the general science journal

# On the Variability of the Gravitational Constant by the Evolution of Stars and Galaxy Clusters

Thierry De Mees
Independent researcher
thierrydemees @ telenet.be

Gravitomagnetism, initiated by O. Heaviside [1] and further developed by O. Jefimenko [2] consists of the Newtonian gravity and *gyrotation*, which is totally analogous to magnetism. This model successfully explained an important number of physical and cosmic phenomena [3]. Striking is the possibility of gravitational repel by particles with like-oriented spins. I also showed [5] why the gravitational constant is varying locally and I prove that, the particles in rotating bodies will preferentially form distributions that globally attract. This explains why masses have never been found to be repulsive. I deduced a new definition for "mass" as a vector, and conclude that the gravitational constant's value is the sum of the orientations of the elementary vector-masses while taking their spacing into account. I found why the gravity force is so weak and why cohesion forces are so large.

In this paper, I attempt to define the variations of the Gravitational Constant in the evolution of stars, and show that, for the same global mass of a star during its evolution, white dwarfs possess a much stronger gravitational constant than the red giant stars. Based upon these findings, I study the possibility that relaxed galaxy clusters possess, due to the same process, a much lower gravitational constant than unrelaxed galaxy clusters. This might be the reason why gravity lensing is a hundred times larger than the visible mass.

**Keywords:** gravitomagnetism, gravitational constant, sun, white dwarf, red giant, galaxy clusters: relaxed, unrelaxed

## 1. The basics of Gravitomagnetism

In 1893, O. Heaviside, the scientist who reduced the 20 Maxwell equations to four, and found the transmission theory of waves through wires, laying at the basis of modern computer chips, deduced the second gravity field due to motion [1]. This was further developed by O. Jefimenko in several books [2].

Rotation and the motion of bodies create fields and forces in addition to the Newtonian gravity. Jefimenko calls that second field co-gravitation, while I call it *gyrotation* [3]. It is the 'magnetic'-analogue in gravitomagnetism, responsible for the flatness of our solar system and of our Milky Way as well as its prograde velocity curve. It explains the hourglass shape of some supernovae as well.

I found the equations for *gyrotation* $\vec{\Omega}$ [3] (dimensions of Hz) due to the motion and the rotation of masses. The properties of this field suffice to explain the inflation of rotating bodies.

The external gyrotation field of a spinning sphere is given by Eq. (1) and is represented in Fig. 1, wherein $\vec{\omega}$ is the spin velocity of the object, $\vec{r}$ the first polar coordinate, $\vec{\omega}\bullet\vec{r}$ a scalar vector product, equal to $r\,\omega\cos\alpha$ with $\alpha$ the second polar coordinate ($\alpha = 0$ at the equator), $R$ the radius of the object and $m$ its mass.

$$\vec{\Omega}_{\text{ext}} \Leftarrow -\frac{G\,m\,R^2}{5c^2\,r^3}\left(\vec{\omega} - \frac{3\vec{r}\,(\vec{\omega}\bullet\vec{r}\,)}{r^2}\right) \qquad (r \geq R) \qquad (1)$$

Eq. (1) can be found analogically to the calculation of the magnetic field of an electric dipole (a closed current loop), where the magnetic field is replaced by the gyrotation field and the electric charge by mass [3].

The analogy with electromagnetism is fully valid, and the Lorentz-like force for gravity $\vec{F}_{\Omega}$ is applicable for a body with mass $m_2$ that travels or rotates in the gyrotation field $\vec{\Omega}$ of the spinning mass $m$.

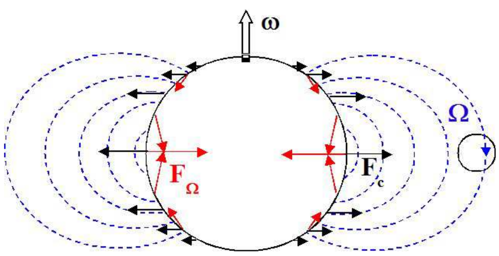


**Fig. 1.** A rotating body provides external gyrotation $\vec{\Omega}$ that has an inverse flow of the body's rotation. Attraction of the orbiting body occurs due to the equivalent Lorentz force [3]. Surface gyrotation forces are indicated $F_{\Omega}$ and centrifugal pseudo forces $F_c$.

$$\vec{F}_{\Omega} = m_2\left(\vec{v}_2 \times \vec{\Omega}\right) \qquad (2)$$

In previous papers [3], I deduced that the faster the body spins, the stronger the Lorentz gyrotation forces act inwards the body nearby the equator, up to the latitude of 35°16′, allowing fast spinning stars to not totally fall apart (Fig. 1, forces $F_\Omega$ ).

