Modified dynamics of massive bodies in the graviton background

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Abstract

The additional deceleration of massive bodies and the redshift of remote objects in the model of low-energy quantum gravity are caused by collisions with gravitons. Some results of numerical modeling of a motion of bodies in the central field by the influence of this additional deceleration are described here. The two peculiarities of modified dynamics take place: an absence of closed orbits and a possibility of the non-planar motion of massive bodies in the central field.

1 Introduction

The claimed discovery of dark energy [1, 2] was accepted by the scientific community without a necessary healthy skepticism. Now big efforts are taken to understand what is this suggested substance. In the model of low-energy quantum gravity [3, 4], gravitation is considered as the screening effect in the sea of super-strong interacting gravitons. The Newton constant G and the Hubble constant H are computable in the model as functions of the background temperature. There is not a need of any expansion of the universe and dark energy in the model to fit corresponding cosmological observations. The two-parametric theoretical luminosity distance of the model is caused by forehead and non-forehead collisions of photons with gravitons. The additional deceleration of massive bodies has the same nature as the redshift of remote objects in the model: these effects are caused by collisions with gravitons, but we should take into account both forehead and backhead collisions with gravitons in a case of massive bodies [5]. Some results of numerical modeling of a motion of bodies in the central field by the influence of this additional deceleration are described here.

2 Modified dynamics in the graviton background

As it was shown in [5], due to forehead and backhead collisions with gravitons,

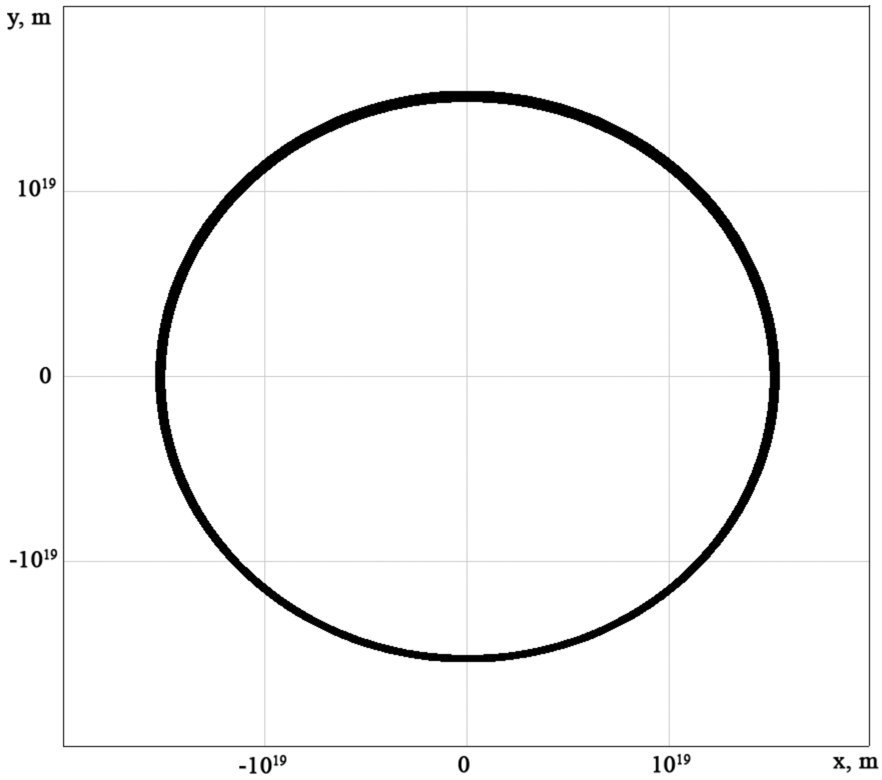

Figure 1: A star orbit in a galaxy with $M = 10^{10} \cdot M_{\circledS}$ by $u = 5 \cdot 10^5$ m/s and $r(0) = 1$ kpc; t 30 Gyr, single loops interflow, the change of the distance to the center $\Delta r/r(0) = -0.034$.

