International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

The Origin of Long-Range Forces

Jose Garrigues-Baixauli

Universitat Politècnica de València, Higher Technical School of Telecommunication Engineers,
Camino de Vera s/n., 46022 Valencia, Spain

Abstract: ***The current theories are based on the assumption that the Big Bang had a unique force, which, along with the expansion of the universe, gave rise to four forces, two of which are of infinite range. In the model developed in this paper, there is only a single force, which is the magnetic force. Gravity and the electromagnetic force are connected at all times in the electron, both being different manifestations of the same phenomenon. On the other hand, the hypothesis that both the universe and the elementary particles are formed by atoms of four spatial dimensions allows relating the mass and the charge of the electron.***

Keywords: 4D space discrete, minimal length, gravitation. Planck' length, long-rang forces

1. Introduction

In nature there are four interactions that are responsible for all phenomena in the universe: force or gravitational interaction, weak nuclear force, electromagnetic force, and the strong nuclear force. According to the Standard Model of Particle Physics (SMPP), the four interactions manifest themselves through an exchange of particles called bosons.

The electromagnetic and gravitational interactions have infinite extent, due to the fact that the interacting particles, photons and gravitons respectively, have zero mass. The weak and strong interactions have finite range, because the interacting particles have non-zero mass. They are the vector bosons and gluons. In the long-range forces, the time variable does not appear, suggesting that the action is performed instantaneously, i.e. at infinite speed. In turn, this implies that there is no material in between interacting bodies. That infinite speed requires the existence of the vacuum.

This action at a distance was a problem even for Newton himself: "*That Gravity should be innate, inherent and essential to Matter, so that one body may act upon another at a distance thro' a Vacuum, without the Mediation of any thing else, by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity that I believe no Man who has in philosophical Matters a competent Faculty of thinking can ever fall into it. Gravity must be caused by an Agent acting constantly according to certain laws; but whether this Agent be material or immaterial, I have left to the Consideration of my readers.*" [1]

Current physics has solved this problem by including particles that can not be detected, such as virtual photons and gravitons. It should be noted however, that the graviton has not yet been discovered, and the photons involved in the electromagnetic force are virtual photons, which have not been discovered either. However, according to the current physics, it is accepted that virtual photons must exist because the electromagnetic force can be measured. According to the SMPP, when energy is high enough, the electromagnetic interaction and the weak interaction are combined into a single interaction called the electroweak interaction. The grand unified theories (GTU) combine the electroweak interaction with the strong nuclear force, but leave aside gravity.

Initially, according to the SMPP, the four forces were unified into a single force. Figure 1 show roughly the times when the various forces separated.

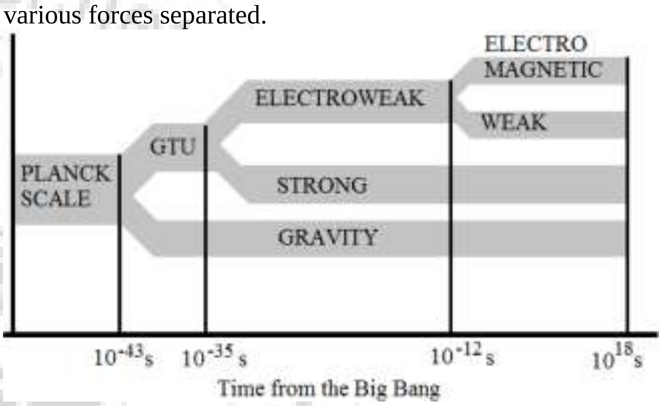

Figure 1: Evolution of forces

In this paper we will see that the long-range forces such as the gravitational and electro-magnetic forces still remain connected, since the electric charge and mass are two different manifestations of the rotation of the Planck particle [2, 5].

2. Discrete Space-Time

The current theories, based on a space-time continuum, sometimes give rise to the appearance of infinites masked with renormalization, and the denomination of singularity, as in the case of black holes. Instead, in the discrete 4D model, the infinities disappear because at no time can the space-time be zero.

General relativity implies that space-time is a continuum. However, there is no experimental evidence for this. Are space and time a continuum or are they composed of indivisible discrete units? We're probably convinced of continuity as a result of education. In recent years however, both physicists and mathematicians have asked if it is possible that space and time are discrete? Smolin states that space is formed from "*irreducible pieces of volume that cannot be broken into anything smaller*" that he calls *"Atoms of Space and Time"* [6].