## 2. Opposite Spins Attract, Like Spins Repel

I also deduced [3] that bodies with opposite oriented spins will attract and bodies with like-oriented spins will mutually repel (Fig.2). This is valid for bodies and for any particle with a spin. In this paper we will generally speak of "particles".

The conclusion above is of utmost importance to fully understand the working of gravity at all levels and the definition of mass and matter.

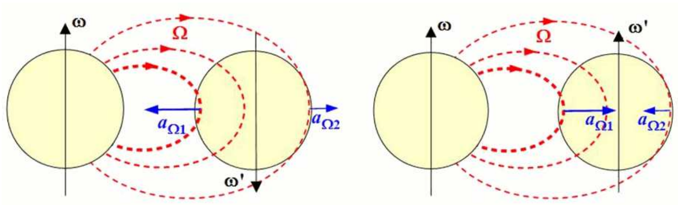


**Fig. 2.** Due to the Lorentz-force for gravity, bodies with opposite-oriented spins will attract and bodies with like-oriented spins will mutually repel.

## 3. Internal Gyrotation Field of a Rotating Body

As explained in my paper [3], the gyrotation $\vec{\Omega}$ of a rotating body provides a magnetic-like field that acts internally as well as externally to the body upon moving masses.

For a sphere, like the Sun, the Earth or Mars, its value inside the body, simplified for an uniform density, is given by [3]:

$$\vec{\Omega}_{\text{int}} \Leftarrow \frac{3Gm}{c^2 R^3}\left(\vec{\omega}\left(\frac{2}{5}r^2 - \frac{1}{3}R^2\right) - \frac{\vec{r}\,(\vec{r}\bullet\vec{\omega})}{5}\right) \qquad (r \le R) \qquad (3)$$

wherein the same symbols are used as in Eq. (1).

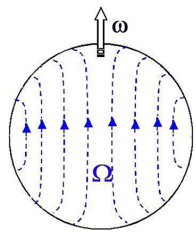


**Fig. 3.** Internal gyrotation equipotentials $\vec{\Omega}_{\text{int}}$ of a spinning body at a rate $\vec{\omega}$.

The internal gyrotation $\vec{\Omega}_{\text{int}}$ of a spinning sphere is represented in Fig. 4 for the component $\Omega_y$ that is parallel to the spin vector [3]. By comparing both Fig. 3 and 4 it appears that the component $\Omega_x$ is rather small compared with $\Omega_y$ (except at the sphere's surface) and will not affect the further reasoning of this paper. The reason will become clear during my explanations. The arrows in Fig. 4 are represented larger for higher amplitudes of the internal gyrotation.

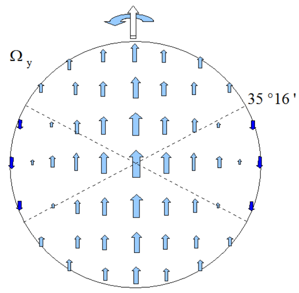


**Fig. 4.** Vector topology of the gyrotation along the spin axis of a spinning sphere. The spin axis contains the highest amplitude of gyrotation. At the latitude of nearly 35°16′, the gyrotation becomes zero. At the equator, the gyrotation is inversed, and one gets a local increase of the attraction!

It appears from Eq. (3) that near the Earth's spin axis, the gyrotation will be strongly oriented like the spin. At the latitude of nearly 35°16′, the gyrotation becomes zero, and around the equator, the gyrotation becomes even inversed near the surface.

## 4. Reorientation of Particles under a Gyrotation Field

When a gyrotation field acts upon a spinning body, a precession occurs, and an internal spin reorientation will occur over long time, parallel to the ambient gyrotation orientation. Indeed, the particles are not to be considered as 'hard' objects, which makes that their internal dynamical structure will be able to swivel orientation.

In Fig. 5, several relevant cases of elementary particles are shown (as rings) that are in an internal gyrotation field and undergo a Lorentz-acceleration

$$\vec{a}_\Omega = \vec{v}_i \times \vec{\Omega}_{\text{int}} \qquad (2)$$

wherein $\vec{v}_i$ is the rotation velocity of the elementary particle and $\vec{\Omega}_{\text{int}}$ the interior gyrotation field of the spinning object.

