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The Second Order Term in the Linearized Theory of General Relativity, Dark Matter and Related Cosmological Mysteries

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ABSTRACT

The blackhole jets, Saturn ring, dark matter and GPB anomaly are generally considered unrelated physical mysteries that have no common causes that create them. In Newtonian mechanics, the center of mass of an object change only when there is an external force applied to the object. However, the longitudinally asymmetric and radially circular (LARC) rotating objects like cone, funnel, and hemisphere have a unique mechanical property of creating a finite shift of relativistic center of mass depending on the speed of the rotation due to the difference in the instant speed of the individual mass components of the object while in rotation (Jeong, 1996). This suggests that the LARC rotating object has a complex mechanical property that does not obey the conventional Newtonian mechanical principle. It turned out that in the weak field limit of general relativity there is a second order mathematical term that requires a finite shift of the center of mass to establish its physicality. This term was discarded as physically meaningless because spherical source does not develop a shift of the center of mass even in rotation due to the mathematical cancelation. It is shown that the relativistic shift of the center of mass from the rotating LARC object is the cause of the physically meaningful dipole gravity that reduces into Lense-Thirring force at the center of the rotating spherical shell. However, after careful examination we found out that the signs of Lense-Thirring forces were reversed and once the signs are corrected, dipole gravity predicts blackhole jets and the flat rotational velocity distribution curve which is the key evidence of the existence of the dark matter. We presented that the rings in Saturn, Jupiter, Neptune and Uranus, the GPB experimental anomaly are also the results of dipole gravity from the rotating spherical sources.

Keywords: Linearized theory of general relativity- dynamic shift of the center of mass- dark matter-flat galactic rotational velocity distribution curve-Saturn ring-GPB experiment-dipole gravity-Lense-Thirring force

INTRODUCTION

The center of mass of a physical object plays an important role in Newtonian mechanics as the practical location of the object in space for the purpose of describing the object's trajectory despite its extended structure. Sphere has been universally chosen for the source of gravity for both in Newtonian mechanics and general relativity because of its simplicity in the center of mass which can be placed at the center of the coordinate system.

Even if the object is not of spherical form, there is a well-defined unique spatial coordinate that determines exactly where the center of mass is located and the center of the coordinate system can always be moved to the center of mass of the object without the loss of generality. On the other hand, in Newtonian mechanics, it takes two steps of operation to move the location of the center of mass of an object from one place to another. First there must be an external force to initiate the movement of the object and second there must be another external force to stop the movement after having created the momentum to start the movement according to the first and second laws of Newtonian mechanics (Ozawa, 2022).

However, we have the unusual case where the LARC rotating object changes its dynamic center of mass without an external force only by the spin rotation due to the special relativistic mass increase effect. Even if initiating the spinning motion is considered an external force, the direction of the shift of the center of mass and the spin initiating action are perpendicular to each other and as such the two are not related in Newtonian mechanical principle of motion. Therefore, the LARC rotating objects represent a special mechanical system where the principle of relativity violates Newtonian mechanical principle and vice versa. Also, even though the relativistic mass is not exactly the same as the rest mass of the object, the well-established mass-energy equivalence principle in relativity theory (Einstein Albert, 1905) indicates that this is an extraordinary mechanical system that needs to be investigated in detail.

Assuming that the relativistic shift of the center of mass is caused by the reaction from the rest of the universe to equalize the effective location of the rotating hemisphere to the new center of mass, the LARC rotating object must be under the influence of the unknown external force initiated by the universe trying to balance the gravitational equilibrium according to Mach's principle (Mach, 1960) which states "local physical laws are determined by the large-scale structure of the universe".

And this force will be continuous because the displacement of the center of mass inside the rotating hemisphere stays the same due to the angular momentum conservation. By the time the rest state center of mass moved toward the shifted dynamic center of mass, the new dynamic center of mass has already moved further ahead.

Despite the constant movement of the rotating hemisphere trying to compensate the offset center of mass, the shifted center of mass persists and does not return to zero. Because of this, the most likely scenario is that the rotating hemisphere will continuously accelerate toward the direction of the flat side of the hemisphere to where the center of mass is shifted. This means there is an unknown dynamic gravity field created by the rotating LARC object which is repulsive at the narrow side and attractive on the wider side.

