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Atomic Gravity

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Abstract In this theoretical development, it was possible to reconcile the "Theory of Relativity" with "Quantum Mechanics" by delegating to the atoms the origin of the natural inertia or gravity. Aided by a philosophy related to the flow of time in the microcosm, in which it is delegated to the protons, due to its infinite temporal stability, the reference of the present, while in the electro sphere the time oscillates around it, so that it remains fully compatible with the QM uncertainty principle. With this mechanism, solutions were found for unsolved physics problems, among them: the origin of the Casimir force, the gravitational anomalies of space probes, the excess mass of the Cooper pairs in Nb superconductors, the superluminal velocity of neutrinos when they cross the Earth's crust or when they arrive before the radiation of a Supernova. It is still shown how, from a set of atoms, it is possible to derive the Universal constant of gravity "G". And through the Cosmological Potential we can understand the mechanism of black holes, the explosion of Supernovae and the origin of high energy Cosmic rays.

Keywords: *gravity, quantum gravity, general relativity, gravitational potential, cosmology*

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1. Introduction

The objective is to show that gravity is an naturally generated inertia by atoms, a necessary prerequisite to understand the connection that exists between quantum mechanics and relativity. To assemble the puzzle it was necessary to introduce the arguments in parts (chapters), which assimilated separately facilitate the understanding of the set as a whole.

It was necessary to introduce an alternative interpretation of relativity (chap. 02), the relativity of time, which is equivalent to general relativity, as shown by the algorithm of fig. 07 (chap. 03), for which the same results are obtained. With it, it is possible to understand the anomalies observed in the Cosmos as shown in chap. 08 and 09. In chap. 04 and 07 is shown how to identify in the atom the origin of natural inertia and its dependence with the Gravitational Potential present, as well as the need to have more than one atom for its perception. In chap. 05 a different form of interpretation is presented, of the uncertainty present in the atom, by which it is possible to understand the symmetrical spherical shape and the origin of the perception of atomic inertial potential and its relationship with electromagnetic asymmetries, which is shown in chap. 06. In chap. 10 is shown how to find the quantum of inertia, or the inertial potential (IP) of atoms (or the atomic gravitational potential equivalent) with which it is possible to find the origin of the Casimir force (chap. 11) and determine the magnitude, with great precision of anomalous masses in superconductors (chap. 12). Still, it is shown in chap. 13, how to find, with the IP, the constant G.

2. The "Gedankenexperiment"

At the beginning of the 20th century, P. Ehrenfest [1] proposed a "Gedankenexperiment", reproduced in Figure 1, also analyzed by M. Born [2], which was also considered several times by A. Einstein [3] in the development of the Theory of Relativity.

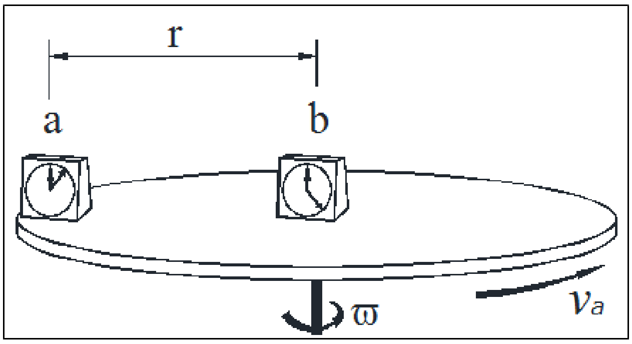

Figure 1. The Gedankenexperiment

When we put the disk in a certain rotation, we simulate an inertia that is equivalent to an artificial gravity. The idea is to analyze the time flow of two clocks as shown in Figure 1.

Let us suppose that these clocks, both "**a**" and "**b**", emit such a constant signal at a certain frequency "**f**". Considering the "Lorentz" transformations, we know, that in relation to the point "**b**" (or in the referential of the point "**b**"), or of any other immobile observer in relation to the point "**a**", the frequency registered by the clock "**a**" (eq. 2.1) is:

$$f_a = f_b \sqrt{1 - \frac{{v_a}^2}{c^2}} \qquad (2.1)$$

Where the lineal velocity "$\boldsymbol{v_a}$" (eq. 2) of the clock "**a**", is:

$$v_a = \varpi . r \qquad (2.2)$$

Where: "**ω**" is the angular frequency and "**r**" the disc radius.

Considering this, the Relativity postulates that the time evolves at different rates for places where the Gravitational Potential (**GP**) has differences in the intensity. We know that this was exhaustively tested, and always confirmed.

That is, if we exchange the clocks by atoms, we could say that: an observer at the "**b**" referential, or at rest to the rotation of the disc, will perceive that a hypothetical atom, placed at the "**a**" point, will have a lower vibration (or it have the time flowing at lower rates), than an identical atom placed at the "**b**" point, or at its referential.

The consequence of this, for the "Atomic Origin Gravity", is that, the same atom will generate in the point "**b**" more **inertia** than in the point "**a**". Here we have the direct influence of the intensity of the **GP modulating** the generation of the gravity.

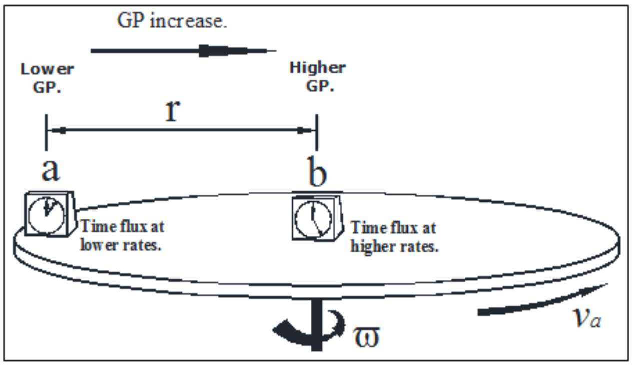

Figure 2. Gravitational Potential present on the Disc

That is, to know in which rate the frequencies of the atoms vibrate, we need to know how much the **GP** varies, see Figure 2. We know that the greatness of the **GP** in a determined place is equivalent to Potential Energy of an object, in that place, divided by his mass.

$$\Phi = -\frac{U}{m} \qquad (2.3)$$

The negative sign is introduced by convention, when considering the gravity, as being, always an attractive force. We should accomplish a work against the centrifugal force (or the artificial inertia or acceleration, or the equivalent gravity of the system), to transport a mass (for example) from point "**a**" to the point "**b**".

Considering the variation of **GP**, we have:

$$\Delta\Phi = -\frac{\Delta U}{m} \qquad (2.4)$$

By the "Virial Theorem", for forces that vary with the inverse of the square of the distance, the conversion between Kinetic Energy (**K**) and Potential Energy (**U**) is made by factor **1/2**. That is:

$$K = \frac{1}{2} . U \qquad (2.5)$$

As the **K**, at "**a**" point, is equal to:

$$K_a = \frac{1}{2} . m . \varpi^2 . r^2 \qquad (2.6)$$

The equivalent **U**, at the "**b**" point, is:

$$U_b = m . \varpi^2 . r^2 \qquad (2.7)$$

While, at "**a**"point, the **U** is null.

Analyzing a frequency in "a", at the "b" point of reference:

By moving, from "**a**" to "**b**" point, we experience a **U** variation of:

$$\Delta U_{a-b} = U_b - U_a = m . \varpi^2 . r^2 \qquad (0.1)$$

So, for the variation of the **GP** from the "**b**" to "**a**" point, we have:

$$\Delta\Phi_{a-b} = \Phi_a - \Phi_b = -\frac{\Delta U_{a-b}}{m} = -\varpi^2 . r^2 \qquad (2.9)$$

Then, the frequency at "**a**" point is obtained by:

$$f_a = f_b . \sqrt{1 + \frac{\Delta\Phi_{a-b}}{c^2}} \qquad (2.10)$$

This is the same eq. 1, given previously. That means that, a clock oscillating in a determined frequency at the "**b**" point, under the influence of the **GP**, will have the frequency reduced, at the "**a**" point.