the deceleration w of massive bodies in this model is equal to:

$$w = -w_0 \cdot 4\eta^2 \cdot (1 - \eta^2)^{0.5}, \tag{1}$$

where $w_0 \equiv H_0 c = 6.419 \cdot 10^{-10}\ m/s^2$, if we use the theoretical value of H_0 in the model; $\eta \equiv V/c$, V is a body's velocity relative to the graviton background. For small velocities we have:

$$w \quad -w_0 \cdot 4\eta^2. \tag{2}$$

In the Newtonian approach, if **u** is a more massive body's velocity relative to the background, M is its mass, and $\mathbf{V} = \mathbf{v} + \mathbf{u}$ is the velocity of the small body relative to the graviton background, we will have now the following equation of motion of the small body:

$$\ddot{\mathbf{r}} = -G\frac{M}{r^2} \cdot \frac{\mathbf{r}}{r} + \frac{4w_0}{c^2}(u \cdot \mathbf{u} - \mid \mathbf{v} + \mathbf{u} \mid \cdot (\mathbf{v} + \mathbf{u})), \tag{3}$$

where $\mathbf{r}$ is a radius-vector of the small body.

To model the motion in the central field, I have slightly modified the program in C++ written for our work [6] to work in 3 dimensions using Eq. 3.

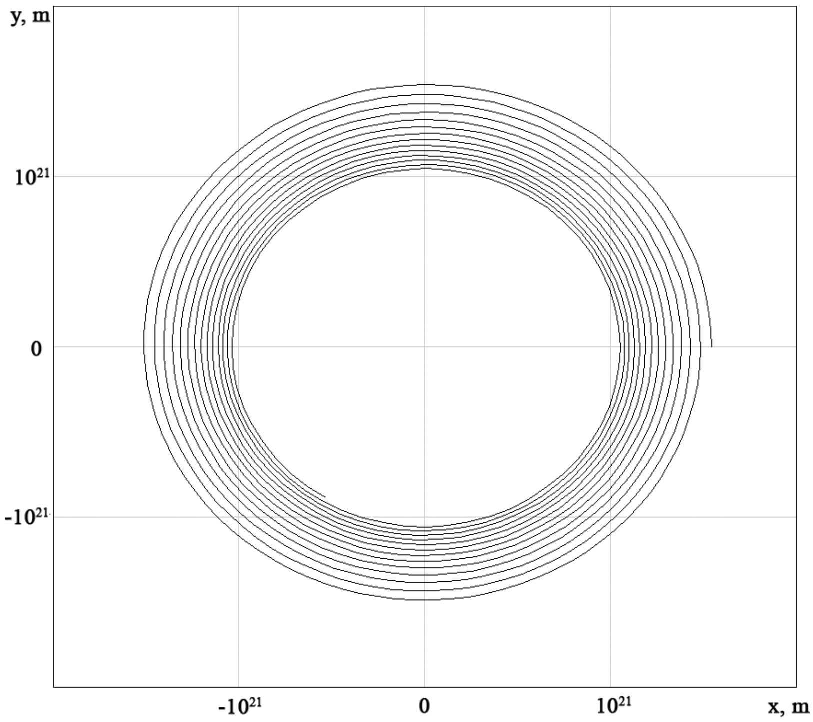

Figure 2: A star orbit in a galaxy with $M = 10^{10} M_{\circledS}$ by $u = 5 \cdot 10^5$ m/s and $r(0) = 100$ kpc; t 300 Gyr, the first unclosed external loop corresponds to 29.2 Gyr.