The gravity field lines in the case of the rotating hemisphere come out of the domed side and enter the flat side like the magnetic field lines.

The question here is if this interpretation of the mechanical consequences of the relativistic shift of the center of mass from the LARC object is consistent with general relativity in its mathematical presentation.

And if so, what would it predict regarding the matter distribution around the rotating blackhole when the full gravitational field produced by the rotational motion of the spherical source in general relativity (Einstein, 1915) is taken into account?

THE SECOND ORDER TERM IN GENERAL RELATIVITY, RELATIVISTIC SHIFT OF THE CENTER OF MASS AND LENSE-THIRRING FORCE

According to the traditional presentation of general relativity in the book "Gravitation" in the weak field limit for a slowly rotating spherical source, dipole gravitational moment appears as the second order term in the following mathematical expression (Misner, Thorne, & Wheeler, 1973),

$$\Phi = -\left[\frac{M}{r} + \frac{d_j n^j}{r^2} + \frac{3f_{jk}n^j n^k}{2r^3} + \cdots\right], \text{ where } n^j = x^j/\mathrm{r} \quad (1)$$

where M is the total mass-energy which is responsible for the active gravitational field and d_j is dipole moment which, depending on how one chooses the origin of the coordinates, can be made to zero, and f_{jk} is the reduced quadrupole moment.

On the other hand, from the perspective of the dynamical shift of the center of mass, d_j/M is a vector quantity that defines the direction and the physical length of the change of the center of mass due to the rotational motion of the source from the center.

And $n^j = x^j/\mathrm{r}$ is a vector quantity defines the direction at any point in the coordinate system from the origin. The scalar product of d_j and $n^j = x^j/\mathrm{r}$ defines the magnitude of the strength of the field created by this particular gravitational effect. When the LARC object is placed upright position with the wider side up with its stationary center of mass positioned at the origin of the coordinate system, the dynamic shift of the center of mass occurs toward the positive Z direction, which simplifies the mathematical analysis of this particular interaction. The importance of this second order term is in the fact that its strength is strong only next to Newtonian. Shifting the origin of the coordinate toward the new dynamical center of mass does not change the dynamics of the system because there is still the separation of the center of mass between the two, the one static and the other dynamic.

The fundamental principle of Newtonian mechanics is that the center of mass of an object does not change unless there is an external force acting upon it. By choosing the sphere as the source by default in the weak field limit, the deciphering process of general relativity has automatically excluded the possibility that there may be a case that the center of mass may change dynamically due to the rotational motion.

When the sphere is employed as the source, there is no relativistic shift of the center of mass due to the symmetry of the sphere since the dynamic shift of the center of mass from the two oppositely oriented hemispheres cancels each other. The choice of the origin of the coordinate system does not affect the dynamics of the system other than the convenience of the mathematical calculation. Therefore, when only the translation of the coordinate system is taken into account, there is no displacement of center of mass that can establish a physically meaningful dipole gravity from the rotating spherical source. As such, it was concluded from the beginning that gravitational dipole moment does not exist in the weak field limit of general relativity (Misner et al., 1973).

Years later, von Laue (Von Laue, 1921) presented an argument against the existence of rigid body in relativity theory. His point of view is consistent with the fact that the finite internal binding force of the material cannot withstand the infinite effective mass when the object rotates fast so that the rotational velocity at the outer rim reaches the speed of light. However, apart from the presentation by Weinstein (Weinstein, 1971) and Phipps (Phipps Jr, 1974) that demonstrated rigid body can exist in relativity theory, rigidity is considered a relative concept of a solid object because at room temperature environment, the rotating body is rigid until the centrifugal force exceeds the particular binding force of the material. Even in the case of ultra-fast rotation, as long as the centrifugal force is not strong enough to break the internal binding force of the material whether it is metallic, molecular or nuclear origin, the object preserves its form and remains solid. And the relativistic mass increase takes effect as soon as the object starts rotating however slow it may be, and so is the shift of the center of mass in case of the rotating LARC objects.

