$, potential; G, gravitational constant and M, mass. In our case

$$G\frac{mM_g}{r_g^2}\exp^{-\frac{\lambda}{r}} \approx \frac{mv^2}{r_g}, \tag{11}$$

then

$$v \approx \sqrt{\frac{GM_g}{r_g}}\exp^{-\frac{\lambda}{r}} \tag{12}$$

because the correction coefficient $\exp^{-\lambda/r}$ for gravity, r_g and M_g radius of Galactic rotation and mass of Galactic.

On the one hand, force F is expressed using infinite Taylor expansion. On the other hand, gravitational force F_g can also represented as a series, as follows from the principle of equivalence. If this series is replaced by an exponential, then we can write metric for the Einstein equation with cosmological constant

$$ds^2 = \exp^{-\frac{r_0}{r}} dt^2 - \exp^{-\frac{r_0}{r}} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta d\phi^2$$

which we call the dark metric [5], where $r_0 = \dfrac{2GM}{c^2}$.

The dark metric is the asymptotic of the Schwarzschild metric for $r_0 < r$. The definition of dark metrics for matter and energy presented to replace the standard notions of dark matter and dark energy.

The dark metric can also obtain from the standard metric:

$$ds^2 = B(r)dt^2 - A(r)dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta d\phi^2$$

Conditions $A(r)B(r) = 1$ and $limA(r) = B(r) = 1$ for $r \to \infty$ must be satisfied for the standard metric. The dark metric also satisfies to these conditions. Gravitational forces are presented as a series with changing signs. The theoretical curve is shown in Figure 1 and its comparison with the observed results is shown in Figure 2.

4. CONCLUSIONS

In the general case, non-inertial dynamics can describe by high order differential equations. From the principle of equivalence, it follows that the gravitational force also has to be represent as a series [7]. The corresponding metric called the dark metric. The dark metric describes gravitational interaction with additional terms that lead to the description of observable effects of dark matter and dark energy. This means that the correct calculation using the dark metric leads to an abandonment of notions of dark matter and dark energy. Therefore, there is no need to seek for something that does not exist. The proof of this statement is the good agreement between our theoretical corrections Newton Law and experimental data. We hope that the gravity correction at galactic distances can be decision the problem of Dark Matter and Dark Energy [8].

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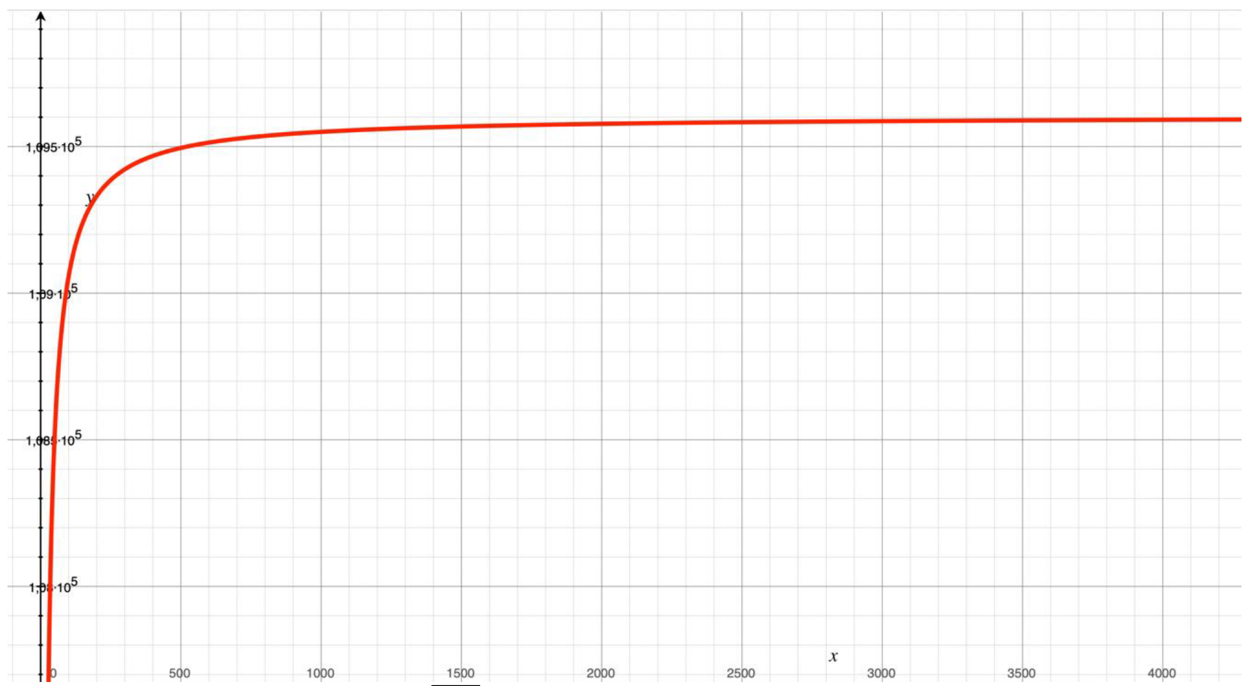