Analyzing a frequency in "b" at the "a" point of reference:

Now, when we move from the "**a**" to the "**b**" point, we will have a variation of the **U** of:

$$\Delta U_{b-a} = U_a - U_b = -m . \varpi^2 . r^2 \qquad (2.11)$$

And a variation in the **GP** of:

$$\Delta\Phi_{b-a} = \Phi_b - \Phi_a = -\frac{\Delta U_{b-a}}{m} = \varpi^2 . r^2 = v^2 \qquad (2.12)$$

And the frequency at the "**b**" point is obtained with:

$$f_b = f_a . \sqrt{1 + \frac{\Delta\Phi_{b-a}}{c^2}} \qquad (2.13)$$

Replacing, we have:

$$f_b = f_a . \sqrt{1 + \frac{v^2}{c^2}} \qquad (2.14)$$

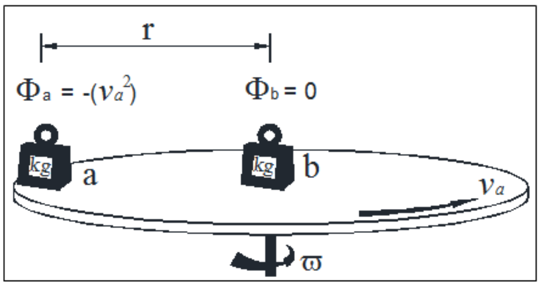

Figure 3. A Mass in Rotation on the Disc

Analyzing a hypothetical mass (**m**), placed at the same disc in rotation, at the "**a**" and "**b**" point. See Figure 3.

Considering relativity, what would be the virtual magnitude of a hypothetical mass (**m**) placed at "**a**" point for the "**b**" reference point? We know that this mass will be (apparent) dilated in relation to the "**b**" point of reference, and this dilation is obtained by:

$$m_a = \frac{m_b}{\sqrt{1-\frac{v_a^2}{c^2}}} \qquad (2.15)$$

So, we verified a variation in the mass. We can obtain the greatness of this variation, with:

$$\Delta m = m.\left(\frac{1}{\sqrt{1-\frac{v_a^2}{c^2}}}-1\right) \qquad (2.16)$$

This mass variation represents an energy that can be obtained with:

$$E = \Delta m.c^2 \qquad (2.17)$$

And we can verify that this energy **E** is of the same greatness as the kinetic energy **K** (eq.6).

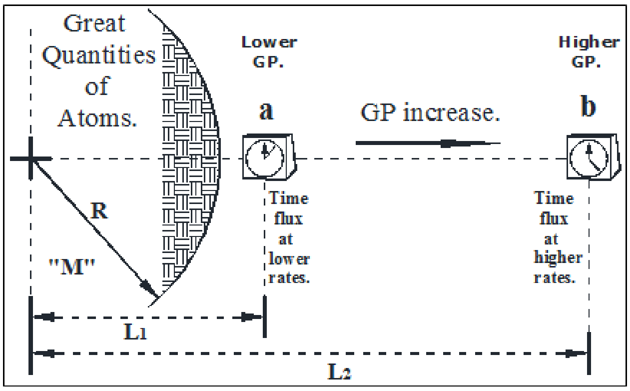

Figure 4. The Gravitational Potential and the Flux of Time

Now, we will analyze the system shown in the Figure 4, similar to the system of Figure 2. We had an artificial inertia, and now we have an object of great mass, in an empty space, which has natural inertia or gravity. Purposely, we put the clocks, in the same sequence of the increase of the intensity of the **GP**.

In this case, the **GP** (Φg) is obtained with:

$$\Phi g = -G.\frac{M}{L} \qquad (2.18)$$

Where: **G** is the Newton Constant of the Gravity, **M** is the object mass and **L** is the distance to the mass center.

In a similar way, as it was obtained previously, with eq. 13, the frequency of a clock at the "**b**" point, we can obtain the same with the variation of the Potential

Then, for the Potential variation, we have:

$$\Delta\Phi_{b-a} = G.M.\left(\frac{1}{L_1}-\frac{1}{L_2}\right) \qquad (2.19)$$

As "$\Delta\Phi_{b-a}$" is > 0, the frequency in "**b**" (eq. 13) will be higher than in "**a**".

What could we say about a certain period of time? We know that the frequency is inversely proportional to time, that is:

$$\Delta t_b = \frac{1}{f_b} \ and \ \Delta t_a = \frac{1}{f_a} \qquad (2.20)$$

This means that, in the case of analyzing, a time variation in the "**a**" point (Δt_a), in the reference of "**b**" point, we will have a time variation of:

$$\Delta t_b = \frac{\Delta t_a}{\sqrt{1+\frac{\Delta\Phi_{b-a}}{c^2}}} \qquad (2.21)$$

As it was expected, to consider that $\Delta\Phi_{b-a}$ is > 0, the time flows at faster rates at the "**b**" point. A certain time interval, at the "**a**" point, will have a smaller time interval at the "**b**" point!

3. Relativity of the Time

We need to verify if the eq. 21 is in agreement with reality, that is, verify if it can obtain results that are within the predictions of what has already been observed or proven experimentally. The idea is to calculate the deviation of a photon that passes tangent to the Sun.

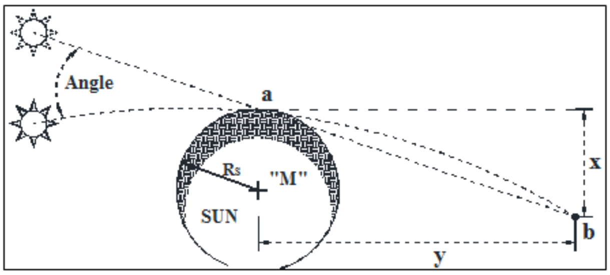

Figure 5. Deflection of the photons by the Sun mass

In Figure 5 (done purposely without scale) we can verify the angle that a photon undergoes of a very massive object. We know that the Sun causes an average deviation of 1.75 seconds of arch for the photons that pass close to its radius.

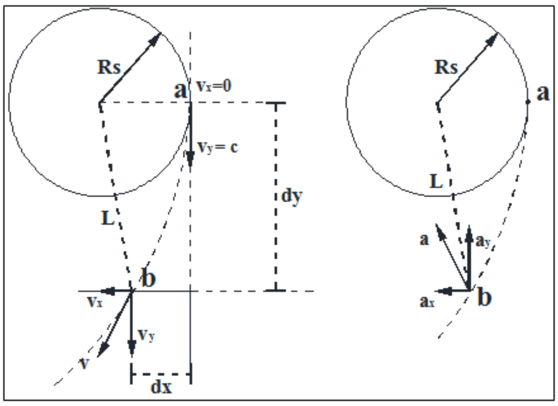

Figure 6. Geometric Analysis

We have developed an algorithm, as simple as possible, in which we can simulate a two-dimensional (2D) grid (with N divisions), which divides the space volume (in this case a surface) into fractions of time, and with it to better visualize the curvature of space Time imposed by gravitational potential. This algorithm also works in 3D, just add the z-axis.

We deduce, by the configured geometry, as shown in Figure 6, the equations of the components of acceleration of the photon.

$$a_x = G.\frac{M_\odot}{L^2}.sin\left(\arctan\left(\frac{x}{y}\right)\right) = G.\frac{M_\odot}{L^3}.x \quad (3.1)$$

$$a_y = G.\frac{M_\odot}{L^2}.\cos\left(\arctan\left(\frac{x}{y}\right)\right) = G.\frac{M_\odot}{L^3}.y \quad (3.2)$$

The fraction, of time **dt**, is obtained for the distance of one astronomical unit (Sun-Earth distance), where it is divided by the **c** speed and by the divider **N** of the grid (larger the **N** greater the accuracy), or dt = (1 A.U.)/c/N.

The angle in seconds of arc (eq. 3.3) is obtained by:

$$\alpha = angle.\frac{360.60.60}{2.\pi}(00.00^\circ) \quad (3.3)$$

In the sequence (Figure 7 and Figure 8), we presented the two algorithms, the first which calculate the deviation with Newton's equations, and the second for the calculation with the eq. 2.21.

Where: $R_\odot$ is the Sun's radius and $M_\odot$ the Sun's mass.

Solving, we find for Newton: 0.8743 sec. of arch, and for the T.R.: 1.7436 sec. of arch. The found results (for an $N = 10^{10}$) are entirely in agreement with the observation.

That is, we verified how to transform the G.R. (general relativity) geometric interpretation, caused by the presence of **mass,** into an **equivalent** 3D space, in which, the inertia generated by atoms modulates this volume by the rate of the **time** flow.