Therefore, it is concluded that the phenomenon of the physically meaningful dipole gravitational moment exists regardless of the question if rigid body can exist or not in relativity theory. In fact, Lense-Thirring (Lense & Thirring, 1918) employed the rotating coordinate system in their calculation of the rotation induced general relativistic dynamical force. Their method of calculation technically bypassed the question on the rigidity of the source located at the center of the coordinate system. The center of mass of the half of the spherical shell of radius R placed flat side up below the equatorial plane of the spherical coordinate system shifts from $\vec{r_0} = (0,0,-\frac{R}{2})$ to $\vec{r_c} = (0,0,r_c)$, where r_c is given by (Jeong, 1996),

$$r_c = \frac{-R\frac{1-\sqrt{1-\alpha}}{\alpha}}{\sqrt{\frac{1}{\alpha}} sinh^{-1}\sqrt{\frac{\alpha}{1-\alpha}}} \quad (2)$$

where

$$\alpha = \frac{\omega^2 R^2}{c^2}$$

When the speed of the rotational frequency is slow $\omega R \ll c$ in nonrelativistic regime, the shift of the center of mass is approximated to be

$$\delta r_c = \frac{\omega^2 R^3}{24c^2} \quad (3)$$

The gravity potential including dipole gravity from the slowly rotating hemispherical shell placed in a bowl configuration in spherical coordinate system is given by

$$\Phi = -\frac{M}{r} - \frac{d_z}{r^2} cos\theta + O(\frac{1}{r^3}) \quad (4)$$

where

$$d_z = M\delta r_c = M\frac{\omega^2 R^3}{24c^2} \quad (5)$$

and the origin of the coordinate is located at the center of mass of the hemisphere which is in the middle between the pole and the center of the full sphere. The full gravity potential from the rotating spherical shell which consists of the two oppositely oriented rotating hemispheres is given by (Jeong, 1999).

$$\Phi = -\frac{M}{r} - \frac{\frac{d_z}{2}}{\left|-\left(\frac{R}{2}\right)\hat{z} - \bar{r}\right|^2} cos\theta' + \frac{\frac{d_z}{2}}{\left|\left(\frac{R}{2}\right)\hat{z} - \bar{r}\right|^2} cos\theta" + O(1/r^3) \quad (6)$$

where

$$\theta' = tan^{-1}\left[\frac{rsin\theta}{rcos\theta + R/2}\right] \quad , \quad \theta" = tan^{-1}\left[\frac{rsin\theta}{rcos\theta - R/2}\right] \quad (7)$$

There is non-zero dipole gravity field from the rotating sphere despite the opposite orientation of the two hemispheres due to the fact that the centers of mass of the two hemispheres are separated by the distance R. There are two repulsive dipole gravity poles, one at the North and the other at South and two attractive poles near the center in the rotating sphere independent of Newtonian gravity.

In the limit of low speed of rotation, dipole gravity force from the rotating spherical shell in Cartesian coordinate system is given by in the form of the equation of the motion

$$\begin{aligned} \ddot{x} &= -\frac{2M}{R}\omega^2 x \\ \ddot{y} &= -\frac{2M}{R}\omega^2 y \\ \ddot{z} &= \frac{4M}{R}\omega^2 z \end{aligned} \quad (8)$$

On the other hand, the Lense-Thirring force (Lense & Thirring, 1918) from the slowly rotating spherical shell was calculated to be,

$$\begin{aligned} \ddot{x} &= \frac{M}{3R}(\frac{4}{5}\omega^2 x - 8\omega^2 v_y) \\ \ddot{y} &= \frac{M}{3R}(\frac{4}{5}\omega^2 y + 8\omega^2 v_x) \\ \ddot{z} &= -\frac{8M}{15R}\omega^2 z \end{aligned} \quad (9)$$

which includes the velocity dependent Coriolis force. Besides the tangential velocity-dependent Coriolis force, dipole gravity force (7) from the rotating spherical shell is identical to Lense-Thirring force (8) within the multiplication factor $-\frac{2}{15}$. The signs of the Lense-Thirring force indicate the radial component of the force is repulsive and the axial directional force is attractive.