FIGURE 1: The curves velocity rotation $v = \sqrt{\frac{GM_g}{r_g}} \exp^{-\lambda/2r} = \sqrt{\frac{6.674 \cdot 10^{-11} \cdot 9 \cdot 10^{40}}{5 \cdot 10^{20}}} \cdot \exp^{-1/2r}, (m/s)$ of Milky Way Galaxy depends from radius of rotation r (kpc).

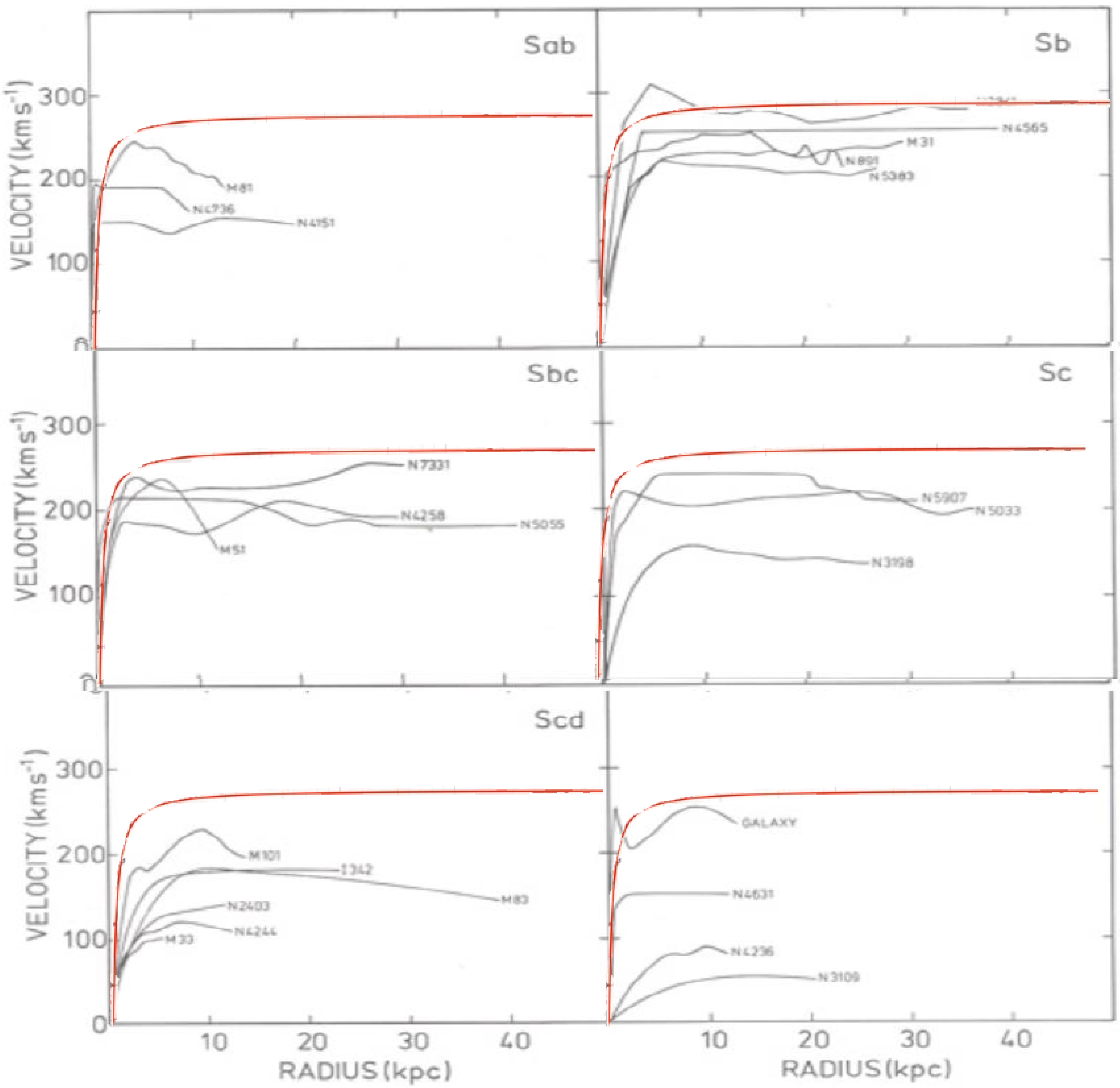

FIGURE 2: The rotation curves of the 25 galaxies published by Albert Bosma in 1978 [6] (red is our theoretical result).