Heisenberg said that physics must have a fundamental length scale, and with Planck's constant, *h*, and the speed of light, *c*, allow derivation of the masses of the particles [7, 8]. Planck's length can be considered as the shortest distance having any physical meaning. To Sprenger, "*a fundamental (minimal) length scale naturally emerges in any quantum theory in the presence of gravitational effects that accounts for a limited resolution of space-time.*" The Planck scale appears to combine gravity (*G*), quantum mechanics (*h*), and special relativity (*c*) [9]. Padmanabhan shows that the Planck length provides a lower limit of length in any suitable physical space-time [10,11]. Also, Meessen starts from a minimum length he calls *a*, and a four-dimensional space, which allows him to characterize the different types of particles by quantum numbers. Then, different states of the particles correspond to different excitations of space-time [12].

3. 4D Planck Atom

From Planck units Planck force is derived, which is associated with the gravitational potential energy and electromagnetic energy. Planck force can be expressed as

$$F_p = G\frac{m_p^2}{r_p^2} = \frac{\hbar c}{r_p^2} = \frac{m_p c^2}{r_p} \qquad (1)$$

where G is the gravitational constant, m_p the Planck mass, c the speed of light, $\hbar$ the reduced Planck constant ($h/2\pi$), and l_p the Planck's length, which can be expressed in terms of G, $\hbar$ and c as

$$l_p = \sqrt{\frac{G\hbar}{c^3}} \qquad (2)$$

Substituting all of these into Equation (1), results in

$$F_P = \frac{c^4}{G} \qquad (3)$$

Suppose that the universe is formed by discrete atoms, of four spatial dimensions (4D), and that the particles photons, neutrinos, electrons and quark first generation also have four spatial dimensions with a diameter equal to the Planck's length $l_p=(G\hbar/c^3)^{1/2}$. Of the four dimensions, three are observed as space (x, y, z), and the fourth dimension $(u = ct)$ is observed as time [13]. These are the atoms of space and time from Smolin [6].

Therefore, in every atom we have the potential due to Planck's gravitational field, or any other field, to consider:

$$U_{GP} = G\frac{m_p}{l_p} = c^2 \qquad (4)$$

Here, m_p is the Planck mass, l_p the Planck's length, G the gravitational constant, and c is the speed of light.

To simplify the drawing, only three dimensions are considered: r (x, y) and u:

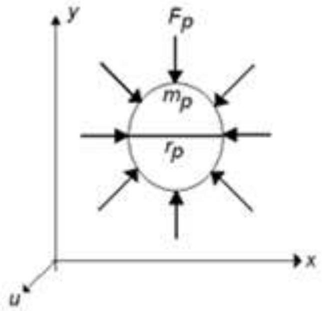

Figure 2: 4D Planck atom *(u=ct).*

4D atom may rotate both in three dimensional space as in the fourth dimension (u, Figure 3), which results in the following combinations:

- Zero rotations. The empty space.
- One spatial rotation ω_e. Neutrinos.
- One rotation in the fourth dimension ω_u. Photons.
- Two rotations, one spatial rotation *(ω_e)* and one rotation in the fourth dimension ω_u. Electrons and quarks of the first generation.

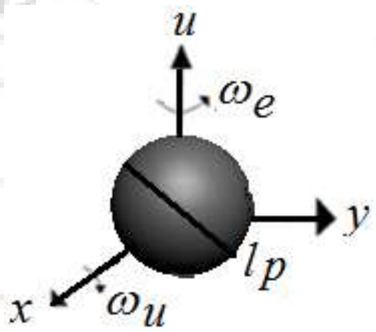

Figure 3: 4D Planck atom rotations

Static spatial atoms are not observed, it is what we call empty space. We can observe the atoms that rotate on themselves as elementary particles, such as electrons, photons and first generation of quarks and neutrinos

4. Relation between Rest Mass and Electric Charge of Electron

If space is made up of Planck-size atoms, each Planck atom can only be resting or turning on itself. The rotations can be in three-dimensional space or in the fourth dimension. The rotational energy in the fourth dimension gives rise to the rest mass and period originating the electric charge.