The repulsive radial component of Lense-Thirring force is consistent with the interpretation of the centrifugal force originally suggested by Einstein. The problem with this sign designation is that there is no physical interpretation of the attractive Z directional force which is left unassigned once the repulsive radial components of the force is interpreted as the centrifugal force since the axial and the radial components of Lense-Thirring forces always appear in pairs since they originate from the same mathematical representation.

SIGN CONTROVERSY IN LENSE-THIRRING FORCE

Cohen and Sarill (J. M. Cohen & SARILL, 1970) discussed the centrifugal force component of Lense-Thirring force earlier and suggested that it must be from quadrupole effect. Bass and Pirani (Bass, Pirani, Magazine, & Science, 1955) also presented a similar argument regarding the origin of the radial component of Lense-Thirring force as due to the latitude angular dependency of the velocity of the rotating spherical shell. There were questions regarding the validity of the interpretation of the radial component of Lense-Thirring force as the centrifugal force. However, since Lense-Thirring forces was identified as being originated from dipole gravity by the identical mathematical structure except the constant multiplication factor, there were no reasons to question the validity of the original signs of Lense-Thirring forces which was approved by Einstein, and it was presented that dipole gravity produced Lense-Thirring force including the signs.

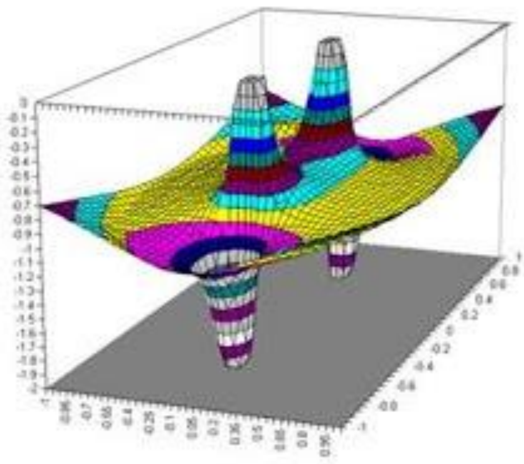

Fig. 1. Dipole gravity potential from rotating sphere with reversed polarity: four poles are aligned along the rotation axis with the saddle point located at the center

However, it became obvious that the adopted signs from Lense-Thirring force for dipole gravity are not compatible with other cosmological problems except for the observed anomalous red shift that doesn't require the accurate designation of the direction of the force originated from dipole gravity.
After the publication of the first paper (Jeong, 1999) we found that dipole gravity the way it was formulated cannot explain other cosmological problems like jets and dark matter problem. As a new force of gravity, one would expect that it should be able to explain certain other cosmological problems.
To elucidate the problem in detail, once the signs of Lense-Thirring force (9) are adopted for dipole gravity, the gravity potential (6) is represented by the potential diagram shown above in Fig 1, where two sets of dipole gravity potentials are aligned along the Z axis face to face.
As Cohen and Sarill (Lense & Thirring, 1918) have suggested earlier, Lense-Thirring force came out of the quadrupole field configuration along the axis of the rotating spherical shell as shown in Fig.1 and Fig.2.
Incidentally, there were no additional reports of the studies on Lense-Thirring force in the literature after Cohen, Sarill and Vishveshwara (J. M. Cohen, Sarill, & Vishveshwara, 1982) questioned the centrifugal force origin of the radial component of Lense-Thirring force and claimed that it must be originated from the quadrupole effect.
The saddle potential at the center of Fig. 2 represents Lense-Thirring force and its sign representation where the potential indicates downward (repulsive) equatorial force and upward (attractive) longitudinal directional force.
The integral equation set forth by Lense-Thirring using the rotating coordinate model to find the gravity field created by the rotating spherical shell cannot be solved except near the center of the sphere due to the mathematical divergence problem.
This drawback resulted in the ambiguity of the detailed structure of the rotation induced gravity field far from the center inside and out of the rotating spherical shell and especially the question on where this force was originated from.