The swiveling acceleration is then given by Eq. (2) and the inertial angular moment of the elementary particles will in the first place cause a precession of the particles' spin vector.

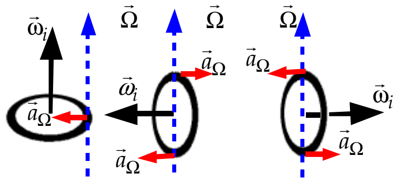


**Fig. 5.a.b.c.** Three situations of spinning particles at a spinning rate $\vec{\omega}_i$ , under a gyrotation field $\vec{\Omega}$ . In the cases 5b. and 5c. there occurs a swiveling of the particle towards a like orientation as the ambient gyrotation's direction, due to an acceleration $\vec{a}_\Omega$ .

In Figs. 5b and c, the particles will swivel their spin vector until the gyrotation field's orientation; the particle in the Fig. 5a will not swivel, since its acceleration is oriented inwards the particle.

It follows that after time, the distribution of particles will not maintain random, but instead, one direction will be preferential, in the direction of the gyrotation distribution $\Omega_y$ of Fig. 4. Thus, this figure also shows that the distribution of the density decreases (due by repel and thus, expansion) inside the Sun. Remark that the distribution $\Omega_x$ is not relevant because of the continuous rotation of the Sun whereby the gyrotation orientations rotate as well, parallel to the equatorial plane.

## 5. Why Gravity Generally Attracts

### 5.1. The Early Sun and Its Particles' Orientation

From the general point of view, one could say that the particles in the early Sun probably were oriented more randomly, because the spinning did not modify the particles' orientations yet. But the Sun was formed from a certain physical process.

It will be shown below that there always occurs attraction between particles.

### 5.2. Why the Preferential Orientation of the Sun's Particles is Attractive

Why is the preferential orientation of the Sun's particles attractive? Imagine several particles side by side that are randomly oriented upwards or downwards, say, ↑↓↓↑. As we saw earlier [1,2], opposite oriented particles attract and like oriented particles repel. According to gravito-magnetism [1,5], the first particle at the left attracts the second and the third particle, the second particle repels the third one, but attracts the first and the fourth ones, and so forth. The particles that are oriented differently, → or ← , do not affect this reasoning because they don't interact much with ↑ and ↓ (thus, the reasoning for ↑↓↓↑ is similar to that of, say, ↑←↓←↓→↑). The final situation of the example is given by a void between the second and the third particle, like ↑↓ ↓↑. Between the two downwards oriented particles of this example, the space between them increase and some room is created for another particle to fill it. We have a probability of more than 1/6 that this will be a ↑ , because ↑ is attracted by ↓ , resulting in a double attraction (left side and right side). In this example, we obtain a higher probability for ↑↓↑↓↑, which globally is an attracting group, noted as ▲ , that is oriented upwards. Remark however that the global orientation is only of an amplitude ↑ , for the five particles. The same reasoning is possible for groups: ▼▲▲▼ will result in ▼▲ ▲▼ , and then in a higher distribution probability of ▼▲↓▲▼ or ▼▲▼▲▼, which here gives a downwards super-group. These super-groups on their turn form hyper-groups the same way. However you look at it, one always gets a majority of attraction-oriented compositions. But even hyper-groups will get an amplitude of only ↑ , which suggest the reason why the external gravitation force is so small, while the cohesion forces in matter are so large.

Now we know why the heavenly bodies are attractive, despite the fact that gravito-magnetism allows both attraction and repulsion of particles. We also found the first reason why the Gravitational Constant isn't identical everywhere.

## 6. Gravitational Consequences of the Preferentially Like-oriented Particles

Let's recall the main features of like and unlike spinning elementary particles:

1. Gravity between elementary particles can be attractive as well as repulsive.
2. Consequently, the 'universal' gravitation constant isn't universal at all but 'local' and its value depends from the degree of like or unlike orientations of hyper-groups of particles in the bodies.
3. Rotating (spinning) bodies get steadily more like-oriented particles and consequently, steadily lower attracting and higher repelling values of the 'local' gravitation constant.
4. Rotating (spinning) bodies inflate and their density decrease.
5. The gravity of an object, containing ideally random-oriented particles (if that would exist) doesn't get any global external gravitational effect! In other words, if there is no preferential orientation of the particles, no global gravitational attraction (or repel) will occur!
6. Microscopic and elementary masses have now got a vector propriety because the attraction or repel between bodies only depends from the mutual (global and individual) spin orientation of these bodies and of their particles.
7. The parameters of the gravitational attraction and repel of bodies are their masses (as far as they can be regarded as absolute values), their distance and their mutual orientation (also expressible by the 'local' gravitation constant of each of the bodies, as vectors).
8. The grouping of the particles' orientation of spinning bodies make them preferentially attractive, but with a small attraction amplitude, which explains the high cohesion forces of matter and, at the same time, their low gravitation forces.