The energy of the particle can be expressed as:

$$E = m\,c^2 = \hbar\omega_u = \tfrac{1}{2}\hbar\omega_e \qquad (5)$$

Equation (5) can be expressed in terms of period $\omega_u = 2\pi / T_u$ resulting in:

$$E = m\,c^2 = \frac{h}{T_u} \qquad (6)$$

The electric charge will be due to the rotation (one of three possible rotations) or period (T_u) in the fourth dimension, known as the rest time in special relativity. Therefore, the electric charge can be expressed as:

$$q = \frac{1}{c\, r^2} \frac{\partial V_{4D}}{\partial u} = 2\pi^2 T_u \qquad (7)$$

Substituting (T_u) in Equation (6), the following is obtained:

$$E = m\, c^2 = 2\pi^2 \frac{h}{q} \qquad (8)$$

where *m* is the electron rest mass, and electric charge *q* is in seconds.

$$q = 2\pi^2 \frac{h}{m\, c^2} = 1.597\ 10^{-19} s \qquad (9)$$

To preserve the units, it is only necessary to multiply Equation (6) by the current unit (I = 1 A). A coulomb is an arbitrary unit of electrical charge. Current theory allows one to measure the electrical charge but not to explain it. Simply, the electric charge is defined as an intrinsic or fundamental property of matter.

$$E = m\, c^2 = \frac{h}{q_u} I \qquad (10)$$

The rest mass and charge of the electron were calculated above, according to Planck's constant *h* and the speed of light *c* [5].

5. Variation of the Gravitational and Magnetic Forces

Suppose we have a circular coil, traversed by a electric current I. Suppose further that we reduce the loop to the size of Planck ($l_p \approx 10^{-33}$ m), and that the current flowing is equal to 1A. Under these conditions, the coulombs, which is an arbitrary unit of electric charge (it was an agreement), coincide with the time that the particle is late in giving one spin.

Quantum fluctuations produce a four-dimensional Planck atom that can rotate in three-dimensional space, and also in the fourth dimension. The Planck energy is

$$E = m_p c^2 = \sqrt{\frac{\hbar c^5}{G}} = \hbar \omega_p \qquad (11)$$

where $\omega = c t_p$ is the angular velocity of Planck.

Therefore we have two forces initially; one due to the rotational energy, and the other due to the period in the fourth dimension. The energy of rotation gives rise to the mass, while the period will generate the electric charge. The force due to the energy of rotation, or Planck mass, will be initially

$$F_G = G \frac{m_p m_p}{l_p^2} \qquad (12)$$

That is the gravitational force of Planck. For a current of one ampere ($I = q/tp = 1A \rightarrow q = tp$), the rotation of the particle will cause a magnetic force, whose value will be

$$F_B = \frac{K}{c^2} \frac{t_p c t_p v}{l_p^2} \qquad (13)$$

Initially $v = c$, so the electric force coincides with the magnetic one.

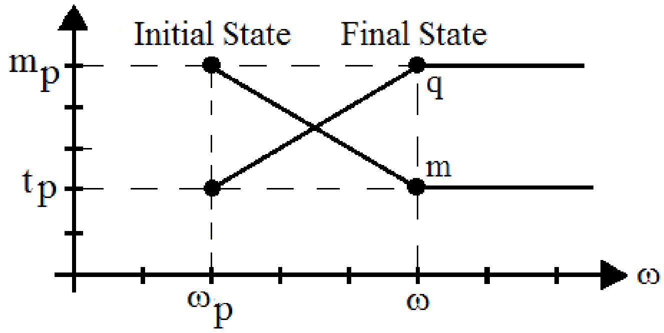

Figure 4: Initial and final state of 4D Planck atom.

As the universe expands, the rotation of the four-dimensional Planck atom will decrease, resulting in a decrease in mass (Figure 4), and an increase in electric charge or rotation period.

The increased electrical charge (rotation period) will cause an increase in the magnetic force, which approaches the Planck force,

$$F_B = \frac{K}{c^2} \frac{Q_p c Q_p v}{l_p^2} \qquad (14)$$

where Q_p is the electric charge of Planck. Moreover, it should be noted that as the universe expands, the rotation of the four-dimensional Planck atom causes a decrease in the velocity of the particle, so that in the final state its speed will be given by

$$v = \alpha\, c \qquad (15)$$

Substituting Equation (15) into Equation (14) results in

$$F_B = \alpha \frac{K}{c^2} \frac{Q_p c Q_p c}{l_p^2} = \alpha F_p = K \frac{qq}{l_p^2} \qquad (16)$$

When the magnetic force reaches the value αF_p, the decrease in rotation stops. The rotation has reached its minimum value. The four-dimensional Planck atom is in the state of minimum energy. The mass reaches its minimum value, and its maximum value of electric charge. That is, the gravitational force decreases as the electric force (F_B) increases.