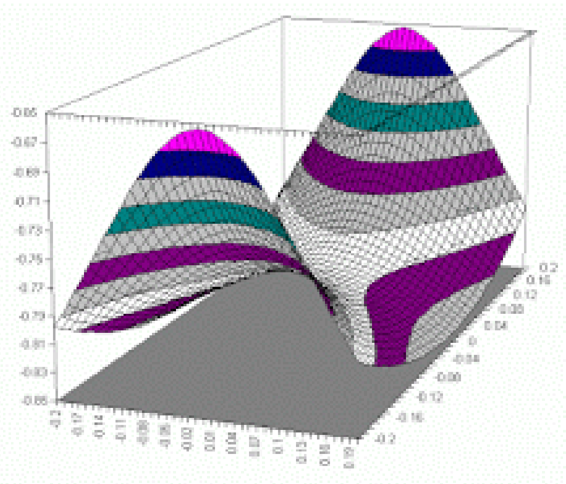

Fig. 2. Magnified saddle potential of reversed polarity from rotating source representing Lense-Thirring force

As such, the true cause of Lense-Thirring force (Lense & Thirring, 1918) remained a mystery since their study was first published in 1918. Bass and Pirani (Bass et al., 1955) discussed the possible origin of Lense-Thirring force from the latitude dependent velocity distribution of the rotating sphere. Pietronero (Pietronero, 1973) and Cohen, Sarill and Vishveshwara (J. M. Cohen et al., 1982) proposed that the origin of the centrifugal force in Lense-Thirring force must be from a quadrupole gravity effect.
In fact, the two oppositely superposed dipole gravitational fields display a single quadrupole field represented by the four poles inside the rotating sphere as shown in Fig.1. However, dipole gravity potential with the adopted signs from Lense-Thirring force shown in Fig. 1 is strongly attractive at the poles, which does not have an application for known cosmological problems especially for the jets from the blackholes.
On the other hand, viewed from the fundamental principle of mechanics, the fact that the dynamical center of mass shifts toward the flat side of the rotating hemisphere indicates there is an unbiased effort by the rest of the universe trying to balance the equilibrium of the center of gravity of the rotating hemisphere toward the direction of the flat side. This point of view is consistent with the idea of Mach's principle (Mach, 1960) which states "local physical laws are determined by the large-scale structure of the universe". It also means the force experienced by a test object placed at the dome side of the rotating hemisphere is repulsive and attractive on the flat side originating from the shift of the center of mass due to the velocity dependent relativistic mass increase effect.
Another way to view the problem is by questioning what change of the force of gravity a test body would experience outside the spherical shell in the horizontal plane when the sphere starts rotating. The first order change of the force will

be toward the center of the sphere because the rotational kinetic energy increases the total mass-energy of the spherical shell. Therefore, the rotation induced gravity force at the horizontal plane from outside must be attractive toward the center.

On the other hand, the constant change of linear momentum of the mass attached at the end of the string in circular motion creates the centrifugal force which is an outgoing force which does not have the latitude angular dependency based on the analysis of the rotating spherical shell presented by Cohen et al (J. M. Cohen et al., 1982) which indicates that the centrifugal force has no relation to the physical origin of the Lense-Thirring force.

Therefore, we conclude that the signs of Lense-Thirring force are reversed and once dipole gravity has its original signs (6) (7) recovered, we have the full double dipole gravity fields from the rotating sphere 180 degree turned from the one shown in Fig 1.

Now the two repulsive poles are located at the north and south pole of the rotating sphere and the two attractive ones at the center of the horizontal plane that pulls back the matter particles toward the center and then repel particles from the poles because dipole gravity field lines from the two rotating hemispheres have closed loops like magnetic field lines. The equatorial plane of the rotating galaxy becomes a stable resting place where the matter particles that came out of the both poles have time to merge together and start nuclear-synthesis to generate heat, light and form planetary systems. This is caused by the latitude angular component of dipole gravity from the two rotating hemispheres cancels at the equatorial plane and form a narrow potential dip around the circumference.

The repulsive dipole gravity at the poles of the rotating source also indicates the galaxy with a rotating blackhole at the center is not planar shape but the full space is filled with flying matter particles of limited sizes. These flying matter particles are not visible by telescope since they do not have enough mass to start nuclear fusion to produce lights.

