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Asymmetric gravitational force

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ABSTRACT

Gravitational forces on gravitational mass particle in parallel gravitational field, changing in magnitude in direction perpendicular to the field direction, is studied. This field exerts asymmetric gravitational force on the particle which pushes the particle in perpendicular direction of the force resulting into the particle to follow a curved path. This behavior of the particle is similar to that of in gravitomagnetic field. Further motion of the particle in static curled gravitational field (circular gravitational field) is studied using concept of asymmetric gravitational force.

Key words: Maxwell's like gravitomagnetic equations, Asymmetric gravitational field, Asymmetric gravitational force, Virtual gravitational force

INTRODUCTION

The study of asymmetric electric force [1,2] have revealed few new aspects related to motion of electric particle in curled static electric field. However, curled static electric field may be produced by a steady current of magnetic monopoles. Appealing issue found in the study is that the particle moves in a curved path such as it is experiencing a virtual perpendicular force in addition to the usual force applied by the electric field. This additional force pushes the particle aside the trajectory that is impelled by the usual electric force to push the particle along the field direction. Such type of behavior of the particle is generally observed in static magnetic fields.

In this way the comparative study of asymmetric electric force and magnetic force is made. For that deferent parameters of the curled static electric field as well as that of the particle are considered for investigation. This study, first time, have been revealed that asymmetric electric force and magnetic force on an electrical charged particle have some common nature. It implies that observation of a curved path or a trajectory of an electrical particle does not mean that there is a magnetic field. In absence of magnetic field a curled static electric field, producing asymmetric electric field on the electric particle, can produce such trajectory.

Recent observations on many space probes launched in space for observations of planetary motions and for the study radiations in space including radiations by black holes too reveals that asymmetric gravitational fields and asymmetric gravitational forces do exist. Existence of Jupiter's asymmetric gravitational field is studied and reported in various literatures [3-8]. Similarly, the feasibility of asymmetric gravitational lenses using the lensing properties of asymmetric matter density distributions is being investigated [9-11].

Existence of asymmetric gravitational field causes to apply asymmetric gravitational force which impels for detailed theoretical study of asymmetric gravitational force. The cause of existence of asymmetric gravitational field, the force being produced on gravitational mass particle and the trajectory produced there with considering different parameters of the field as well as that of the particle are studied in this paper. Static asymmetric electric field having curled nature can be produced by steady current of magnetic monopoles. In similar way static gravitational field having asymmetric nature or curled nature can be produced by gravitomagnetic monopoles as long as theoretically, though such monopoles do not exist in universe. First theoretical equations are to be existed with such kind of monopoles with equation for forces on gravitational mass particle. Secondly curled gravitational field is to be produced using steady current of gravitomagnetic monopoles and finally by placing a mass particle in this field a theoretical investigation of motion of the particle with considering different parameters of the field as well as that of the particle is to be studied.

In next section, theoretical equations including gravitomagnetic monopoles required for study are setup. In preceding section, the actual investigation of motion of mass particle in asymmetric static gravitational field is made. Conclusions are drawn in the last section.

MAXWELL LIKE GRAVITOMAGNETIC FIELD EQUATIONS

The Maxwell-like gravitational field equations or gravitomagnetic equations [12-14] can be written as

$$\nabla \cdot \boldsymbol{G} = 4\pi\rho_g \quad (1a)$$

$$\nabla \cdot \boldsymbol{H_g} = 0 \quad (1b)$$

$$\nabla \times \boldsymbol{G} + \frac{1}{c_g}\frac{\partial \boldsymbol{H_g}}{\partial t} = 0 \quad (1c)$$

$$\nabla \times \boldsymbol{H_g} - \frac{1}{c_g}\frac{\partial \boldsymbol{G}}{\partial t} = \frac{4\pi}{c_g}\boldsymbol{j_g} \quad (1d)$$

where G, H_g are the gravitational vector field and gravitomagnetic vector field, ρ_g, j_g are the source mass density and the source mass current density respectively and c_g is the gravitational wave velocity. The gravitational force and gravitomagnetic force on a mass particle would be,

$$\boldsymbol{F} = m\left(\boldsymbol{G} + \frac{\boldsymbol{v}}{c_g} \times \boldsymbol{H_g}\right) \quad (2)$$

Where, v is the velocity of the particle.