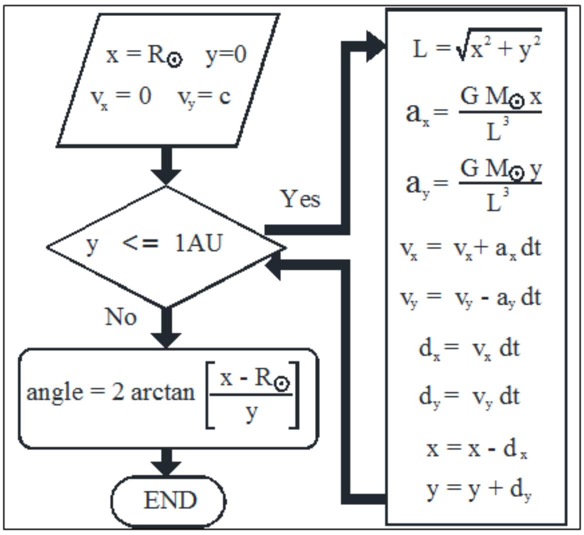

Figure 7. Newton algorithm

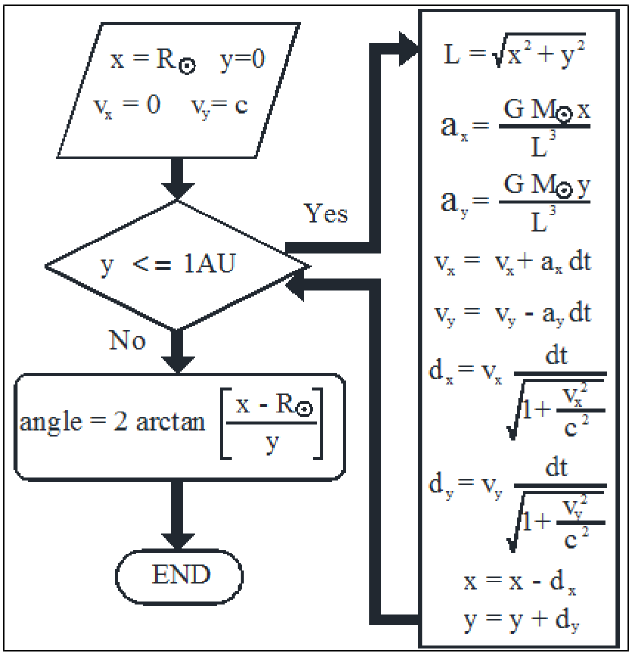

Figure 8. Time Relativity algorithm

4. Atomic Gravity - Part A

Let us imagine a situation in which we create a very poor "Universe", with only "one single atom". Let us suppose that this atom is a hydrogen "H" atom. See Figure 9.

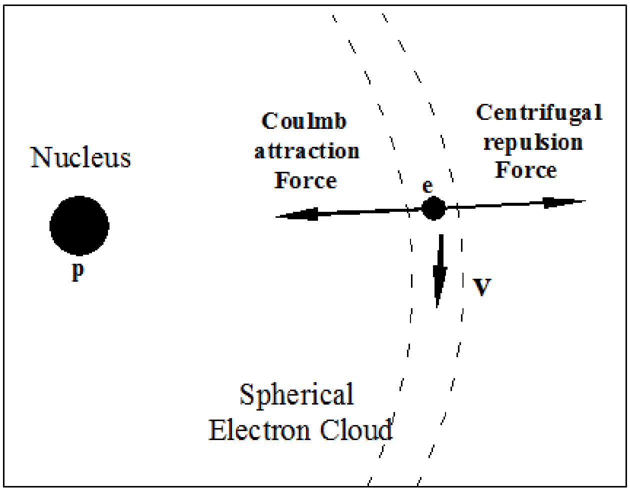

Figure 9. Universe with only one hydrogen atom

We know that this only atom, it is not disturbed by any interference type, of any origin. The Quantum Mechanics (**QM**) establishes the existence of a perfect balance among the Coulomb's force (electrostatic force that results of the attraction among the electric charges), and the centrifugal force ("fictitious" force that results of the spinning of the electron). Or be:

$$F_{Coulomb} = F_{Centrifugal} \quad (4.1)$$

We will suppose that Newton's theory is correct (mass attracts mass). In this context (acting between the nucleus and the electron cloud) we have the presence of this force. The atomic nucleus possesses a mass, very larger (many orders of greatness) than the present **mass** in the electron cloud. We know that this gravitational attraction force possesses an insignificant greatness, but even so, we sum her as being more a central force. After all, the observation proves his existence. We can do:

$$F_{Coulomb} + F_{Gravitational} = F_{Centrifugal} \tag{4.2}$$

Here, we have two central forces that obey the inverse-square law of distance, both acting with similar rules. In other words, we perceive that the greatness of the original forces (see eq.03-03) cannot be exactly the same (they should be imperceptibly different).

$$F_{Coulomb} \neq F_{Centrifugal} \tag{4.3}$$

Considering that the centrifugal force and the gravitational forces are similar in nature and they still posses the same units, we find that the atom presents (even if it is a negligible quantity), to an external observer, a reality that is in agreement with the observation, and the physics forecasts. That is, what is observed is something similar to what is illustrated in Figure 10.

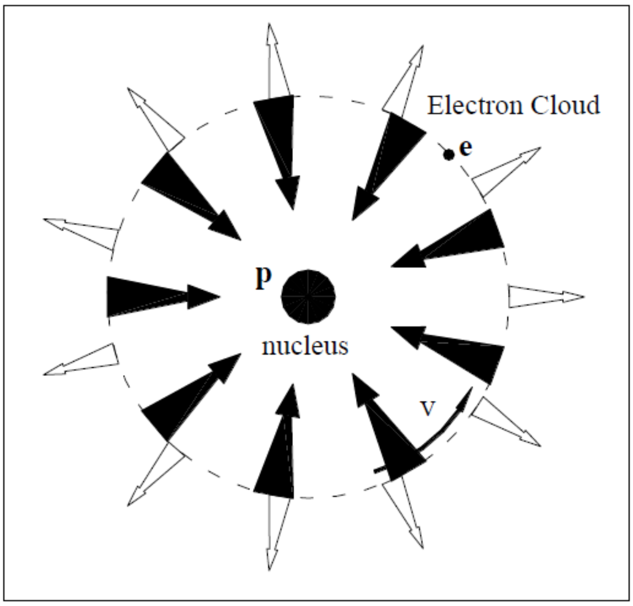

Figure 10. The centrifugation of the "electron as a field"

In the Figure 10, the arrows in bold, identify the field of the Inertial Potential (direction of the highest potential) or the equivalent **GP** generated by the centrifugation of the "electron as field" (much stronger), and the drained arrows, the field of the **GP** generated by the gravity of the atom (much weaker).

That is, we have in the atom an inertia, generated by some force, of similar nature than the gravitational field, which has the property of maintaining the charge of the electron (here we are referring only to the electric charge of the electron) orbiting in the electro-sphere in an **apparent** stationary condition. Something likes what is shown in Figure 11.

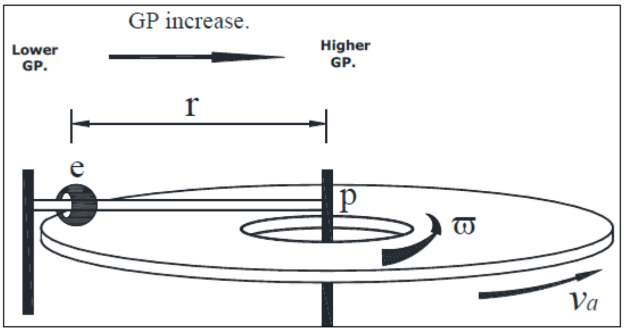

Figure 11. The inertia of the "electron as a field"

This relativistic effect (as we shall see) is created by the electromagnetic asymmetries conditioned by Space-Time around the atom, that is, the sum of infinite Observation Systems (OS), that represent Space-Time, create the effect by which an Inertial Potential (IP) arises due to the presence of, one or more, electric charges in relative motion.

5. The Duality of the Nature

The "Louis De Broglie" hypothesis experimentally proved postulates that the matter possesses a wave characteristic similar to observed for the radiation. In other words, the matter (electrons etc.) similar to radiation (photons) possess this dual behavior, confirmed the existence of a natural symmetry in the nature.

These matter waves' posses a total energy related to the oscillation frequency "***f***", through an associated wave to the movement, according "De Broglie's" relationship given by the following equation:

$$E = h.f \tag{5.1}$$

Where: "***h***" = is the Planck constant.

Still, in accordance with "De Broglie", the momentum "***p***" is related with the wavelength "***λ***", of the associate wave, by this another relation:

$$p = m.v = \frac{h}{\lambda} \tag{5.2}$$

Analyzing the eq. 5.1 and 5.2, we can conclude that everything obeys some type of oscillation or some type of wave movement, so at the microscopic level as for the macroscopic level. That is, we perceive that the Microcosm so with the Macrocosms, of some way looks for the equilibrium around some common place. This place is a type of "Time Line" that represents the Present Time.

This time characteristic is considered by the QM (in some way) by the fourth quantum number, the "SPIN". We know that the first three (n, 1, m) describe the spatial location.

We believe that a graphical analysis (like a "Gedankenexperiment") make easier to perceive what the QM mathematics, empirically built upon observation, does not allow (limited by the hidden variables, due to the time amplitude or the time indefiniteness in the Microcosm).