MATTER DISTRIBUTION DUE TO THE JETS, ACCRETION DISC, FLAT ROTATIONAL VELOCITY DISTRIBUTION CURVE AND DARK MATTER PROBLEM

The Newtonian central gravity potential created by the matter distribution $\rho(r)$ caused by the ejected matter particles from the both poles of the rotating blackhole at the center of the rotational galaxy is given by in differential form,

$$dV(r) = \frac{\rho(r)}{r} 4\pi r^2 dr \qquad (10)$$

where $\rho(r)$ is the matter density distribution along the radius of the galaxy from the center. The trajectory of these particles follows dipole gravity field lines which are similar to the magnetic flux lines. The matter flux coming out of the both poles of the black hole take large loop in space until they reach the horizontal galactic plane. And the range of the matter flux is not infinite but it has certain range depending on the initial kinetic energy they carried off of the rotating black hole at the center of the galaxy. In the range from the radius of the blackhole to the far outreach of the galaxy, the matter flux distribution will be close to being originated from narrowly positioned two-point sources going outward in all spherical directions. Therefore, the matter flux density times the spherical area $\rho(r)4\pi r^2$ must be a constant

$$\rho(r)4\pi r^2 = const \qquad (11)$$

The gravitational potential created by this matter distribution is given by

$$V(r) = \int \frac{\rho(r)}{r} 4\pi r^2 dr = \int \frac{const}{r} dr = const \times \ln(r) \qquad (12)$$

Logarithmic gravity potential is known to produce flat rotational velocity distribution (Navarro, 1996) curve which is observed in the rotating galaxies. The strong radial dipole gravity dominates the gravitational force at the short distance r from the center but outside of the blackhole which is given by

$$F_{dipole-radial} = \frac{-3M\delta r_c R}{2r^4} \qquad (13)$$

in the range $r > R$, where M is the mass and R is the radius of the rotating source and δr_c is the relativistic shift of the center of mass from the half of the sphere. The radial component of dipole gravity force depends on $\frac{1}{r^4}$ instead of $\frac{1}{r^3}$ due to the contribution from the latitude angular dependent component of dipole gravity.

This explains the sharply rising slope of the rotational velocity distribution curve near the galactic center. The Coriolis force provides the velocity dependent force in the tangential direction which contributes to the strong spiraling effect of the accretion disk near the galactic center.

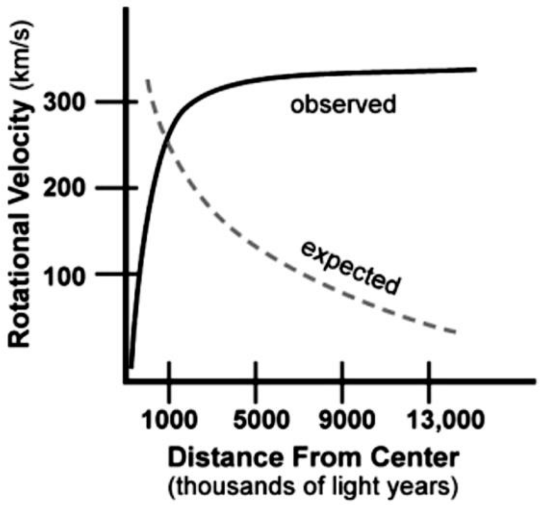

Fig. 3. Flat Rotational Velocity Distribution Curve *Courtesy of Dr. Greg Bothun* (Bothun, 1998)

The fundamental mystery of the dark matter problem was "what causes the flat rotational velocity distribution curves observed from the rotating galaxies?" and "where are all the matter particles that contribute to this effect?"(Navarro, 1996). The matters distributed along the equatorial plane follow the same pattern of decreasing mass density as the distance increases from the center which follows the same logarithmic potential that results in the flat rotational velocity distribution curve shown in Fig. 3.

After all, this analysis indicates that the missing dark matter is scattered all over the galaxy in the form of the matter particle flux originated from the center of the blackhole. They are not visible because they do not emit light due to their limited mass that is not large enough to start nuclear fusion.

The range of the flat rotational velocity distribution curve does not stretch to infinity as has been confirmed by the researchers in the field. This is because the flying matter has limited kinetic energy in such a way that their trajectory does not stretch to infinity and also it does not end abruptly at the edge of the galaxy due to the thermodynamic property of the initial kinetic energy that carried by the matter particles ejected from the blackhole.