However, these equations include only gravitational mass density and gravitational mass current as sources. They are not eligible to produce gravitational curled static field or asymmetric static gravitational field. For that a steady current of gravitomagnetic monopoles is essential which compels to generalize these equations.

$$\nabla \cdot \boldsymbol{G} = 4\pi\rho_g \quad (3a)$$

$$\nabla \cdot \boldsymbol{H_g} = 4\pi\rho_g{}^m \quad (2.3b)$$

$$\nabla \times \boldsymbol{G} + \frac{1}{c_g}\frac{\partial \boldsymbol{H_g}}{\partial t} = -\frac{4\pi}{c_g}\boldsymbol{j_g}{}^m \quad (3c)$$

$$\nabla \times \boldsymbol{H_g} - \frac{1}{c_g}\frac{\partial \boldsymbol{G}}{\partial t} = \frac{4\pi}{c_g}\boldsymbol{j_g} \quad (3d)$$

ρ_g^m, j_g^m are the source grvitomagnetic mass density and the source gravitomagnetic mass current density respectively.

The prior interest of our study is the motion of gravitational mass particle experiencing asymmetric gravitational force. Therefore, equation (2c) is significant and after all the static gravitational field makes the study easy. For steady gravitomagnetic current density, equation (2c) reduces to

$$\nabla \times \boldsymbol{G} = \frac{4\pi}{c_g} \boldsymbol{j_g}^m \quad (4)$$

Figure 1 illustrates the gravitational field produced by a straight and steady gravitmagnetic current I_g^m.

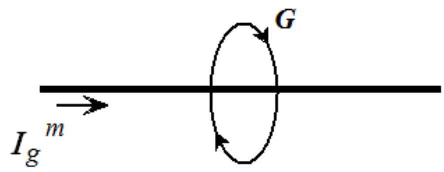

Fig. 1. Gravitational field of steady gravitomagnetic current.

This field is curled static gravitational field decreasing gradually away from the current in perpendicular direction. However one may consider such type of circular gravitation field with increasing magnitude in going away from its centre. The difference in motions observed in such two fields will reveal new knowledge of the dynamics. Before studying these two types of fields it is essential to study a parallel gravitational field which changes in magnitude in direction perpendicular to its polarization. It will provide basic understanding of the motion of particle with giving theoretical equations.

ASYMMETRIC GRAVITATIONAL FORCE

A theoretical static gravitational field, parallel to a particular axis, z-axis, varying in magnitude in perpendicular direction of the field may be described by

$$\boldsymbol{G} = \frac{\boldsymbol{k}G_0}{r} \quad (5)$$

where $r^2 = x^2 + y^2$.

For investigation, a gravitational mass particle is placed bearing mass m and initial velocity v parallel to z-axis (Fig. 3.1). Obviously, the field accelerates the particle with the force $\boldsymbol{F}$ specified by,

$$\mathrm{F} = m\mathrm{G}(r) \quad (6)$$

It produces instantaneous acceleration a along the force direction by

$$\mathrm{a} = \frac{\mathrm{F}}{m} \quad (7)$$

It candidly shows the particle is to be accelerated along the direction of force means along the field direction or parallel to the y-axis. If the particle is not of zero size the particle will not fallow the straight path but will be deflected towards the weak field since the field strength decreases away from the axis of centre of the field (y-axis). First we deal with a particle having a particular size and then we reduce the particle size to zero to become an ideal point particle.

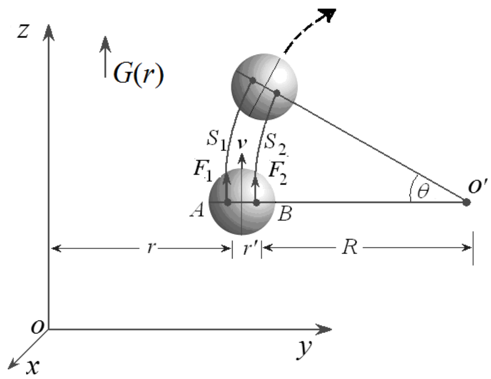

Fig. 2. A gravitational mass particle is placed in parallel gravitational field described by equation (5).