We know that the irradiation of energy, in the form of an electromagnetic field, or photons, happens only in the atom when we have a quantum transition or exchange of energy from the electrons from one mode of vibration to another mode of vibration, or from one equilibrium to another, or until the electron reaches in the atom a new stability.

It has been proven experimentally, in measurements made by collisions, that the “electron as a particle” has a very small dimension (something smaller than 10^{-16} m), that is, many orders of magnitude smaller than the size of an “electron as field” in which, theoretically, it would be distributed.

We verified that, in the atom, the “electron as a particle” (considering it as a point) must be there, somewhere in that spatial volume (probability density) or at the “electron as a field”, mathematically obtained by the QM, and somehow its electric charge must be mysteriously distributed so as not to radiate energy and unbalance the atom.

To assist in a “Gedankenexperiment”, we presented, in the Figure 12, some probability density functions, derived from the QM, for the “H” atom. In the “$\boldsymbol{\psi}_{100}$” function, the electron is in the fundamental state, while in the other three “$\boldsymbol{\psi}_{200}$, $\boldsymbol{\psi}_{210}$, and $\boldsymbol{\psi}_{211}$”, in the first excited state.

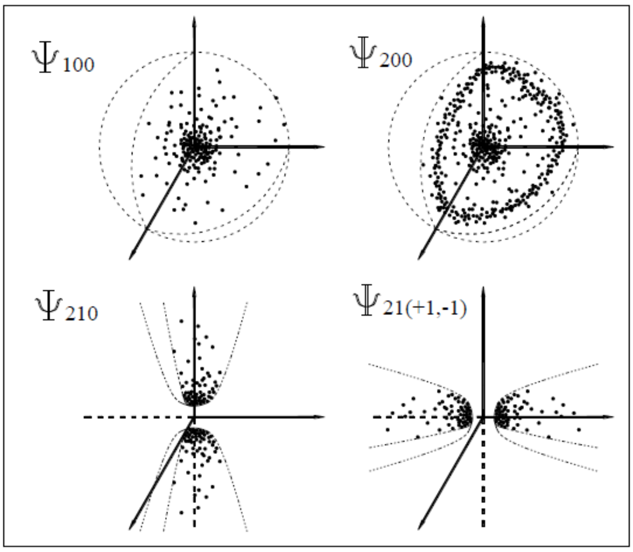

Figure 12. Three-dimensional aspect of the probability density distribution

Let us imagine that we have a multitude of observation systems (OS), spatially distributed **in 3D**, **equidistant** and at **different angles** of what is observed, that possess certain special features, with which it is possible to **synchronize an observation** in an **instantaneous and simultaneous** way of this single “H” atom.

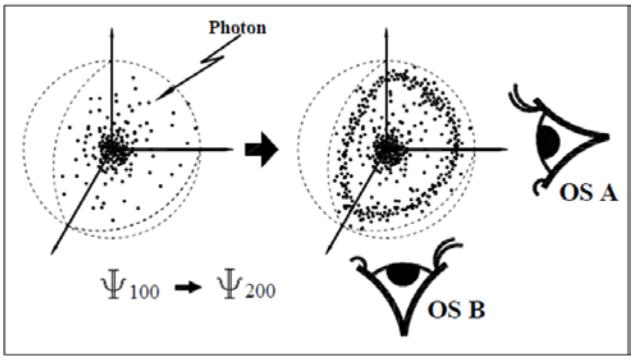

Figure 13. Electron absorbs a photon and jumps for a higher state.

Through a graphical analysis we can arrive at some observations:

A - We can verify (as shown in Figure 13, where we have a transition between allowed energies states according to the selection rules, from “$\boldsymbol{\psi}_{100}$” to “$\boldsymbol{\psi}_{200}$”, that all OS should testify, **in 3D**, (regardless of the orientation of the “**z**” axis) the same probability density distribution function (obtained by QM).

That is, the “electron as particle” must be at the same instant at the same place of the “electron as field” for any OS. They must verify the same quantum numbers (spatial and spin) for the same "electron as particle", because it is the same particle of the same Atom! For this specific case ("$\boldsymbol{\psi}_{100}$" to “$\boldsymbol{\psi}_{200}$”) we can imagine that this really happens.

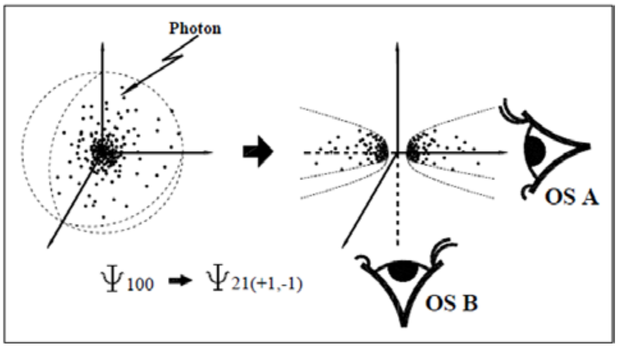

Figure 14. Photon absorption and the new probability density function

B - In case of a transition from state “$\boldsymbol{\psi}_{100}$” to “$\boldsymbol{\psi}_{211}$”, (absorption of a photon), as shown in Figure 14, we can verify that all OS, **in 3D,** will testify similar probability density distribution, but each with different “**z**” axis orientation.

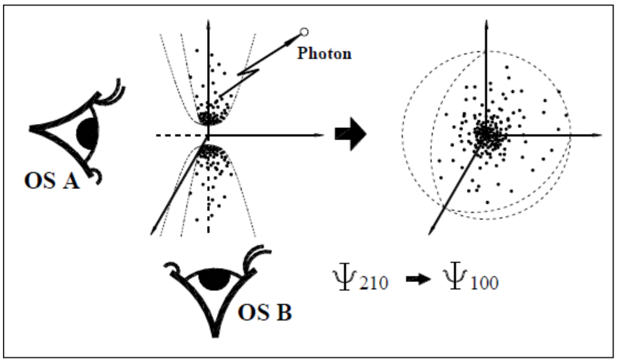

Figure 15. Photon emission and the new probability density function

C - At the transition from “$\boldsymbol{\psi}_{210}$” to “$\boldsymbol{\psi}_{100}$”, (emission of a photon), as shown in Figure 15, the emitted photon of the “electron as particle”, by the source atom, should present the same spatial origin location, **in 3D**, for any OS. And it must still have the same frequency (energy), at the collapse in the target atom, including the deviation caused by the spin of the electron (responsible for the thin line)!

Question: all possible OS realize that the photon spreads from the same spatial point, **in 3D,** of the space volume?

We then find that the "electron" exhibit two different forms, "electron as a particle" and "electron as a field", and these differences are perceived depending of the reference. In the microcosm, or at the atom referential, it is the "electron as a particle", whereas for the macrocosm, or for any referential external to the atom, it is the "electron as a field."

Through this graphical analysis (considering the observations A, B and C), we can verify, that if we make a summation, or overlap **in 3D** the information received from "**n**" OS, in which we eliminate the repetitions (considering that we have only the presence of **one** "electron as a particle"), which is caused by the temporal amplitude in atoms (temporally unsynchronized, each OS will perceive a different time), for the "electron as a field" we will always have a spherical-symmetric distribution.

It is now possible, begin to understand why so many different particles (by the quantum numbers we can verify that there are a lot of combinations options). The particles (even after collision), in some way, carry the spatial and temporal characteristics of his origin, or from the atom of origin.

Empirically, by observation, it was already known that the atom has a spherical shape. That is, it is possible now to show graphically, that the atom has a symmetrical spherical shape, and its electron cloud (H) has the thickness of one electron.

6. Electromagnetic Asymmetries

We know that an electric charge in motion generates a magnetic field (B), and that this field will exert a force on the other electric charge, also in motion. We must have charges in motion for there to be interaction. That is, we find that there is a reciprocal interaction, as if there were two electrical currents. It happens that this interaction is not symmetrical. We know that if the charges are in perpendicular motion, one of the forces will be zero, whereas in parallel or anti-parallel motion, the force between the charges will be at its maximum.

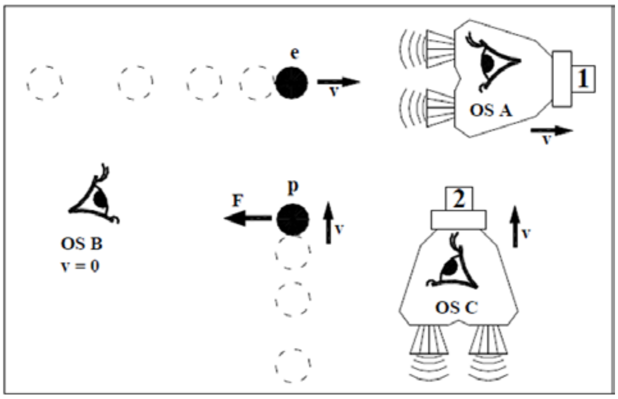

Figure 16. Relative forces resulting from the motion of the electric charges

The influence between the charges will also depend on the angle between the direction of motion and the field orientation. This force may vary from zero (perpendicular) to a given maximum (parallel).

