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Research Article

Gravitational Waves and Gravitational Lensing According to Particle Based Gravity

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Abstract

This paper builds on the discovery that the Newtonian constant *G* is not a universal constant of nature, but rather increases in the vicinity of a mass. As measured at the Earth surface the variation is very small and applies over a limited distance, though in galactic systems the variation of *G* can be large and can apply over long distances. The variability of *G* is generally obscured by incorrect spectral shift measurements of the rotation speed of stars around the center of gravity. For the case of the Milky Way this was clearly shown by data based on the third Gaia satellite data release. Correction of the measurements by gravitational spectrum shift has led to a new interpretation of galactic rotation curves without the need to introduce dark matter in the galactic system. The reason why *G* can and does vary is studied in the current paper. A possible mechanism is provided by a modified particle based theory of gravity, which is compatible with the general theory of gravity. By applying geometry to the paths of the particles it is analyzed whether this theory can explain the increase of *G* in the vicinity of a mass. In the same way it is studied whether this theory can accommodate the detection of gravitational waves and the principle of gravitational lensing. The analyses make use of the basic features of particle based gravity only, and do not need any ad-hoc assumptions.

Keywords

Gravitational Constant, Push Gravity, Gravity Waves, Gravitational Lensing

1. Introduction

A longstanding problem in astronomy has been the occurrence of flat galactic rotation curves. This rotation curve represents the rotation speed of the stars against the distance to the center of the galactic system, which usually is a black hole. Based on Newton's and Keppler's laws one would expect that at larger distances from the center, the rotation speed decreases. However, this is not the case for most of the galactic systems studied. This problem has been solved ad hoc by assuming the existence of dark matter in the galactic system, which would compensate for the missing baryonic matter [3]. However, as dark matter cannot be observed directly, the problem is still considered pending.

A solution to the problem was published recently [2]. It had been found that the Newtonian constant *G* is not a constant of nature, but is slightly larger in the vicinity of a center of mass [1]. Accordingly, the magnitude of *G* should increase from the outskirts of a galactic system towards the center. However, this is not always clear from measurements. The reason appears to be that the rotation speed of stars is commonly measured by the Doppler shift and this needs a correction. This need was clearly shown by the third data release from the Gaja satellite, which measured the rotation

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speed of stars in the Milky Way directly without using the Dopler shift [10]. The correction leads to galactic rotation curves with a more Keplerian shape without introducing dark matter.

Now the question arises what the mechanism can be, which causes the variability of *G* and in particular its increase in the vicinity of a mass. Such mechanism should not conflict with the known laws of physics and be compatible with Einsteins general theory of gravity. It has been suggested that the key may be found in a modified theory of particle based gravity [2]. This mechanism is explored in the current article.

2. Particle Based Gravity

The particle based theory of gravity (sometimes called push gravity) is a theory of gravity, first proposed by the scientist Le Sage in 1748 [4]. It was assumed that throughout the universe elementary particles are at high speed traveling randomly in all directions [9]. These particles do not interact with each other and many of them pass without interaction through the masses of cosmic bodies, but some particles collide with these and by doing so exert a pushing force. According to Le Sage the collisions are inelastic, but the present study is based on a modified theory in which the collisions take place elastically.

The random movement of the particles implies that in free space a body is hit radially symmetrically by the particles, which results in no net force. However, two neighboring masses partly shield each other from part of the particles, and as a result they are pushed towards each other by the net flux of incoming particles. This implies a force according to Newton's law, in which the local magnitude of the gravitational constant *G* is determined by the incoming flux and the effectiveness of the shielding. The latter depends on the fraction that collides with the mass of the body. That fraction will depend on the density and other characteristics of the cosmic body being hit. It is quite well possible that in the early universe the magnitude of *G* has been very high because of its very high density of matter.

The closer the two neighboring masses are, the larger is the fraction which is shielded, and so the larger is the gravitational force F between the two masses. In fact, the incoming flux is diminished by the presence of any other bodies in the vicinity. This explains why nearby the Earth - or any other mass - *G* is larger than in free space.

Obviously, it remains to study what are these particles and whether their existence could eventually link gravity to quantum theory. Some authors have suggested that the particles could be gravitons [5, 6].