HEAVY ATOMIC ELEMENT CREATION AND WOBBLING BLACKHOLE

The long stretch of light display observed from the rotating galaxy is attributed to the collision between the outgoing and the incoming matter objects toward the center along the rotation axis that is causing the massive firework. This happens because the initial kinetic energy given to the matter ejected from the center of the blackhole limited as shown in the dipole gravity potential well between $R/2$ and R along the rotation axis.

The dipole gravity potential diagram in Fig. 4 is a side view along the Z axis of the rotating sphere. The matter objects in the galactic plane are pulled into the center through the accretion disk of the horizontal plane which is vertical to the Z direction in Fig 4. The height of the wall of the dipole gravity potential well goes higher as the speed of the rotation of the black hole increases. The enormous compression of the matter objects in this process creates heavy atomic elements which are ready to be distributed throughout the galaxy.

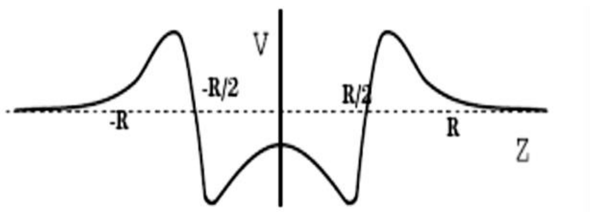

Fig. 4. Z directional component of dipole gravity potential from the rotating spherical source. The potential shows the matter particles are repelled toward both the N and S poles of the rotating source

Once the dipole gravity potential well is filled up with matter particles there are two points of the peak potential as shown in Fig. 4 where the attractive Newtonian gravity cannot fully contain the molten matter particles and this is the point where the matter objects start spilling over. The spilt over molten matter objects due to high compression are being pushed down the steep potential well along the two opposite poles of the blackhole.

The sudden release of the pressure makes this molten matter objects to change its phase into fragmented particle states of matter. This is the mechanism that shows how the matter objects are capable of coming out of the rotating blackhole at the galactic center based on the principle of the dynamic gravitational dipole moment. The matter objects went out straight up along the Z axis come back once the initial kinetic energy obtained from the repulsive dipole gravity reaches the level of the central gravity potential at far distance r since the strength of dipole gravity falls off rapidly as the distance increases.

The collision between the incoming and outgoing matter objects along the rotation axis of the black hole is inevitable and they produce enormous light show which is observed as blackhole jets. The ejected matter particles that did not go out straight line will follow the dipole gravity field lines in the galactic space drawing the dipole field curve until they arrive at the galactic plane where they meet other particles ejected from the opposite pole of the blackhole. After a certain period of oscillation back and forth centering on the horizontal galactic plane and losing kinetic energy, the matter particles settle down and the clusters form individual planetary systems. However, if the axis of the rotating blackhole wobbles because of the additional off the axis angular momentum, there is a chance that visible jets may not be formed because the incoming and outgoing matter objects can avoid collision along the rotation axis.

Even if this is the case, the rotating galaxy with the wobbling axis still ejects matter particles and they manifest the same dark matter problem because the absence of visible jets only means the longitudinal polar orbit is not stationary due to the wobbling effect.

GALACTIC PLANE, RINGS IN SATURN, JUPITER AND URANUS

Aside from the blackhole, fast rotating planets also create dipole gravity field that is not strong enough to produce jets but have appreciable strength of the angular component of dipole gravity potential which creates a dip in the horizontal plane of the rotation that catches the flyby satellite matter objects and harbor them for long period of time which are observed as rings. Rings have been observed in Saturn, Jupiter, Uranus, and Neptune in our solar system. The two angular components of the oppositely oriented dipole gravity fields cancel each other in the horizontal plane of the rotating planet where the matter objects including ice particles tend to settle down. The formation of the hexagonal pattern at the poles of Saturn indicates that while the planet does not have jets, the repulsive dipole gravity effect is not entirely negligible at the poles relative to the Newtonian central gravity which allows the matter objects on the ground of the poles to slide around like fluid influenced by the centrifugal force to form the specific geometrical pattern.