In Figure 16, we can see two charges in perpendicular relative motion. The Observation System "**B**" (OS **B**), which is at rest, perceives a force "**F**" in particle "**p**", as a result of the induction of the magnetic field of particle "**e**", in motion at velocity "**v**". If we consider the perception of forces in the (Figure 16), we can suppose that here, OS **A**, within the point of reference of particle "**p**", does not perceive the force "**F**", while OS **C**, within the point of reference of particle "**e**", perceives it just as does OS **B** (at rest).

Considering what we have seen for two electric charges when separated, we will check what is found when these are now coupled.

Let us imagine a perfectly isolating rod, with a metallic sphere at each end, one positively-charged (lacking electrons) and one negatively-charged (with an excess of electrons). By means of a cable attached to the middle of the rod, this system is pulled through completely empty interstellar space at constant velocity by spaceship **1**, as shown in Figure 17.

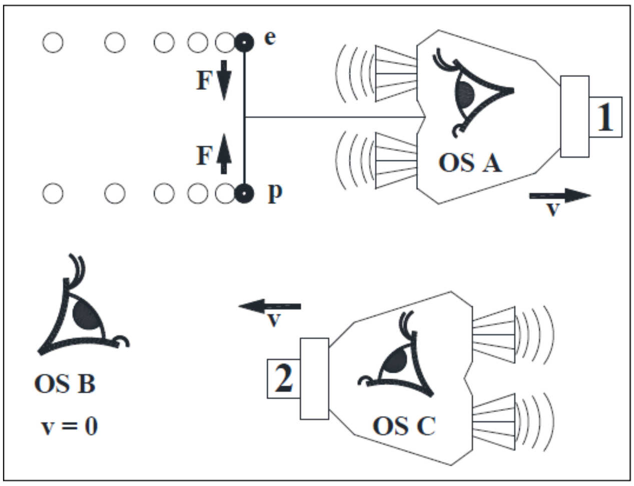

Figure 17. Relative forces resulting from the motion of the electric charges

The OS **A**, at the spaceship **1** referential**,** perceives only a Coulomb force attracting the two spheres. In addition to the Coulomb force, the OS **B**, at a stationary point of reference close to where spaceship **1** passes, perceives electromagnetic forces resulting from the relative motion of the electric charges. The OS **C**, in spaceship **2**, moving with the same velocity as spaceship **1**, but in the opposite direction, will perceive an attractive force twice as great as that measured by OS **B**.

Extending the graphical findings of chap. 04, to what we have seen for electromagnetic asymmetries, we conclude that in a summation, in which we consider all OSs to be one (after all the inertia is present for the whole set and is perceived equally by all OS), we can modulate for the space-time referential in 3D, what Figure 11 (of chap. 4) represents in 2D.

That is, the simultaneously requirement to verify the same quantum numbers for all OS (or the same perception for all OS), we construct an atom in 3D that has to be compatible with the observation of inertia in the referential of the present (of all OS). That is, the "electron as field" arises in 3D by the simultaneous perception (for the OS summation) of the "electron as a particle", as they are temporarily out of the present, and still necessary, the elimination of repetitions (or the infinities), when considering the existence of only **one** "electron as a particle".

This is because only one OS can realize or verify the observation, only one atom receives the information,

only one observation can be recorded (remembering the double slit).

We then find that the oscillations of the electrons (around the time line of the present) have, as a consequence, for a referential external to the atom, the perception in 3D of a certain inertia (in the present reference), which is modulated by the sum of OS distributed in 3D, type a force without the presence of mass, distributed in symmetrical spherical form, as partially illustrates Figure 18 (in 2D).

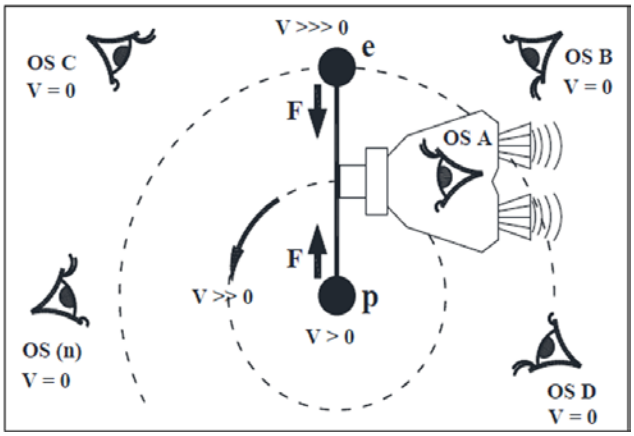

Figure 18. Relative forces resulting from the motion of the electric charges

And still it is possible to perceive that the magnitude of this inertia is proportional to the square of the speed of the electron.

7. Atomic Gravity - Part B

We increase to our poor "Universe", from chap. 4, with more one "H" atom, Figure 19.

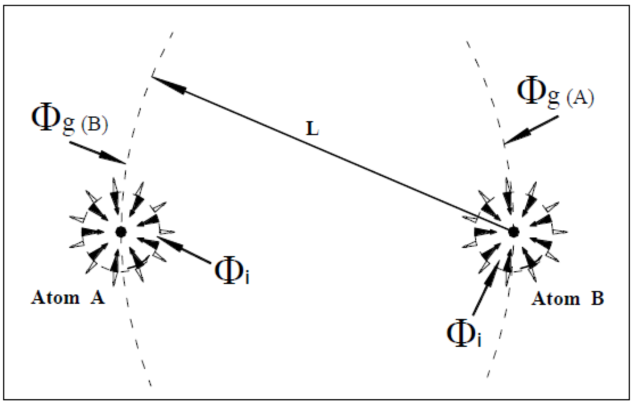

Figure 19. Universe of two atoms

According to Newton, one perceives the (gravity) presence of the other, after all the atoms possess mass. The presence of one will influence the other, by the intensity of the Gravitational Potential (**GP**).

In the electro sphere, in the referential of the nucleus of each atom, we have the presence of an Inertial Potential, which it is obtained by:

$$\Phi i = v_e^2 \tag{7.1}$$

This Inertial Potential, for an external atomic referential, has not attractive characteristics but yes repulsive, for that now the positive sign.

Let us analyze the situation in which these atoms (Figure 18) are under mutual influence of the **GP** generated by the other. Let us suppose that the distance between the atoms is sufficiently large that the potential generated by them (according to eq. 7.3) can be considered homogeneous.

All parts of any one of these atoms, or of these two microcosms, will be equally affected. But at the nucleus referential, as at the electron cloud referential, it won't be perceived any **GP** variation of external origin.

Let's see, at the referential of the electron cloud, we have a potential of:

$$\Phi_E = \Phi_i + \Phi_g \tag{7.2}$$

Where:

$$\Phi_g = -G.\frac{m_{atom}}{L} \tag{7.3}$$

And, at the nucleus referential:

$$\Phi_N = 0 + \Phi_g \tag{7.4}$$

For the Atom variation we have:

$$\Delta\Phi = \Phi_E - \Phi_N = \Phi_i \tag{7.5}$$

The variation of the Inertial Potential, in the volume of this microcosm (or atom), continues being the same! That is, at the nucleus referential or at the electron cloud referential are not perceived variation at the Potential <u>within the atom</u>.

However, the reality will be other for any external referential to the atomic system. **The new potential present at the electro cloud will change the perception, to an outside observer of this atomic system, of the electrons velocity.**

An external observer, at his referential, it doesn't verify, directly, internal variations of Potential, or among the parts of this microcosm! But verify the consequences of the influence of his Potential for the perception of the speed of the parts of this microcosm.

The new speed of the electrons, realized by the macrocosm, is obtained by:

$$v_e = \sqrt{\Phi_E} \tag{7.6}$$

The consequence of this is that an <u>external</u> observer, of this atom, will have an unbalance perception among the nuclear forces.

We can also see this by introducing, in the centrifugal force equation, the relative (apparent) mass, that is, the relative attraction force of the nucleus perceived by an external observer:

$$F_{Centrifugal} = \frac{m_e}{r_{atom}}.\frac{v_e^2}{\sqrt{1-\frac{v_e^2}{c^2}}} \tag{7.7}$$

At the Nucleus or Electron cloud referential, we have:

$$F_{Coulomb} = F_{Centrifugal} \quad (7.8)$$

But, for an external Referential to the atomic system, we have:

$$F_{Coulomb} > F_{Centrifugal} \quad (7.9)$$

This nuclear force difference is an inertia or Gravity, a force without mass, a relativistic effect, that it is only perceived by an external referential to the atomic system!