In the following sections it is studied if and how this modified theory of particle based gravity can be compatible with some phenomena of gravity, which are known from Newtons law and the general theory of gravity.

3. Newtons Law

Two bodies at a certain distance from each other in free space are being hit by a flux of particles from all directions. Because of mutual shielding of part of the flux, they experience a force towards each other. The solid angle of the two bodies with respect to each other and the masses of the two bodies lead directly to Newtons law:

$$F = GMm/R^2$$

F is the force, M and m are the masses, R is the distance between the masses and *G* is a matching factor which varies with the local conditions, e.g. the presence and characteristics of matter in the vicinity. It is seen that Newtons law follows directly from the particle based theory of gravity.

4. Gravitational Constant at the Earth Surface

It has been found that at points at the Earth surface which are closest to the mass center of the Earth, *G* is slightly higher than at points further away [1]. According to the theory of particle based gravity this is explained by the fact that at the Earth's surface more upward directed particles are being shielded by the Earth. Hence, the net downward flux of particles at this point is largest. This implies a larger force, which in Newtons law is accounted for by an enlarged *G*. At a point further away from the Earth's mass center more and more particles with an upward component skim the Earth and are hitting that point. Hence the net downward flux of particles is counteracted here more effectively as compared to the case at the Earth's surface. At a point still further away the particles with an upward and downward component match each other. Therefore the magnitude of *G* is here back to normal, which in the case of the Earth means the magnitude within the solar system. The decrease of *G* from the Earth surface towards a point far away will be asymptotic.

It should be noted that the analysis is based on geometry only, applied to the Earth as a spherical mass. As the laws of physics are not supposed to change with the particle based theory of gravity, what is found here will also apply to any other spherical mass in the universe. For simplicity only homogenous spherical masses are considered in this study.

We see that the particle based theory of gravity can explain the observation that close to the Earth the magnitude of *G* is slightly higher than at higher altitude. In fact, from the data in ref. [1] it is seen that the variation of *G* near the Earth is only about 0.12% and that the enlarged *G* takes place over a very short distance. Note that the oblateness of the earth is only around 20 km.

5. Measuring *G* near the Earth's Surface by the Cavendish Method

The particle based theory of gravity can also explain the variation of *G* at the Earth surface as measured by the Cavendish Method. Imagine the two test masses of Cavendish are far away from the Earth. They experience a force towards each other like in free space. Now imagine the same test masses at a position closer to the Earth. Here, because of the shielding by the Earth, the fluxes of particles hitting the test masses are in principle equally diminished. This leads to no effect on the force of the two test masses towards each other, except for the fluxes which hit part of the 'inner sides' of the test masses. By the inner side is meant the side of each test mass which is directed towards the other test mass. Those areas of the test masses are the first ones to experience diminishing of the fluxes skimming the Earth surface and these are exactly the fluxes which counteract the force driving the test masses towards each other. As a result the test masses are driven stronger towards each other, which implies a larger *G* at this position closer to the Earth as compared to the case in free space.

The closer the Cavendish test masses are to the earth, the more of these fluxes hitting the 'inner sides' are being shielded by the earth. Henc, the closer to the earth, the larger *G* will be. The variation is explained by the particle based theory of gravity.

6. Detection of Gravitational Waves

Gravitational waves are being detected by a LIGO (Laser Interferometer Gravitational-Wave Observatory) and other related instruments [7]. These waves are thought to originate from a clash or encounter of very large masses somewhere far away in the universe. When by the encounter strong fluxes of elementary particles are generated, part of these fluxes arrive at the LIGO and superpose on the particles which were already coming from all directions.

In essence the LIGO consists of two arms directed perpendicular two each other. On each arm two mirrors are mounted opposite each other. These mirrors can be moved towards and away from each other by a force. Imagine that one of the arms is positioned horizontally and the other one vertically.

When somewhere far away to the left or far away to the right an encounter of big masses takes place and generate a strong flux of particles, the two mirrors on the horizonal arm will move towards each other, because of the shielding of particles by the one mirror with respect to the other one. However, because the encounter takes place on the horizontal axis, none of the mirrors on the vertical axis shields the other one from particles and so no force results there. LIGO detects the difference of the reactions by the mirrors on the horizontal axis and the vertical axis. That difference is very small but it is amplified by the LIGO system about 10^{22} times.