This decrease of the gravitational force will be due, on one hand, to the decrease in mass due to the rotation of the four-dimensional Planck atom, and on the other hand, to the separation of those atoms due to the expansion of the universe. The decrease of the gravitational force is given by the gravitational force of the Planck mass at distance λ,

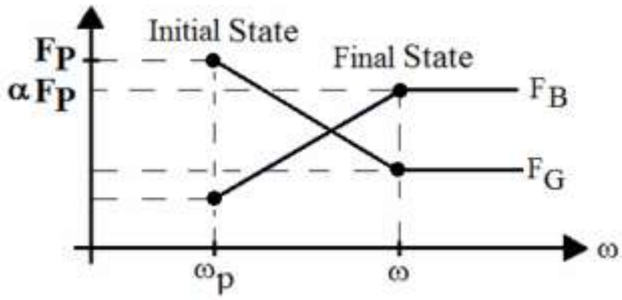

Figure 5: Evolution of gravitational and magnetic forces with the rotation.

$$F_G = G\frac{m_p m_p}{\lambda^2} \quad (17)$$

where λ is the wavelength of the electron. If we consider that the angular momentum *h*, of the Planck atom (Heisenberg Uncertainty Principle) remains, then

$$h = m_p c l_p = m_e c \lambda \quad (18)$$

Here m_e is the mass of the electron. Substituting into Equation (17), we obtain

$$F_G = G\frac{m_e m_e}{l_p^2} \quad (19)$$

This shows that the wavelength λ, is the distance at which two Planck's masses m_p exert the same force, that the two masses *m* at the Planck's distance (l_p).

Equation (18), can be rearranged as

$$h = m_p T_p = m_e T_e \quad (20)$$

where *Tp* is the period of rotation of the four-dimensional Planck atom, and *Te* is the period of rotation of the electron. Therefore the initial electric force will be

$$F_E = K\frac{T_p T_p}{l_p^2} \quad (21)$$

As the rotation of the Planck atom decreases, the period increases, the electric force increases in the same proportion as the gravitational force decreases. The final state of the electric force will be

$$F_E = K\frac{T_p T_p}{l_p^2}\left(\frac{m_p}{m_e}\right)^2 \quad (22)$$

Using Equation (20) gives

$$F_E = K\frac{T_e T_e}{l_p^2} \quad (23)$$

If we also take into account that fact that as the rotation decreases the universe expands, it turns out that in the final state the electric force will be:

$$F_E = K\frac{T_e^2}{\lambda_p^2} \quad (24)$$

To preserve the units we multiply Equation (24) by a current of 1 A squared (*I=q/Te*).

$$F_E = K\frac{T_e^2}{\lambda_p^2}(I)^2 \quad (25)$$

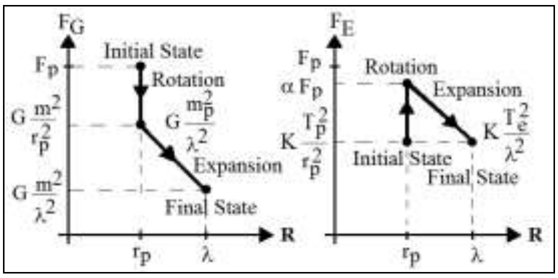

Figure 6: Total variations of the gravitational and magnetic forces.

Figure 6 shows the total variation of the gravitational and magnetic forces due to the decrease in the rotation of the four-dimensional Planck atom and the expansion of the universe.