If we extend what we saw previously, for atoms, that are under a more solid influence of **GP**, in other words, generated by very large amount of atoms, as shown by the Figure 20, and to obtain for each specific point, quantitatively the greatness of the **GP** (with the eq. 7.10), below:

$$\Phi = -\frac{G.M}{L(n)} \quad (7.10)$$

Then, comparing quantitatively results, for the surface referential of the mass "**M**", we can verify the following:

$$\Phi_b >> \Phi_a > \Phi_S \quad (7.11)$$

Where: Φ_S is the GP at the surface of the mass "**M**".

And comparing the electrons speeds (insignificant difference), we verify:

$$v_e(b) << v_e(a) < v_e(S) \quad (7.12)$$

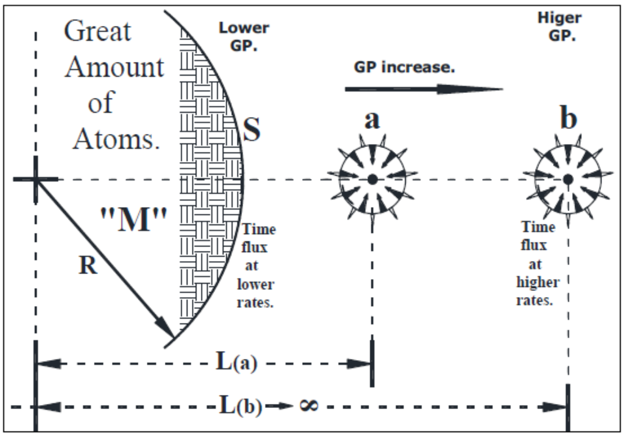

Figure 20. Gravitational potential and the flow of the time

Analyzing the Figure 20, we perceive that in the atoms for the referential of the mass "**M**", greater the distance, greater will be the difference, between the Coulomb's force and the Centrifugal force, in other words, the most distant atom will have a larger' **atomic gravity** or a larger gravitational "mass".

$$m_g(b) >> m_g(a) > m_g(S) \quad (7.13)$$

We verified that the gravitational attraction of these atoms is directly proportional to the local intensity of the Potential and inversely proportional to the speed of the electrons.

By doing a thorough analysis of this we can understand the "Equivalence Principle". We will now analyze two experimental evidences that will illustrate this mechanism well.

8. The Pioneer Anomaly

The interplanetary space probes, Pioneer X (launched by NASA (USA) in 1972) and Pioneer XI (1973), as they were moving away from the Solar System, presented a very small gravitational anomaly. Starting from the collected data [4,5], was verified, that the Earth receiving equipment, of the electromagnetic waves, constantly needed to have adjusted the synchrony to not losing the sign.

This frequency variation at 50 AU (see Figure 21), represents a theoretical slowing down of the probes (or a deceleration) or the increase of the attraction force to the Sun (gravitational blue shift) verified by the classic physics model.

We saw that the "**gravitational mass**" of the atoms possess the attraction force proportional to the local Gravitational Potential (GP) intensity or even inversely proportional to the frequency of vibration of the atoms (speed of the electrons) to the local reference.

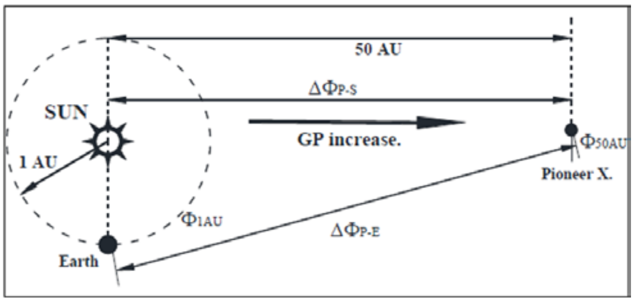

Figure 21. Gravitational anomaly of the Pioneer

Considering the eq. 2.13 we needed to know which is the variation of the **GP** ($\Delta\Phi$), between the probes and the Earth's surface (or referential point).

At the point of reception, that is, on the Earth's surface, basically we have the GP of the Earth's gravity ($\Phi_\oplus$), added with the Sun's GP ($\Phi_\odot$), obtained for the distance of one astronomical unit (AU), for the first approximation, we despise the others celestial bodies, then we have:

$$\Phi_\oplus(R_\oplus) = -G.\frac{M_\oplus}{R_\oplus} = -6.24955 \pm 0.00077).10^7 \frac{m^2}{s^2} \quad (8.1)$$

$$\Phi_\odot(AU) = -G.\frac{M_\odot}{AU} = -(8.87155 \pm 0.00051).10^8 \frac{m^2}{s^2} \quad (8.2)$$

To find the GP's imposed by the masses of the Earth and the Sun at a point in space at 50 AU we do:

$$\Phi_\oplus(50AU) = -G.\frac{M_\oplus}{50AU} = -(53.2899 \pm 0.0066)\frac{m^2}{s^2} \quad (8.3)$$

$$\Phi_\odot(50AU) = -G.\frac{M_\odot}{50AU} = -(1.7743 \pm 0.0001).10^7 \frac{m^2}{s^2} \quad (8.4)$$

With the eq. 8.1, 8.2, 8.3 and 8.4, we can found the total variation of the GP, by:

$$\Delta\Phi = (\Phi_{\oplus}(50AU) + \Phi_{\odot}(50AU)) - (\Phi_{\oplus}(R_{\oplus}) + \Phi_{\odot}(AU)) \quad (8.5)$$

Solving, we found: $\Delta\Phi = (9.3190 \pm 0.0002).10^{8}.m^{2}.s^{-2}$
Applying in the eq. 2.13 of the frequency, we found:

$$\frac{f_b}{f_a} = \sqrt{1 + \frac{\Delta\Phi}{c^2}} = 1 + (5.184 \pm 0.001).10^{-9} \quad (8.6)$$

So, this is the factor that corrects the "**gravitational mass"** of the Probes into the distance of 50 AU, or the rate in which the transmission frequency must be corrected. Or the rate in which increases the gravity attraction force, of the probe's "**atoms**", to the center of our Solar System.

9. Supernova SN 1987 A

The stellar explosion SN 1987 A was a Supernova in the outskirts of the Tarantula Nebula in the Large Magellanic Cloud, a nearby dwarf galaxy. It occurred, approximately 51.4 kilo parsecs from Earth (see Figure 22) approximately 168,000 light-years, close enough hat it was visible to the naked eye. The light from SN 1987 A reached the Earth 2 to 4 hours after the neutrinos on February 23, 1987 [6]. We can find out why this happened.

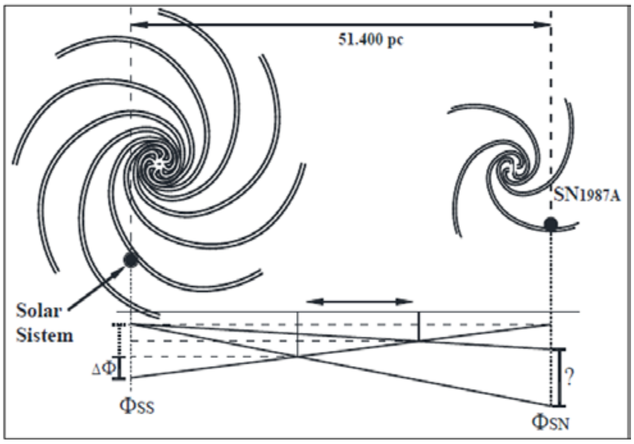

Figure 22. Neutrinos of Supernova SN1987A

Considering the long distances (D(SN)) involved, we will introduce an uncertainty of 5%. So, for the distance we have:

$$D(SN) = 51,400.206,264.8.AU = (1.568 \pm 0.078)10^{21} m \quad (9.1)$$

And the time that the radiation takes to, we have:

$$t(SN) = \frac{D(SN)}{c} = 5.290529 \pm 0.00333).10^{12} s \quad (9.2)$$

This represents something like 168,000 years.

Due to the fact that neutrinos have mass, they suffer in this path the influence of the variation of Gravitational Potential (PG), which will change their speed, we can by eq. 2.13 (frequency variation), find this speed, and therefore the time.

Analyzing the local situation, we found that practically only the GP's imposed by the gravity of the Sun ($\Phi_{\odot}$) and Earth ($\Phi_{\oplus}$) have significant greatnesses, and these were obtained in the previous chapter (8).