The same applies when an encounter takes place somewhere far away up or far away down on the vertical axis. In that case the mirrors on the vertical axis move because of the shielding effect. However, because the encounter takes place on the vertical axis, there is no shielding on the horizontal axis by one of these mirrors and so no force results there. Here again LIGO detects the difference between the pair of mirrors on the horizontal arm and on the vertical arm. Also this difference is multiplied by the LIGO system about 10^{22} times.

Now consider the case that the encounter takes place in a direction between the horizontal and vertical axes. In this case the effect on both mirror pairs is the same and so LIGO does not measure an effect.

It is concluded that the effect of the gravitational wave is maximal when the encounter takes place in the direction of either of the two LIGO arms and minimal (i.e. zero) when the encounter takes place in the direction exactly between those. Obviously, there is a gradual decrease over the directions from maximum to minimum.

For simplicity the two-dimensional configuration is described here, but nothing changes when the configuration is rotated around the vertical axis. So the conclusions remain the same in three dimensions.

The question can be raised whether the force which results from the shielding of the particles can be strong enough to cause a movement of a mirror, considering the weight of the mirror. The point here is what is meant by a movement. It has been reported that the effect of a gravitational wave on the mirror is a 'movement' of the size of one proton radius of 0,833 femtometer. Hence, the word movement is a little confusing. The effect is nevertheless detectable after amplification by LIGO.

It can be concluded that the theory of particle based gravity can accommodate the phenomenon of gravitational waves. The particles, which hit the mirrors, are responsible for the effect measured by LIGO.

7. Gravitational Lensing

From the very fact that gravitational lensing exists, we may conclude that light is influenced by mass [8]. Apparently, when light is in the vicinity of a mass, this can lead to a measurable effect. Here it is analyzed if and how this effect can be explained by the theory of particle based gravity.

Imagine in a two-dimensional representation a large spherical mass, which is to act as a gravity lens. High above this mass is a source which emits light. And far below this spherical mass is the observer. From the light source to the observer a line can be drawn through the middle of the spherical mass. Let's call the upper point of the spherical mass the north pole and the lowest point the south pole.

Consider a light beam from the source that hits the spherical mass at a point slightly to the right hand side of the north pole. Above that point particles from right and left compensate each other, which implies that the photons of the light beam do not experience a net force to the right or left. However, immediately below this point part of the particles coming from the left are being shielded by the spherical mass and hence the photons experience a net force toward the left. That means that the light beam is pushed towards the right hand side of the spherical mass. As the light beam progresses its path downward, the photons experience a net force to the left, because there is a diminished counterforce from the other side, and so the light beam keeps following the path close to the right hand side of the spherical mass.

However, arriving at the south pole there is no more shielding and hence the light beam continues its path downward.

The same process takes place with a light beam which hits the spherical mass slightly to the left of the north pole. That light beam travels along the left hand side of the spherical mass towards the south pole. For simplicity the case is here represented two dimensionally, though obviously, the process takes place in three dimensions. At the south pole all light beams come together in their path downwards. Obviously interference takes place and hence the observer does not see a simple image of the light source, but rather some interference pattern.

This analysis shows that gravity lenses are in principle compatible with the particle based theory of gravity.

8. Conclusions

This study shows that a modified theory of particle based gravity, which is compatible with the general theory of gravity, can explain the observation that the magnitude of G increases in the vicinity of a mass. Also Newtons law follows from this theory, whereas G is interpreted as a matching factor, the magnitude of which is determined by the presence of nearby masses and their characteristics. Furthermore, the mechanism of the detection of gravitational waves can be explained by this theory by applying geometry to the paths of the particles. It is also shown that the phenomenon of gravity lensing can in principle be accommodated by the particle based theory of gravity. Further studies should be directed to the nature and origin of the unknown particles and whether they can eventually link gravity to quantum theory.

Abbreviations

LIGO Laser Interferometer Gravitational-Wave Observatory

Author Contributions

Willem Hulscher is the sole author. The author red and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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