## 7. Matter, Mass, and the Gravitational Constant

It is possible that the most elementary particles don't possess a scalar mass. This point of view directly follows from the definition of matter as "trapped light", where light circles.

Since mass is regarded as a fixed matter-related quantity, not as a quantity of attraction, the rate of attraction or repel should ideally be treated by the gravitational constant. One should find a description that's keeps the original value of the word "matter" as "mass", and keep the gravity constant as the relationship between the vector-masses.

When elementary mass really behaves as a vector with respect to gravity, the more correct description is the following.

I can consider Newton's law as a Coulomb-like law, but where the masses become vectors, defined by the sum of their elementary spins, and where the constant $G$ only defines the 'normalized elementary gravitational constant', this is, the value that is obtained when two like-oriented or opposite-oriented elementary particles are considered. The resulting equation then avoids regarding the 'gravitational constant' as the variable [6].

$$\begin{aligned}\vec{F} &= G_{\text{norm}} \sum \frac{\vec{m}_i \bullet \vec{m}_j}{R_{ij}^3} \vec{R}_{ij} = G_{\text{norm}} \sum \frac{m_i \, m_j \cos(\alpha_{ij})}{R_{ij}^3} \vec{R}_{ij} \\ &= G_{\text{norm}} \sum \frac{\text{proj}(M_i) \cdot \text{proj}(M_j) \cdot \cos(\alpha_{ij})}{R_{ij}^3} \vec{R}_{ij}\end{aligned} \tag{4}$$

wherein the used symbols speak for themselves according Fig.5: $\vec{R}_{ij}$ is oriented in the direction of the $y_{ij}$-axis and $\vec{m}_i$ and $\vec{m}_j$ are two-dimensional projections of the corresponding masses $\vec{M}_i$ and $\vec{M}_j$ in the $x_{ij}$-$z_{ij}$-plane.

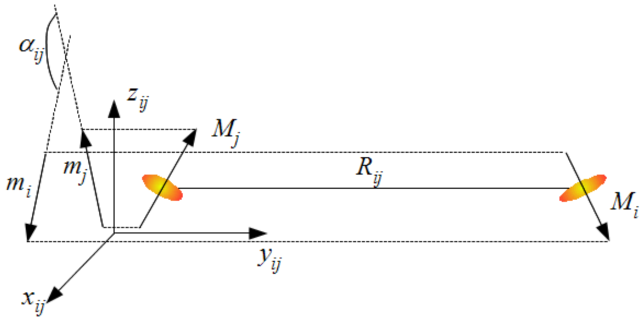


**Fig. 6.** Definition of the attraction or repel between two elementary masses $\vec{M}_i$ and $\vec{M}_j$ as the two-dimensional scalar vector product of the projections $\vec{m}_i$ and $\vec{m}_j$ in the $x_{ij}$-$z_{ij}$ –plane, according to Eq. (4).

The value of $G_{norm}$ is then defined by the structure of a set of two particles. For larger objects, $G_{norm}$ is defined by the average hyper-group structure, which can be seen as the maximal value for the object, in the case of an ideal attraction of the particles.

## 8. Gravitational Constants of Stars

The evolution if stars is quite intriguing. A nebula gets a spontaneous spin due to the fact that like-moving particles attract slightly more, and opposite-moving particles attract slightly less than Newtonian gravity [3]. While spinning, the star contracts and forms a bright star. The star slowly grows until it becomes a red giant, so large that it cannot be explained why the matter is not kept together by gravity at all. Then it collapses into a white dwarf or a black hole.

Since planets have been found to orbit white dwarfs [7], while according to general belief that planets would have been absorbed by the red giant phase, it is more likely that the semi-major axis expands together with the red giant formation and then shrinks when the white dwarf phase is starting.