The particle placed in the hypothetical field (Fig. 2) may be considered as spherical in shape with radius r'. The force applied by the gravitational field on each unit mass of the particle is not same consequently the effective force is asymmetric about the line passing through centre of the particle and parallel to the field. Therefore, to accommodate effect of this asymmetry, a simple approach is to divide the particle into two hemispheres by a plane passing through its centre (Fig. 2) producing one hemisphere towards z-axis and other hemisphere away from that axis. The next step is to calculate centre of charge of each hemisphere. Obviously, for the subjected mass particle the distance between the two centres of charges is r'. The fields at these centres of masses of hemispheres 'A' and 'B' correspondingly are

$$G_1 = \frac{G_0}{r} \quad (8)$$

and $$G_2 = \frac{G_0}{r + r'} \quad (9)$$

The corresponding forces are

$$F_1 = \frac{m}{2} \frac{G_0}{r} \quad (10)$$

and $$F_2 = \frac{m}{2} \frac{G_0}{r + r'} \quad (11)$$

Corresponding accelerations are

$$a_1 = \frac{G_0}{r} \quad (12)$$

and $$a_2 = \frac{G_0}{r + r'} \quad (13)$$

Therefore, the distances covered by these hemispheres in very small time t are

$$S_1 = vt + \frac{1}{2} \frac{G_0}{r^n} t^2 \quad (14)$$

and $$S_2 = vt + \frac{1}{2} \frac{G_0}{r + r'} t^2 \quad (15)$$

Undoubtedly, when the particle gets displaced the field values and position of centres of masses vary implying equations (14) and (15) are not correct for long distances but still our aim is to find out the nature of the apparent force, existed because of the asymmetric nature of the real force, which pushes the particle in perpendicular direction of its path. In the analysis we assume S_1 and S_2 are very small.

From above equations, certainly, $S_1 \neq S_2$, implying the particle will start go along a curved path. Thus, while accelerating, the particle gets pushed away from the axis of centre of the field or into the weak field region. Therefore, radius of the curved path, which the particle starts to follow at the initial stage, is

$$R = \frac{r' S_2}{S_1 - S_2} \quad (16)$$

Equation (3.12) takes the form

$$S_1 - S_2 = \frac{1}{2} G_0 t^2 \left[\frac{1}{r} - \frac{1}{r + r'} \right]$$

or $$S_1 - S_2 = \frac{1}{2} G_0 t^2 \left[\frac{r'}{r(r + r')} \right] \quad (17)$$

Due to the unequal distances ($S_1 \neq S_2$) the particle as a whole follows a curved path. It turns away from z-axis or towards the weak field. The radius of the curved path followed by the particle at initial point is

$$R = \frac{r' S_2}{S_1 - S_2} = r \left(\frac{2v}{G_0 t} (r + r') + 1 \right) \quad (18)$$

Our aim of the work is to find out the effect of the asymmetric electric force on an infinitesimal small mass particle. For that the two poles of the considered particle must coincide on each other and form a single particle having mass m. This will happen when $r' \to 0$. At this time equation (18) reduces to

$$R = \frac{r' S_2}{S_1 - S_2} = r \left(\frac{2vr}{G_0 t} + 1 \right) \quad (19)$$

Indeed it is radius of a curved path followed by a single particle having mass m, with initial velocity v in the direction of the field and placed at distance r from the centre of the field described by equation (5). In this case the particle gets pushed in weak filed or away from z-axis referred to figure (2).

For zero initial velocity of the particle, the radius of the curved path surprisingly depends only on initial position of the particle. For this equation (19) gives,

$$R = r \quad (20)$$

If the mass particle has initial velocity in opposite direction of the field then the radius of the curved path becomes

$$R = \frac{r' S_1}{S_2 - S_1} = r \left(\frac{2rv}{G_0 t} - 1 \right) \quad (21)$$

In this case the particle gets pushed in strong filed or towards z-axis referred to figure (2).

For zero initial velocity of the particle, the radius of the curved path ion magnitude goes with equation (20).

