Model of the Universe without Dark Matter

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Abstract

- the Newtonian formula of gravitational interaction and the well-known metrics of space, which are solutions of Einstein's equation, do not allow construction of consistent Universe model.

- the Newtonian formula of gravitational interaction is applied not only within our solar system but also to the entire Universe.

- In this work, we take a different approach.

- We introduce a correcting coefficient to the formula of gravitational interaction for large intergalactic distances in such a way that it becomes possible to construct a Universe model without dark matter.

Introduction

- Dark matter presence to explain discrepancies between observed gravitational effects and the visible matter in the universe.

- Swiss astronomer Fritz Zwicky noticed the anomalous motion of galaxies within the Coma Cluster.

- In the 1970s that further evidence emerged from astronomer Vera Rubin's groundbreaking observations of galaxies rotation curves.

- The true nature of dark matter remains enigmatic.

Correction Coefficient

From Ostrogradsky formalism using a Lagrange function is

$$\boldsymbol{L = L(q, \dot{q}, \ddot{q}, \ldots, q^{(n)}, \ldots)},$$

but not

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

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

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

This equation can write in the form of a corrected Newton's second law of motion in non- inertial reference frames [3]:

$$\boldsymbol{F} - \boldsymbol{ma} + \boldsymbol{f}_{0} = \mathbf{0}.$$

Here,

$$f_0 = mw\,,$$

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

is a random inertial force [3] that can be represented by Taylor expansion with high-order derivatives coordinates on time

$$\boldsymbol{F} - \boldsymbol{ma} + \boldsymbol{\tau m\dot{a}} - \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{\tau}^{2}\boldsymbol{ma}^{(2)} + \ldots + \frac{\mathbf{1}}{\boldsymbol{n}!}(-\mathbf{1})^{n}\boldsymbol{\tau}^{n}\boldsymbol{ma}^{(n)} + \ldots = \mathbf{0}$$

in inertial reference frame w = 0.

In Newtonian case

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

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 [3]. Therefore

$$\boldsymbol{ma} - \boldsymbol{\tau m\dot{a}} + \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{\tau}^{\mathbf{2}}\boldsymbol{ma}^{(2)} - \dots + \frac{\mathbf{1}}{\boldsymbol{n}!}(-\mathbf{1})^{n}\boldsymbol{\tau}^{\boldsymbol{n}}\boldsymbol{ma}^{(\boldsymbol{n})} + \dots$$

$$= m\frac{GM}{r^2}\left(1 - \frac{\lambda}{r} + \frac{\lambda^2}{r^2} - \cdots\right) = m\frac{GM}{r^2}e^{\left(-\frac{\lambda}{r}\right)},$$

here λ is measure of interaction r.

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 [4]

$$\boldsymbol{\varphi = \varphi_0 e^{-\frac{\lambda}{r}}}$$

where $\boldsymbol{\varphi_0 = \frac{GM}{r}}$, potential; $\boldsymbol{G}$, gravitational constant and $\boldsymbol{M}$, mass.

In our case

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

then velocity of rotation in Galactic

$$v \approx \sqrt{\frac{GM_g}{r_g}}e^{-\frac{\lambda}{2r}}$$

because the correction coefficient $e^{-\frac{\lambda}{r}}$ 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 $\boldsymbol{F_g}$ 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 Dark Metric

$$\boldsymbol{ds^2 = e^{-r_0/r}dt^2 - e^{r_0/r}dr^2 - r^2d\theta^2 - r^2sin^2\theta d\phi^2}$$