The evolution process can be well explained by the actual description of gravitomagnetism [1,2,3]. A star grows because the particles' spin become more like-oriented, which results in more repel. When the red giant has formed, it almost doesn't spin any more at all, and the particles are much more distant, allowing so a spatial reorganization of the particles in the red giant: like-moving particles and opposite-spinning particles will group, and opposite-moving particles and like-spinning particles will repel more. This causes a new possibility to create a global internal attraction with global spin, resulting so in a collapse, with an ever-increasing spin, until a white dwarf or a black hole is obtained. The latter occurs if the atoms themselves collapse due to global pressure.

When using Eq.(4) it is obvious that the distances between the particles in the star is determining the balance between the gravitational attraction and the electromagnetic repel between the particles. Hence, the attraction will be maximal for a certain average distance, which also will result in the optimal average angle between the mass vectors. We can state that the maximal attraction between atoms is obtained in a white dwarf.

The same way, we can state that the maximal stable situation of a large distance between the particles is given by the situation of a red giant, giving also a certain average angle between the mass vectors.

If the gravitational constant has to be defined in the frame of classical Newtonian gravity, we can operate as follows: the actual gravitational constant in our solar system is known, and it is related to the solar dynamics [4]. Indeed, I found the empirical equation

$$\upsilon_{eq} = \frac{G\,m_{Sun}}{2c\,R_{eq}^{\ 2}} \qquad (5)$$

in which the rotation frequency $\upsilon_{eq}$ at sun's the equator is related to the Sun's dynamics and the gravitational constant. This connects the gravity constant even closer to the solar dynamics than just the Newtonian gravity law and suggests that other stars may respond to other values of the gravitational constant. In [4], a even more compelling relationship is found, which I will not redevelop here.

Since for a certain mass, the conservation of angular momentum is valid, we get:

$$G\,m_{Sun} = \text{constant} \qquad (6)$$

Note however that Eq.(6) is the classic Newtonian notation in which $G$ and $m_{Sun}$ are invariable. This should however be expressed as an average of the vector equation:

$$G_{norm}\sum\left\langle m_i\, m_j \cos(\alpha_{ij})\right\rangle = \text{constant} \qquad (7)$$

in which the brackets express the average of all the particles attraction.

Assuming that the angle $\alpha_{ij}$ doesn't depend from the masses' value, which we can chose identical, Eq. becomes:

$$G_{norm}\left\langle \cos(\alpha_{ij})\right\rangle = \text{constant} \qquad (7)$$

If confirms the conservation of angular momentum of the individual particles as a whole in the star, since:

$$G_{norm} = \text{constant} \qquad (8)$$

by the definition of Eq.(4), and so:

$$\left\langle \cos(\alpha_{ij})\right\rangle = \text{constant} \qquad (9)$$

which means that the average global orientations of the particles didn't change, globally during the evolutionary processes.

However, even if the average angle remains the same, the same set of orientations can give different outcomes as for the distance between particles [5,6]. For an identical set of up and down particles, it is found that :

↑↓↑↓↑ results in the closest particles global distance;
↑ ↑↓ ↓↑ gives wider particles and global distance;
↑ ↑ ↑↓ ↓ form the maximal width of the particles.

On the other hand, the Eq.(4) is expressed with the individual distances between the particles, which manifestly differ in white dwarfs and in red giants of the same global mass. In order to simplify, we can assume all the particles being of the same mass in order to use the average calculus.

$$F = G_{\text{norm}} \left| \sum \frac{\vec{m}_i \bullet \vec{m}_j}{R_{ij}^3} \vec{R}_{ij} \right| = G_{\text{norm}} \sum \left\langle \frac{\cos(\alpha_{ij})}{R_{ij}^2} \right\rangle \left\langle m_i \, m_j \right\rangle \tag{10}$$

or:

$$F \propto \left\langle \frac{\cos(\alpha_{ij})}{R_{ij}^2} \right\rangle \tag{11}$$

which relates the diameters of the stars to their gravitational force.

In other words, when the relationship between the Sun, a white dwarf and a red giant is expressed, one can reduce it to their size.

Written in terms of Newtonian gravity, with Eq.(9), it results in:

$$G_{\text{star}} \propto G_{\text{norm}} \left\langle \cos(\alpha_{ij}) \right\rangle \left\langle \frac{1}{R_{ij}^2} \right\rangle \propto G_{\text{norm}} \left\langle \frac{1}{R_{ij}^2} \right\rangle \tag{12}$$

The larger the star for a same mass, the lower the gravitational attraction becomes. If the Newton gravity equation is used and the masses are seen as constants, solely a modified value of the gravitational constant is needed to express this.