6. General Expression of Long-Range Force

Therefore, as the charge is due to the rotation of the fourth dimension (interior of the particle) it will be imaginary. Consequently, the total energy of the electric charged particles will be real part, due to the mass, and imaginary part due to the electric charge, so that:

where m_e is the mass of the electron and *Eq* the module of the energy due to the electric charge, which will be calculated below.

$$E = m_e c^2 + iE_q \quad (26)$$

Planck energy can be expressed as

$$E_p = K\frac{Q_p Q_p}{l_p} = G\frac{m_p^2}{l_p} \quad (27)$$

And the energy of the electric charge in Planck conditions will be:

$$E_p = m_p c^2 = \sqrt{\frac{K}{G}}Q_p c^2 = \sqrt{\frac{\mu_o}{4\pi G}}Q_p c^3 \quad (28)$$

With

$$\frac{1}{\alpha} = \sqrt{\frac{\mu_o}{G}} = 137.21 \ kg^{-1} m s^{-1} C \quad (29)$$

The constant that links the gravitational and magnetic fields, compared to the fine structure constant (1/α=137.036), gives an error of 0.1%.

$$E = m_e c^2 + i\frac{1}{\sqrt{4\pi}\,\alpha}qc^3 \quad (30)$$

Therefore the energy of the electron $q=-q^-$ is:

$$E = m_e c^2 - i\frac{1}{\sqrt{4\pi}\,\alpha}q^- c^3 \quad (31)$$

and the positron $q=+q^+$ is:

$$E = m_e c^2 + i\frac{1}{\sqrt{4\pi}\,\alpha}q^+ c^3 \quad (32)$$

The force between the two energy elements (electron and positron) will be given by:

$$FF_p = F_{e^-}F_{e^+} \Longrightarrow F = \frac{1}{F_p}F_{e^-}F_{e^+} \quad (33)$$

Since we start from Planck conditions and two particles must be formed with opposite charges (inverse rotations in the fourth dimension), total imaginary energy is null. Therefore, the force between electron and positron at distance *r* will be:

$$F = \frac{1}{F_p}\frac{E_{e^-}}{r}\frac{E_{e^+}}{r} = \frac{1}{r^2 F_p}\left(\left(m_e c^2\right)^2 + \frac{1}{4\pi\alpha^2}q^+ q^- c^6\right) \quad (34)$$

Considering that the Planck force is given by:

$$F_P = \frac{c^4}{G} \quad (35)$$

Substituting in the above equation and considering Equation (29), we obtain:

$$F = G\frac{m_e m_e}{r^2} + K\frac{q^- q^+}{r^2} \quad (36)$$

°Evidently, Equation (36) is only valid when both particles are at rest (*v=0*). For *v*≠0 the total force produced will be:

$$F = \left(G\frac{m_e m_e}{r^2} + K\frac{q^- q^+}{r^2}\right)\left(1 + \frac{v^2}{c^2}\right) \quad (37)$$

It explains the perihelion shift of Mercury [14-16].

7. Gravitational Action at a Distance

Suppose we have two masses *m* and *m*' separated by a distance *r*. So that each of the masses has the size of Planck. According to relativity, light or information will take a time t = r / c to travel that distance.

On the other hand, in a 4-dimensional universe, formed by Planck atoms, it turns out that in each 4D atom, we have the potential of Planck, then, the energy $E = mc^2$, can be put as

$$E = mc^2 = m\ G\frac{m_p}{l_p} = c^2 \tag{38}$$

Therefore it is a gravitational potential energy, with respect to the potential of Planck that we have in the atom of space 4D and that is located back in the past at a distance *lp*.

If the two masses are separated by a distance r, this implies that at least the age of the universe is $t = r / c$. Therefore, in the fourth dimension we will have a Planck atom located at a distance r equidistant from both masses. The Planck potential of each of the masses, with respect to that atom will be

$$U_p = G\frac{m_p}{l_p}\frac{l_p}{r} = c^2\frac{l_p}{r} \tag{39}$$

Each of the masses is made up of particles that have the size of Planck. Therefore the gravitational potential energy of each of the masses with respect to that Planck atom, located at distance r, will be

$$E = mG\frac{m_p}{l_p}\frac{l_p}{r} = mc^2\frac{l_p}{r} \tag{40}$$

$$E' = m'G\frac{m_p}{l_p}\frac{l_p}{r} = m'c^2\frac{l_p}{r} \tag{41}$$

If we consider that the Planck force or the Planck energy is what causes the expansion of the universe, it results

$$E_G E_p = EE' = mc^2\frac{l_p}{r}m'c^2\frac{l_p}{r} = mm'c^4\frac{l_p^2}{r^2} \tag{42}$$

And as

$$E_G = F_G l_p \tag{43}$$

$$E_p = F_p l_p = \frac{c^4}{G} l_p \tag{44}$$

Substituting into the equation (42) we obtain

$$F_G = G\frac{mm'}{r^2} \tag{45}$$

What is the law of Newton's gravitation. Where the action at a distance, is due to the existence of Planck atoms of 4 dimensions, located in the fourth dimension, that is, back in the past.