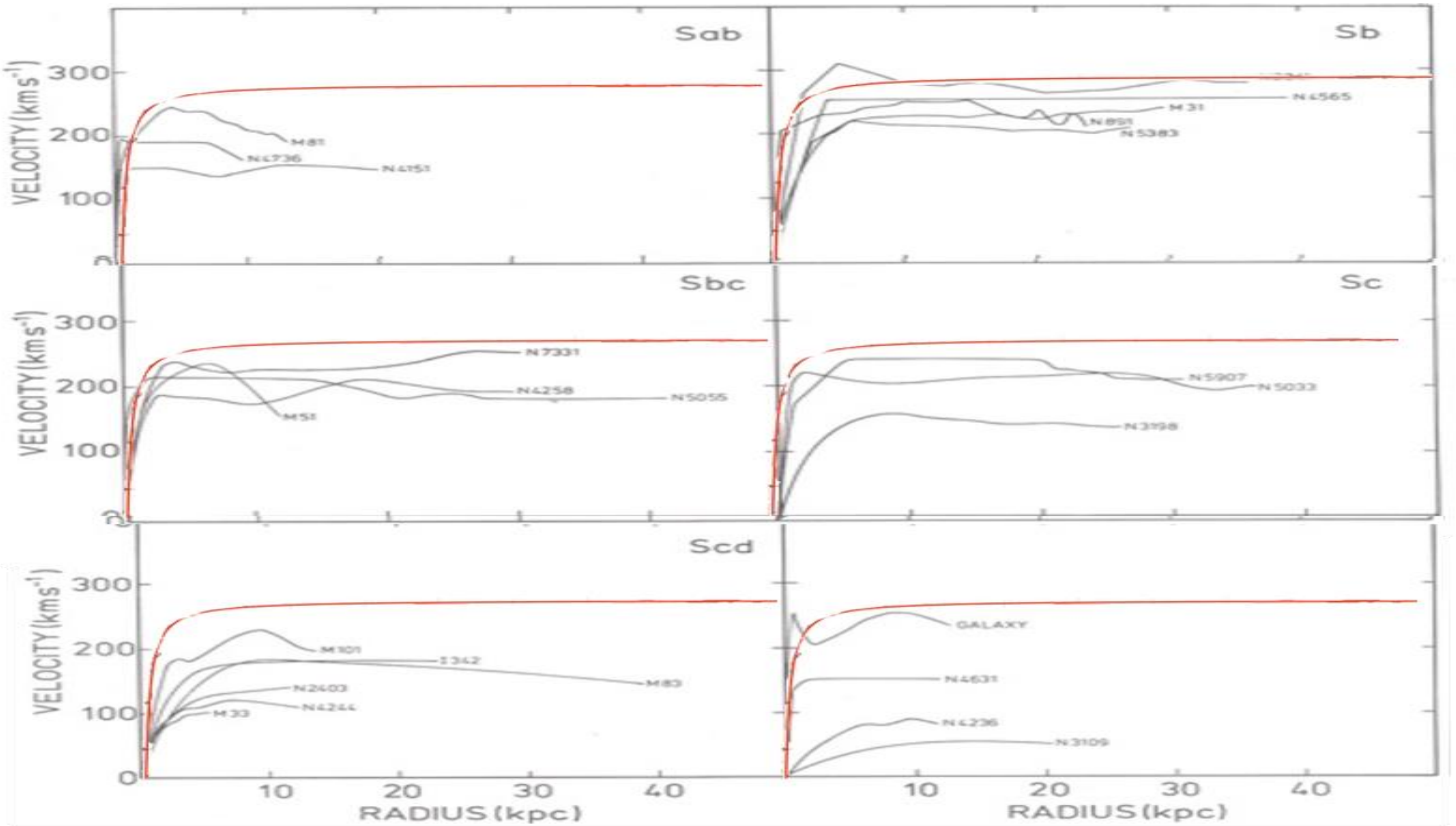
which we call the dark metric [3], where $\boldsymbol{r_0 = 2GM/c^2}$.

The dark metric is the asymptotic of the Schwarzschild metric for $\boldsymbol{r_0 < r}$. The definition of dark metrics for matter presented to replace the standard notions of dark matter.

The dark metric can also obtain from the standard metric:

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

Conditions $\boldsymbol{A(r)B(r) = 1}$ and $\boldsymbol{limA(r) = B(r) = 1}$ for $\boldsymbol{r \to \infty}$ 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.



Sab
Sb
Sbc
Sc
Scd
VELOCITY (kms^{-1})
RADIUS (kpc)
M81
N4736
N4151
N4565
M31
N891
N5383
N7331
N4258
N5055
M51
N5907
N5033
N3198
M101
I342
M83
N2403
N4244
M33
GALAXY
N4631
N4236
N3109

Modified Newtonian Dynamics (MOND)

- **MOND suggests that the need for dark matter could be avoided if this modified acceleration law were taken into account.**

- **MOND offers an interesting alternative perspective, but it faces challenges in interpreting a wide range of astrophysical observations.**

- **MOND also lacks a strong theoretical basis to explain its proposed modifications of gravity.**

FIG. 1. The curves velocity rotation $v = \sqrt{\frac{GM_g}{r_g}}\, e^{-\lambda/2r} = \sqrt{\frac{6{,}674\cdot 10^{-11}\cdot 9\cdot 10^{40}}{5\cdot 10^{20}}} \cdot e^{-\frac{1}{2r}}$ **(m/s) of Milky Way Galaxy depends from radius** of rotation r (kpc).

Conclusion

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. 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. This means that the correct calculation using the dark metric leads to an abandonment of notions of dark matter. 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 of potential and experimental data. We hope that the gravity correction at galactic distances can decide the problem of Dark Matter

References

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