3 A motion in the central field

Let us consider the initial conditions by which a material point trajectory in the classical case is circular, i.e. $v(0) = (G\,M/r(0))^{0.5}$, and $\mathbf{v}(0) \perp \mathbf{r}(0)$. T is a period of motion in the classical case of a circular trajectory by the given initial distance to the center. To evaluate a stability of planetary orbits in the solar system in a presence of the anomalous deceleration w, we can use the following trick: to increase w by hand to see a very small change of the orbit's radius, and to re-calculate a value of the resulting effect. In a case of the Earth-like circular orbit, i.e. by $M = M_{\circledS}$, $r(0) = 1$ AU, given $u = 4 \cdot 10^5$ m/s and that three vectors **r**, **v**, **u** lie in one plane, we get by the replacement: $w \to 10^4 w$ for one classical period T : $\Delta r/r(0) = -1.08 \cdot 10^{-8}$ yr^{-1} by $\Delta t = 10^{-10} T$. It means that by the anomalous deceleration w we should have now: $\Delta r/r(0) = -1.08 \cdot 10^{-12}$ yr^{-1}. For the case when **u** is perpendicular to **r**, **v** we have: $\Delta r/r(0) = -7.2 \cdot 10^{-13}$ yr^{-1}. The Earth orbit will be stable enough to have not contradictions with the estimated age of it in the solar system.

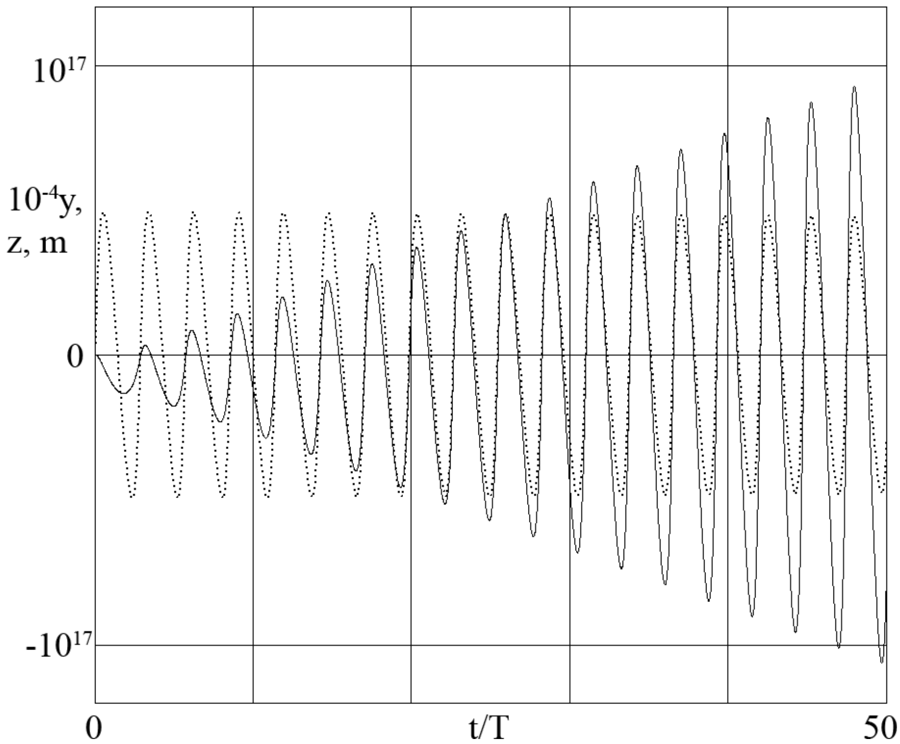

Figure 3: The deviation $z(t)$ (solid) of a star orbit in a galaxy (with $M = 10^{10} M_{\circledS}$ by $u = 5 \cdot 10^5$ m/s and $r(0) = 10$ kpc) from the classical plane (x, y) for the case of $v(0) = 1.2\,(G\,M/r(0))^{0.5}$; $T = 0.781$ Gyr, the graph of $10^{-4} y(t)$ (dotted) is shown for the comparison.