GPB ANOMALY AND FIGURE 8 LISSAJOUS CURVE

The GPB gyros (Xiao et al., 1991) are oriented to point the star located at the far distance from the earth. The satellite is circling around the polar orbit from North to South Pole of the earth. They reported the reversal of the direction of the precession of the gyros when the satellite passes the equatorial plane.

As presented above, the half of the rotating Earth constitutes a gravitational dipole moment and therefore, there are two dipole moments superposed in opposite direction on the way of the satellite from North to South Pole.

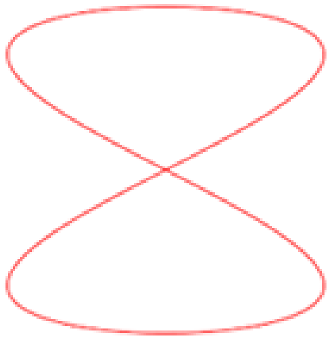

Fig 5. Figure 8 (2 x 1) Lissajous Curve

Since the axis of the gyro points to the remote star, the magnitude of the force causing the precession changes every the 1/4th (90 degree) revolution of the craft and the latitude angular component of dipole gravity force of the earth changes its direction after the craft crosses over the equator for the next 1/4th (90 degree) revolution up to the south pole.

Therefore, there is a 2 to 1 ratio of the period of the force influencing the precession of the gyro, i.e., the direction of the force on the gyro changes along the latitude angle (from zero to 180 degree) as shown in Fig 5. On the other hand, the frame dragging force along the direction of the motion of the surface of the earth does not change its direction in half of the revolution of the space craft around the path from North to the South Pole. In such case, the precession of the gyro would be circular (1x1 Lissajous Curve).

Lissajous curve cannot be closed unless the ratio $a \times b$ is an integer multiple (C. E. Cohen, Keiser, Parkinson, & dynamics, 1992). The observed closed 2×1 Lissajous curve is unique and it is not likely that this type of precession can be caused by random electrostatic patch effect (Everitt et al., 2011). Consistent closed looped Lissajous curves from the three separate gyros as shown in (Stanford University, 2004) indicate that there are no significant systematic errors due to the electrostatic patch effect. The point of the change of the curvature from right-handed to left-handed rotation in the Lissajous curve coincides with the point where the latitude angular dependent dipole gravity force reverses its direction at the horizontal plane.

According to the report, it also happened that the detected precession effect from the gyros was much larger than the originally expected according to the prediction of the gravitomagnetic frame dragging effect. The three videos of the gyro motion published by NASA (Stanford University, 2004) indicates that the original rotational speed of the gyro was reduced in the second and third experiment case as shown in the videos since the Lissajous curve of the first one was very large and almost out of the scale. The consistent figure number 8 of the gyro's movement in all three cases indicates that there was not much of random electrostatic patch effect but the experiment was a clear manifestation of the oppositely superposed second order effect in the linearized theory of general relativity originating from the rotating Earth.

CONCLUSION

We presented the case that the relativistic shift of the center of mass from the rotating LARC object creates dipole gravity field in the weak field limit of general relativity based on the mathematical presentation associated with Lense-Thirring force. The typical forms of the source that creates a single dipole gravity effect are hemisphere, cone and funnel which may be called monotonic LARC objects due to the uniform directional slope unlike the sphere that has two oppositely oriented slopes in the longitudinal direction. As such, rotating uniform cylinder does not create dipole gravity field due to the absence of the longitudinal curvature. The strong central gravity tends to force the stellar or planetary objects to become spherical and essentially this is the cause of the oppositely faced double dipole gravity field from the rotating spherical source. If any single LARC astronomical object in the universe rotates fast, it will cause the effect reminiscent to the anomalous red shift as observed in astronomy. The dipole gravity force lines resemble the magnetic field lines and this force is the cause of the blackhole jets and the dark matter problem in cosmology when two oppositely oriented dipoles are in action at the center of the galaxy. The thin rings observed around the fast-rotating planets Saturn, Jupiter, Uranus and Neptune in the solar system are due to the two oppositely positioned latitude angular dependent dipole gravity fields from the spherical source that cancel at the horizontal plane which creates narrow potential dip around the equatorial plane of the fast-rotating planets.

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