Deceleration of massive bodies by the isotropic graviton background as a possible alternative to dark matter

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Abstract

Deceleration of massive bodies by the isotropic graviton background is considered here as a possible alternative to dark matter. This deceleration has the same order of magnitude as a small additional acceleration of NASA deep-space probes.

1 Introduction

If one takes into account only the following: a) a distribution of visible matter mass and b) the classical gravity laws, the form of rotation curves of spiral galaxies is unexplainable. There are two obvious possibilities: to introduce some dark matter and to search particles or bodies that may represent it; or to suggest some small deviations from classical gravity at least on the galactic scale (of course, both variants may take place simultaneously). Many candidates for dark matter particles were proposed; but when some kind of them is found, this particle should be placed in the hierarchy of elementary particles - in other words, it means a new revolution in high energy physics. The second possibility has a remarkable example of simple and successive model: MOND by Mordehai Milgrom [1]. This model differs from Newton's gravity if the gravitational acceleration is less than some $a_0 \sim 10^{-10}\ m/s^2$. It is important that $a_0 \sim Hc$, where c is the light velocity and H is the Hubble constant. The Pioneer anomaly discovered in the solar system [2] has the same order. It is impossible to embed the Pioneer anomaly in a frame of general relativity; a magnitude and a sign of this effect are able to overshade successes of the current cosmological model. Recently, it was shown by Francisco et al. [3] that the thermal acceleration of the deep-space probes Pioneer 10/11 may have the same order as the full anomaly. Additionally, analysis of recently recovered Doppler data for both spacecraft by Turyshev et al. [4] favors a temporally decaying anomalous acceleration that supports namely the possible thermal nature of the Pioneer anomaly. Both newest finding are very important for future understanding of the anomaly, but complexity of the task to model the thermal radiation emissions of the spacecraft does not give a possibility to prove definitely the pure thermal origin of the effect. We need the future mission designed with a special goal to verify the nature of the anomaly and taking into account the recent results.

In the model of low-energy quantum gravity by the author [5, 6], every massive body with a non-zero velocity relative to the isotropic graviton background should experience a constant deceleration of the order Hc. This deceleration is considered here as a tentative cause of non-classical motion of bodies by very small gravitational accelerations.

2 Deceleration due to collisions with gravitons

In the model [5, 6], the deceleration of massive bodies and the redshift of remote objects have the same nature: these effects are caused by collisions with gravitons of the low-temperature graviton background. To demonstrate how similar are predictions about distance moduli as a function of redshift of this model and of the concordance cosmology, I reproduce here their comparison from my paper [7]. On Fig. 1, the two theoretical Hubble diagrams are sown: $\mu_0(z)$ of this model with $b = 1.137$ taking into account the effect of time dilation of the standard model (solid); and $\mu_c(z)$ for a flat Universe with the concordance cosmology by $\Omega_M = 0.27$ and $w = -1$ (dash). You can see a good accordance of this diagrams up to $z \approx 4$. The comparison of predictions of the model with Supernovae 1a and GRBs observational data may be found in [6]. Due to only forehead collisions with gravitons, the

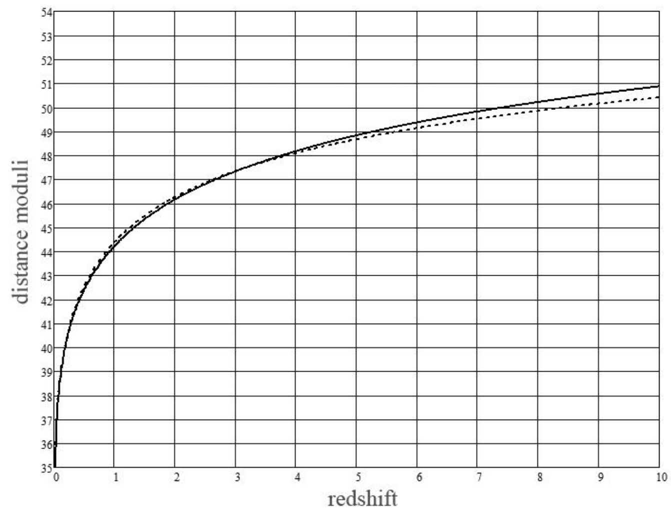

Figure 1: The two theoretical Hubble diagrams: $\mu_0(z)$ of this model with $b = 1.137$ taking into account the effect of time dilation of the standard model (solid); $\mu_c(z)$ for a flat Universe with the concordance cosmology by $\Omega_M = 0.27$ and $w = -1$ (dash).

deceleration of massive bodies in this model is equal to:

$$w = -Hc(1 - V^2/c^2), \tag{1}$$

where V is a body's velocity relative to the graviton background [6]. For small velocities: $w \simeq -Hc$. This deceleration is universal, and in a bound system of two bodies with very different masses, if we consider a motion of a smaller body relative to its more massive partner with a velocity $\mathbf{v}$, it is necessary to take into account the force of inertia. In the Newtonian approach, if $\mathbf{u}$ is a more massive body's velocity relative to the background, M is its mass, and $\mathbf{v} + \mathbf{u}$ is such the velocity of the small body, we will have the following equation of motion of the small body:

$$\ddot{\mathbf{r}} = -G\frac{M}{r^2} \cdot \frac{\mathbf{r}}{r} + w(\frac{\mathbf{u}}{u} - \frac{\mathbf{v} + \mathbf{u}}{\mid \mathbf{v} + \mathbf{u} \mid}), \tag{2}$$

where $\mathbf{r}$ is a radius-vector of the small body, G is Newton's constant. Using the theoretical value of H in this model: $H = 2.14 \cdot 10^{-18}\ s^{-1}$, we have:

$w \simeq 6.42 \cdot 10^{-10}\ m/s^2$. It is necessary to investigate this equation for the case of a star moving relative to a galactic center, to understand how this modification is connected with the problem of dark matter.

3 Conclusion

The considered modification of the equation of motion is not alone of possible causes of deviations from the expected classical laws. The dynamical quantum character of classical gravity in this model may lead to another interesting effect. Due to destruction of graviton pairs in the central part of galaxy, the gravitational attraction of the center may be stronger in outer parts of galaxy. The effect is not investigated, too.

In contrast with high energy physics, the field of gravitational physics has not such a wide range of experimental possibilities to verify different suggestions about new and very tiny phenomena. The suggested dark components of the universe are typical examples which, perhaps, may survive in our minds only in this situation.

References

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