Results of modeling a star orbit in a galaxy in the similar way are shown in Figures 1 and 2 for $M = 10^{10} \cdot M_{\circledS}$, $u = 5 \cdot 10^5$ m/s by $r(0) = 1$ kpc (Fig. 1) and $r(0) = 100$ kpc (Fig. 2). The ratio $\frac{\dot{w}_0}{\ddot{r}(0)}$ is equal to 2.2 and 0.00022 respectively. By $r(0) = 1$ kpc the relative change of the distance to the center is $\Delta r/r(0) = -0.034$ during the time interval of 30 Gyr. By $r(0) = 1$ kpc the

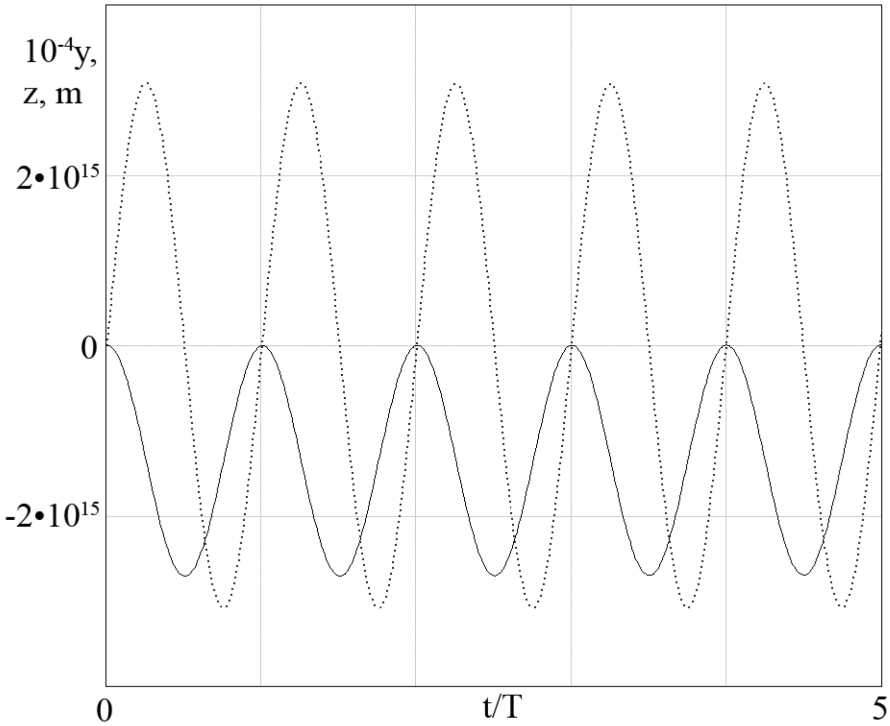

Figure 4: The same graphs as in Fig. 3, but for the case of $v(0) = (G{\cdot}M/r(0))^{0.5}$; $T = 0.781$ Gyr, $10^{-4} \cdot y$ (dotted), z (solid).

first unclosed external loop in Fig. 2 corresponds to 29.2 Gyr. We see that at all scales closed orbits do not exist in the model: bodies inspiral to the center of attraction, but for the Earth-like orbits this effect is very small.

When **u** is perpendicular to **r**, **v**, another effect takes place: the motion of the body in the central field is not planar. The deviation $z(t)$ of a star orbit in a galaxy (with $M = 10^{10} {\cdot} M_{\odot}$ by $u = 5\ 10^5$ m/s and $r(0) = 10$ kpc) from the classical plane (x, y) is shown in Figures 3 and 4. For the case of $v(0) = (G\,M/r(0))^{0.5}$ (the classical orbit would be circular), deviations from the classical plane (x, y) occur in one side off this plane, with returns to it (Fig. 4). In the case of the Earth-like circular orbit, the maximal deviation from the classical plane is lesser of 1 mm by $u =. 4\ 10^5$ m/s. If $v(0) = (G\,M/r(0))^{0.5}$, deviations from the classical plane (x, y) occur in both sides off this plane (Fig. 3, $v(0) = 1.2 \cdot (G\,M/r(0))^{0.5}$), and the ones may be interpreted as a slow revolution of a quasi-classical planar orbit around some axis in this plane.

4 Conclusion

The described results show two peculiarities of modified dynamics in the model: an absence of closed orbits and a possibility of the non-planar motion of massive bodies in the central field due to the anomalous deceleration by the graviton background. These effects are negligible for the Earth-like orbits and, perhaps, too small to be observable during an acceptable time interval in galaxies. But the interaction of photons with the background leads to the observable effects which can be essential for our understanding of the universe.

References

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