In the SN 1987A referential, we should have a PG present, but we don't know the greatness. Considering that the Milky Way is much larger than the Great Magellanic Cloud, perhaps 80 times, that is, the PG present in the SN 1987A region must be smaller than in the Solar System reference. We can argue, for a first approximation, that in SN 1987A we have something like half the PG of the Solar System. That is, for the main variation of PG we have:

$$\Delta\Phi = -(\Phi_{\oplus}(R_{\oplus}) + \Phi_{\odot}(AU)) = -(9.49 \pm 0.02).10^{8} \frac{m^2}{s^2} \quad (9.3)$$

Solving, we found a total variation of time (for k = 2), of:

$$\Delta t(SN) = \frac{D(SN)}{c}\left(\frac{1}{c.\sqrt{1+\frac{\Delta\Phi}{k.c^2}}} - 1\right) \cong -13{,}900s \quad (9.4)$$

That is, the neutrinos arrive, something like 3 h and 53 minutes before the radiation. (For k = 3 we found 2 h and 32 min.).

10. The Inertial Potential

The FERMILB (USA) Laboratory performed a neutrino experiment (MINOS [11]) in which was found that they move faster than the velocity of light "**c**", the result was:

$$Minos \rightarrow \frac{v_{Neutrinos} - c}{c} = (5.1 \pm 2.9).10^{-5}$$

A similar experiment was carried out by the European laboratory CERN (OPERA, for three consecutive years [7,8,9,10]). At the time, an outcome of (2.48 ± 0.28 (stat.) ± 0.30 (sys.)).10^{-5}, in relation to the speed of light, was released. Afterwards, the result was considered an "mistake", which was attributed to a failure in a connector, unfortunately the experiment was not performed again.

These neutrinos cross the Earth's subsoil, see Figure 23, at a depth that can reach 11 km, in a crossing of 730 km of matter (atoms).

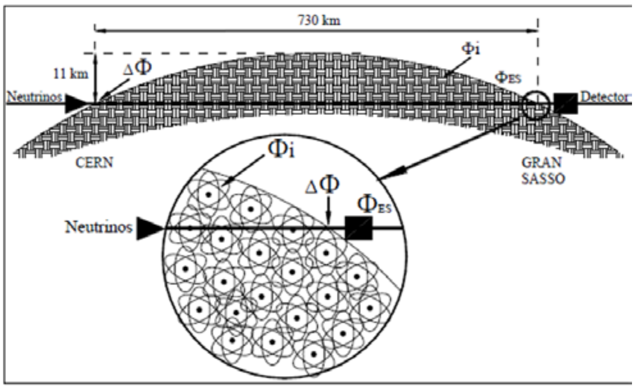

Figure 23. The OPERA neutrino experiment (CERN Lab.)

For the fact that these neutrinos have "mass", will be subject to the influence of the Inertial Potential (**IP**) present in the electro cloud of the atoms, according to eq. 2.13 of the frequency. That is, to determine their velocity (eq. 10.1), we need to know the total variation of potential they are subject to.

$$v_{Neutrinos} = c.\sqrt{1+\frac{\Delta\Phi}{c^2}} \quad (10.1)$$

This variation, should consider the **IP**, present inside the atoms, with the **GP**, present in the Earth's surface. Or be:

$$\Delta\Phi = \Phi_i - \Phi_{ES} \quad (10.2)$$

The Earth's surface **GP** (Φ_{ES}) can be despised, because it is many orders of greatness smaller than the **IP** (Φ_i).

To find the atoms' average **IP** (Φi), in the electro cloud, we must use the average electrons' speed, of all the atoms that predominate in this crossing. And we must still consider, for the calculation of the speed of the "electron as field", which determines the **IP**, the average volume traversed by the neutrinos (they move basically inside the atoms). That is, the average **IP** is found by:

$$\overline{\Phi i} = \left(\frac{\overline{v_e}}{\sqrt[3]{2}}\right)^2 \quad (10.3)$$

With the eq. 10.4, we obtain the Inertial Potential (**IP**) average inside the atoms. For each atom (or different element) we will have a different average **IP**, proportional to the protons quantity (atomic number).

$$\overline{\Phi i_Z} = \sqrt[3]{\frac{3.Z}{4.\pi}}.\left(\frac{q^2}{2.\sqrt[3]{2}.\varepsilon_0.h}\right)^2 \quad (10.4)$$

Where: **Z** is the atomic number of the atom, **q** is the elementary electric charge [15], $\boldsymbol{\varepsilon_0}$ is the vacuum permittivity [15] and **h** is the Planck constant [15].

Next, we will show the simplest way for the derivation of this equation. We will start by showing how we find the average atomic **IP**.

Making a geometric analysis we found that the average electron' speed, which determines the average **IP,** must be equal to the electron maximum speed of an atom with half the volume. Assuming that the atoms have a symmetrical spherical shape, as demonstrated in Chap. IV, and then we can use the sphere volume equation below (eq. 10.5):

$$V = \frac{4}{3}.\pi.r^3 \quad (10.5)$$

We know that, in the ground state of the hydrogen atom, the electron's velocity is equal to "**α c**", (where "**α**" is the fine-structure constant) and then we can do:

$$\frac{4}{3}.\pi.\left(\overline{v}\right)^3 = \frac{1}{2}.\frac{4}{3}.\pi.\left(\alpha.c\right)^3 \quad (10.6)$$

Simplifying, we found:

$$\overline{v} = \frac{\alpha.c}{\sqrt[3]{2}} \quad (10.7)$$

This is the (electron's) speed that we should consider to find the atoms' "**<u>average</u>**" "**IP**". In some cases we need to use the full **IP**, must eliminate the cubic root of two of the divider. To derive the equation of the atomic **IP**, we use a trick, in which we create a variable **Rz**, thus we have:

$$\Phi i_Z = R_Z.\left(\overline{v}\right)^2 \quad (10.8)$$

We must find the equation of this "**Rz**", like an adjustment complement, we can think that this **Rz** is like an imaginary radius that should be a function of **"Z"** (proportional to the amount of protons Z of the nucleus). Then, by analogy, we can use the sphere's volume eq. 09-05, and do a change of variables:

$$Z = \frac{4}{3}.\pi.{R_Z}^3 \quad (10.9)$$

Or yet:

$$R_Z = \sqrt[3]{\frac{3.Z}{4.\pi}} \quad (10.10)$$

Then, we finally found the eq. 10.11:

$$\overline{\Phi i_Z} = \sqrt[3]{\frac{3.Z}{4.\pi}}.\left(\frac{\alpha.c}{\sqrt[3]{2}}\right)^2 \quad (10.11)$$

In the following Table 1 we calculate some **IP** for the most common atoms found in the Earth's Crust (up to 300 m deep).

Table 1. Predominant elements (percentage) in the Earth's crust and their respective IP

Element	Z	Φiz	%
H - Hydrogen	1	1.87035×10^{12}	0.14 ± 0.04
C - Carbon	6	3.39865×10^{12}	0.034 ± 0.015
O - Oxygen	8	3.74070×10^{12}	46.60 ± 2.88
F - Fluorine	9	3.89048×10^{12}	0.08
Na - Sodium	11	4.15962×10^{12}	2.83 ± 1.25
Mg - Magnesium	12	4.28203×10^{12}	2.09 ± 0.64
Al - Aluminum	13	4.39782×10^{12}	8.03 ± 1.33
Si - Silicon	14	4.50781×10^{12}	27.72 ± 3.16
P - Phosphorus	15	4.61268×10^{12}	0.12 ± 0.01
K - Potassium	19	4.99084×10^{12}	2.59 ± 0.71
Ca - Calcium	20	5.07691×10^{12}	3.63 ± 0.54
Ti - Titanium	22	5.24079×10^{12}	0.44
Mn - Manganese	25	5.46893×10^{12}	0.15
Fe - Iron	26	5.54090×10^{12}	5.00 ± 0.81
Others (average)	41	6.44937×10^{12}	0.51
Ba - Barium	56	7.15570×10^{12}	0.04 ± 0.018

We know that as we penetrate the earth's crust, in depth, we will have a greater concentration of heavier elements. We can easily see this by seeing that lighter elements like hydrogen, nitrogen and other gases are found in the atmosphere. While, on the surface we have a wide range of water in liquid or solid form. On the other hand, we are not sure whether the chemical composition found in the first 300 m of the crust is the same at 3.3 km, which is the average depth of the MINOS and CERN experiment. Certainly at that depth, we will have a greater concentration of heavier elements. Considering this, we introduce an uncertainty of 10% to find the average magnitude of the PI of the atoms in the earth's crust:

$$\overline{\Phi i_{EC}} = (4.223 \pm 0.422).10^{12} \frac{m^2}{s^2}$$

This is the average IP intensity of the atoms in the earth's crust "Φi_{EC}" and is the one found in the neutrino route.