If instead of the gravitational potential we consider the Colombian potential we obtain the Coulomb law.

8. Conclusion

The four-dimensional Planck atom evolves so that its mass decreases until reaching the mass of the electron. At the same time, the time it takes to make a turn in the fourth dimension increases, giving rise to the charge of the electron, so that mass and charge are joined as are the gravitational and electric forces. While the gravitational force due to the rotation decreases, the electric force increases. The expansion of the universe separates Planck's four-dimensional atoms, producing a decrease in both forces.

In discreet space-time, neither the renormalization nor singularity are necessary, since the infinites disappear.

As the electric charge turns out to be the period in the fourth dimension, electric charge is imaginary, and therefore, while the masses of the same sign attract, the electric charges of the same sign are repelled.

On the other hand, the existence of Planck atoms in the past creates a potential through which masses and charges transmit their movements to the rest of the universe. Current physics, not considering what happened in the past, interprets this action as a ghostly action at a distance. This is because only the result of that movement is observed, that is, the gravitational or electromagnetic force.

Finally, both gravitational and electromagnetic forces are present in the electron. But because the electromagnetic force is much greater than the gravitational force, the latter is not appreciated

References

[1] J. Berkovitz, "Action at a Distance in Quantum Mechanics", The Stanford Encyclopedia of Philosophy (Winter 2008 Edition), Zalta, E. N. (ed.).

[2] J. Garrigues-Baixauli, "Derivation of the Schrodinger Equation from Classical Physics", Int. J. Sci. Res., **5**(5), pp.77-80 , (2016).

[3] J. Garrigues-Baixauli, "Relation Between the Gravitational and Magnetic Fields", J. Phys. Math., **7**(2), 169, (2016)

[4] J. Garrigues-Baixauli, "Wave–Particle Duality as a Classic Phenomenon", Int. Sci Res. Org. J. 02 (01). (2017)

[5] J. Garrigues-Baixauli, "Classic 4D Model of the Discrete Universe. I: Quantum·, Scholars' Press. (2017)

[6] L. Smolin, "Atoms of Space and Time", Sci. Am., **290**(1), pp. 66-75, (2004).

[7] W. Heisenberg, "Die Leobachtbaren Grossen in der Theorie der Elemntarteilchen", Z. Phys., **120**, pp. 513-538, (1943).

[8] W. Heisenberg, "Quantum Theory of Fields and Elementary Particles", Rev. Mod. Phys., **29**, pp. 269-278 (1957).

[9] M. Sprenger, P. Nicolini, and M. Bleicher, "Physics on the Smallest Scales– An Introduction to Minimal Length Phenomenology", Eur. J. Phys., **33**(4), pp. 853-862, (2012).

[10] T. Padmanabhan, "Planck Length As The Lower Bound To All Physical Length Scales", Gen. Rel. Grav., **17**(3), pp. 215-221, (1985).

[11] T. Padmanabhan, "Physical Significance of Planck Length", Ann. Phys., **165**(1), pp. 38-58, (1985).

[12] A. Meessen, "Space-Time Quantization, Elementary Particles and Dark Matter", (2011). arXiv:1108.4883

[13] J. Garrigues-Baixauli, Quantum Universe. SF J Quan Phy 1:2. (2017)
[14] H. Behera, and. P. C. Naik, "A flat space-time relativistic explanation for the perihelion advance of Mercury", (2003) arXiv:astro-ph/0306611v1
[15] C. J. de Matos, and M. Tajmar, "Advance of Mercury Perihelion Explained by Cogravity", (2000) arXiv:gr-qc/0005040v1
[16] H. Behera, "Gravitational Thomas Precession -A Gravitomagnetic Effect ?" (2003) arXiv:astro-ph/0312013v1

Author Profile

José Garrigues-Baixauli received the M.S. degree in Industrial Engineering and the Ph.D. degree from the Universitat Politècnica de València (UPV), Valencia, Spain, in 1983 and 2013, respectively. Since 1990, he has been a member of the staff at the Department of Electronic Engineering. He is also a member of the Instituto de Reconocimiento Molecular y Desarrollo Tecnológico, UPV. His main areas of interest are artificial neural network applications by microcontrollers and the theoretical physics. Retired professor from 2015.