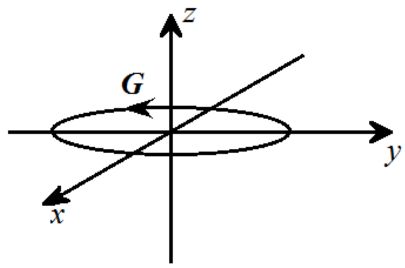

Fig. 3. Curled static gravitational field.

It is of important to look for the motion of the mass particle in a curled electric field provide by equation (3c). Such type of gravitational field may be constructed by

$$\mathbf{G}(\mathbf{r}) = \mathbf{G}_0 \frac{\mathbf{k} \times \mathbf{r}}{r^2} \quad (22)$$

where $\mathbf{r} = \mathbf{i}x + \mathbf{j}y$.

This field, represented by figure (3), gradually decreases away from its centre. Allowing a gravitational mass particle to go along +ve direction of y-axis and examining the fields and forces on the particle while on its journey at three places, as indicated by 1, 2 and 3, the particle gets pushed in weak field as shown in figure 4. This deflection of the particle seems to be usual.

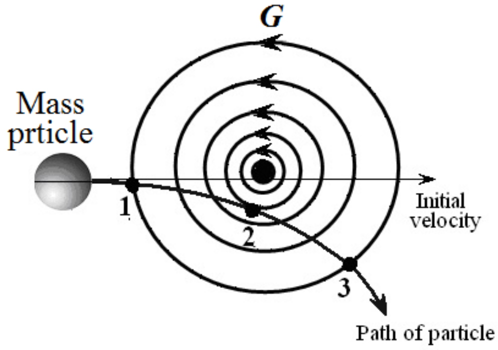

Fig. 4. Motion of a gravitational mass particle in a circular gravitational field decreasing in magnitude away from centre.

However by considering the gravitational field defined by equation (23) the motion followed by the particle is completely different as indicated in figure (5).

$$\boldsymbol{G}(\boldsymbol{r}) = G_0(\boldsymbol{k} \times \boldsymbol{r}) \qquad (23)$$

By examining the fields and forces on the particle at the three places as above, the deflection of the particle along –ve direction of x-axis is acceptable. The deflections of the particle in figure (4) and in figure (5) are mirror images of each other. In which direction the field strength increases, and vice versa, is significant.

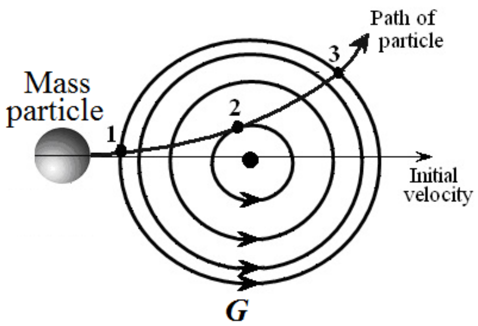

Fig. 5. Motion of a gravitational mass particle in a circular gravitational field increasing in magnitude away from centre.

CONCLUSIONS

Last few decades, asymmetric fields and asymmetric forces have attracted attention of researchers as a consequence of space probes launched for outer planets observations might be experiencing asymmetric gravitational forces. Consequence of that a theoretical study of existence of asymmetric and curled gravitational fields and asymmetric gravitational forces produced by them became mandatory. Theoretical study, carried in this research, reveals that the mass particle gets pushed in perpendicular direction of the actual force because of its asymmetry. The contribution of the virtual force pushing the particle aside from its trajectory depends upon the rate at which the magnitude of the field changes with distance in perpendicular direction of the field. Further, if the initial velocity of the particle is in direction of the force and hence the field, the particle gets pushed into the region where the field becomes weaker and weaker in magnitude. On the other hand, if initial velocity of the particle is in opposite direction of the field, the particle gets pushed into the region where the field becomes stronger and stronger in magnitude. This can be clearly observed in a parallel gravitational field whose magnitude is changing in perpendicular direction of the field. If the field is circular, represented in figure 4, once again the particle acquires a curved path. Surprisingly, the paths acquired by the particle in circular fields, one's magnitude decreasing away from its centre (Fig. 4) and other's magnitude increasing away from its centre (Fig. 5), are opposite (mirror images) of each other. We expect that these results may provide significant contribution in theoretical study of asymmetric field-forces.

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