Since the value of $G$ is that of our solar system, we can conclude that the value of $G_{\text{wd}}$ for a white dwarf is :

$$G_{\text{wd}} = G_{\text{sun}} \, R_{\text{sun}}^2 \big/ R_{\text{wd}}^2 \tag{13}$$

and the value $G_{\text{rg}}$ for a red giant is :

$$G_{\text{rg}} = G_{\text{sun}} \, R_{\text{sun}}^2 \big/ R_{\text{rg}}^2 \tag{14}$$

Although it is only possible to find relative values for the gravitational constant, it is clear that white dwarfs, which have diameters far below the Sun's, will show a much higher gravity attraction to the surroundings, whereas red stars, with diameters of many times that of the sun for a same mass, will show very low gravity to the surroundings.

## 9. Relaxed and Unrelaxed Galaxy Clusters

When galaxy clusters are studied, it is found that relaxed clusters show much less alleged dark matter than unrelaxed galaxy clusters. The gravitational bending of unrelaxed galaxy clusters is reported to contain up to a hundred times more dark matter than the visible mass [9].

Relaxed galaxy clusters are expected to contain galaxies that had the opportunity to spin during very long time, which makes them closer to a group of regular stars, which slowly expand due to the orientation of the particles.

Unrelaxed galaxy clusters on the contrary have been very turbulent for long time, and made the particles be very mobile, which increases the probability for a reorganization in very tight sets of particles, like it is possible in a red giant, just before it becomes a white dwarf. The reorientation of the particles renew the attraction between them, very strongly and allow the red giant's collapse.

It is thus suspected that unrelaxed galaxies will get a much higher gravitational constant than relaxed galaxies.

Since the gravitational bending is directly proportional to the value of the gravitational constant, there is a very strong indication that dark matter is not present, but that the gravity is augmented, spites the remaining of the quantity of matter.

## 10. Conclusion

The modification of the scalar mass-model into a vector mass-model is mandatory to understand the gravitational attraction and repulsion between elementary particles, especially under an external influence of a gyrotation field, as caused in the evolution of stars. However, it doesn't reduce the validity of Newton's gravitation law for massive bodies at low velocities.

It is found that attraction as well as repel occurs by gravity, depending upon the spin orientation of the particles. However, globally, there will always be attraction.

Gyrotation fields, induced from the rotation of masses, orient these spins preferentially the same as the body's rotation, which results in the repel inside the body, and so, in its expansion.

The gravitational constant is not a constant at all but should rather be seen as a combination of spin orientations of the considered elementary masses, and the distances between them. The white dwarfs will therefore get a very strong gravitational constant, hundreds of times larger than that of the Sun, and red giant stars will get hundreds of times lower ones.

It is also expected that relaxed galaxy clusters will have the possibility to get many expanding stars, with lowering gravitational constants, and unrelaxed galaxy clusters at the contrary will have very turbulent zones that had the chance to reorganize in strongly attracting particles, reflected by a very strong global gravitational constant.

## References


[ 1 ] Heaviside, O., A gravitational and electromagnetic Analogy, Part I, The Electrician, 31, 281-282 (1893).

[ 2 ] Jefimenko, O., "Gravitation and Cogravitation", (Electret Scientific, 2006).

[ 3 ] Thierry De Mees, "Analytic Description of Cosmic Phenomena Using the Heaviside Field", *Physics Essays* **18**: 396-401 (2005).

[ 4 ] Thierry De Mees, "Is the Differential Rotation of the Sun Caused by a Coriolis Graviton Engine", *General Science Journal* (2010).

[ 5 ] Thierry De Mees, "Fundamental Causes of an Attractive Gravitational Constant, Varying in Place and Time", *General Science Journal* (2010).

[ 6 ] Thierry De Mees, "The Gravito-Magnetic Inflation of Rotating Bodies and the Nature of Mass and Matter", *General Science Journal* (2011).

[ 7 ] Michele Johnson, "NASA's K2 Finds Dead Star Vaporizing a Mini "Planet"", https://www.nasa.gov/ (Oct. 21, 2015).

[ 8 ] Andrew B. Newman *et al.*, "The Density Profiles of Massive, Relaxed Galaxy Clusters", *arXiv:1209.1392v2*, (2013).

[ 9 ] Hironao Miyatake, "Evidence of Halo Assembly Bias in Massive Clusters", arXiv:1506.06135v3 (2016).

[10] R. Feynman, "Lectures on Physics", (Addison Wesley Pub., 1964).