With this average PI we can find the relative speed in relation to the "c" of the experiment's neutrinos by:

$$\frac{v_{Neutrinos} - c}{c} = \sqrt{1 + \frac{\overline{\Phi i_{EC}}}{c^2}} \quad (10.12)$$

$$= (2.35 \pm 0.235).10^{-5}$$

11. The Atomic Casimir Force

The Casimir effect [12] is a force of attraction between surfaces, of good electrical conductor's elements, measurable when they are very close. That is, the Casimir force is observed only between atoms which have valence electrons, which are responsible for conductivity and also to open gaps in the atomic electrical shielding thus allowing the action, at a distance, of the Inertial Potential (**IP**) inside the atom.

By atomic gravity we know that this force is equal to the difference of the **IP** between the electrons, times the electron mass "$\mathbf{m_e}$", divided by the distance "**d**" between them, that is:

$$F = \Delta\Phi i.\frac{m_e}{d} \quad (11.1)$$

Let's imagine two surfaces separated by a distance "**d**" as shown in Figure 24 below.

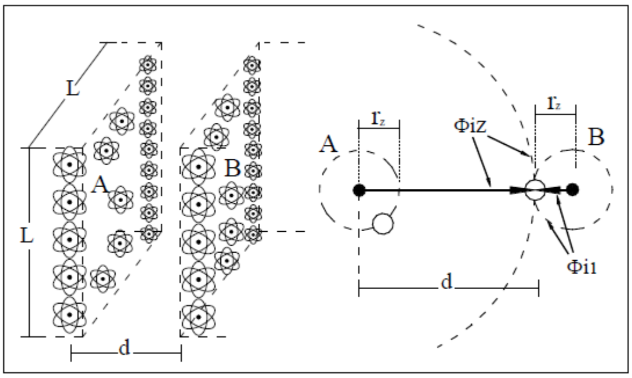

Figure 24. The Casimir atomic force

Let's put ourselves in the nucleus place of the atom "**A**", that is, this is our referential now. At this referential we perceive that the **IP** of the atom imposes at the electron of the atom "**B**" in front, an **IP** with a magnitude that is proportional to the distance volume (eq. 11.2), that is:

$$\Phi i A_Z = -\sqrt[3]{\frac{3.Z}{4.\pi}}.(\alpha.c)^2.\left(\frac{r_Z}{d}\right)^3 \quad (11.2)$$

Where: $\mathbf{r_z}$ = is the empirical radius of the atom (see Table 2) and "**d**" is the distance between surface atoms.

At this same referential, at the nucleus of the atom "**A**", we perceive the presence, in this point (at distance "**d**"), of the **IP** imposed by the nucleus of atom "**B**". But we only observed the presence of a gap. The atom "**B**" at the referential of the atomic nucleus "**A**" is partially shielded. That is, it is as if the atom "**B**" had only one electron or like a hydrogen atom. That is, this **IP** is calculated for Z = 1, which is:

$$\Phi i B_1 = -\sqrt[3]{\frac{3}{4.\pi}}.(\alpha.c)^2.\left(\frac{r_Z}{d}\right)^3 \quad (11.3)$$

As this **IP** points to the opposite direction, we must change the sign. Then, the total variation perceived by the **IP** of the atom nucleus "**A**" is:

$$\Delta\Phi i A = \Phi i A_Z - \Phi i B_1 \quad (11.4)$$

Or yet:

$$\Delta\Phi i A = -\left(\sqrt[3]{\frac{3.Z}{4.\pi}} + \sqrt[3]{\frac{3}{4.\pi}}\right).(\alpha.c)^2.\left(\frac{r_Z}{d}\right)^3 \quad (11.5)$$

With this **IP** variation, we now find the force "**F**", between the atoms, by the eq. 11.1, that is:

$$F' = \Delta\Phi i A.\frac{m_e}{d} \quad (11.6)$$

We can see that in the calculation of the **IP**, we did not include the divisor, the cube root of two, the reason that we want to consider the maximum atom **IP**, or the **IP** present on the border of electron sphere.

Basically it is only the surface atoms which are part of this force, and this amount can be obtained through the empirical dimension (radius) of the atom, see Table 2.

That is, to a side surface "**L**" we have:

$$n^o{}_{atoms} = \frac{L^2}{\pi.r_Z{}^2} \quad (11.7)$$

So the force of atomic attraction between the surfaces (considering we have two) is given by:

$$F = 2.F'.n^o{}_{atoms} \quad (11.8)$$

Table 2. Empirical radius of some good electrical conductor's elements

Element	Z	Radius (pm)	Valence electrons
Cu - Copper	29	135	1
Ag - Silver	47	160	1
Au - Gold	79	135	1

Comparing theoretical with experimental results we can verify the discrete characteristic of the Casimir force, we have only, on each side, one **quantum of inertia** acting between an atom and an electron.

12. Cooper-pairs Mass Anomaly

An experiment performed by Tate and Cabrera [13], [14], using a rotating niobium (Z = 41) superconducting (SC) ring found an unexpected value for the Cooper-pairs (**Cp**) mass. The observable Cooper-pair mass was determined directly by measuring the London moment flux, the result disagrees with theoretical predictions of 0.999992. The relation 12.1 below shows the discrepancy ("$\mathbf{m_{CP}}$" is the measured mass, and "$\mathbf{2.m_e}$" is the mass of an electrons pair at rest):

$$\frac{m_{cp}}{2.m_e} = 1.000084(\pm 21) \tag{12.1}$$

Analyzing the problem by atomic gravity we find the exact result, as we shall see. With the eq. 10.11, we find, the average, inertial potential "**IP**" of the niobium (Nb, Z = 41):

$$\overline{\Phi i_{41}} = 6.4493.10^{12}\,\frac{m^2}{s^2}$$

This average **IP** should be used twice (two times), because we have two electrons forming one Boson, and it has two drag front through the atomic **IP** field. Considering this we can find the relative mass by:

$$\frac{m_{cp}}{2.m_e} = \sqrt{1+\frac{2.\overline{\Phi i_{41}}}{c^2}} = 1.0000717563 \tag{12.2}$$

This result would be acceptable because it is within the margin of tolerance, but does not fully explain everything that happens within the SC, we still have the **IP** generated themselves by the Cooper-pairs' electrons.

The Cooper pair has two electrons, which try to balance around the present time, by keeping an oscillation which generates an **IP**. This oscillation between electrons pairs is similar to found in atoms where in pairs electrons are balanced around the present. That is, we have a self-generating **IP**, of these free electrons, which in some proportion influences the flow of Cooper pairs.

We can find some help from the helium atom, it has a similar behavior to a Cooper pair (here we also have two electrons). That is, we may add, to the average **IP** of "**Nb**", some portion of the "**He**" average **IP,** that is:

$$\overline{\Phi i_2} = 2.35649.10^{12}\,\frac{m^2}{s^2}$$

But, in what proportion we can count with this **IP**, or in what spatial ratio this **IP** influence the flow of the Cooper pairs. Supposing that we have the contribution of one electron of each atom of **Nb**, that is, for every two **Nb** atoms we have creating a virtual He atom. In this case we must divide by two then **He**'s **IP** (because, by the volume ratio, for every two **Nb** atoms we have one He atom).

Whereas the **Nb** atom loses an electron in the formation of the virtual **He** atom, they also loses an virtual proton, that is, from a **Z** = **41** we go to a **Nb** with a **Z** = **40**, it loses a quantum of inertia, the two virtual **Nb** protons represent, for the Cooper pair, the reference present time (or the core of the virtual atom of **He**), around which electrons are balanced. The **IP** for, Z = 40, is:

$$\overline{\Phi i_{40}} = 6.3965.10^{12}\,\frac{m^2}{s^2}$$

In this case, the superconductor ring has a total **IP** magnitude of:

$$\overline{\Phi i_{SC}} = \overline{\Phi i_{40}} + \frac{\overline{\Phi i_2}}{2} \tag{12.3}$$

With this **IP** in the equation 12.2, we have:

$$\frac{m_{CP}}{2.m_e} = \sqrt{1+\frac{2.\overline{\Phi i_{SC}}}{c^2}} = 1.0000842(2) \tag{12.4}$$

13. The Derivation of the "G"

In chap.7 we introduced a poor Universe, with only two atoms (see Figure 25, reproduced below), which we use to explain the origin of gravity by the influence of the atomic Inertial Potential "**IP**" of an atom on the other and which will now help us to derive the "**G**".

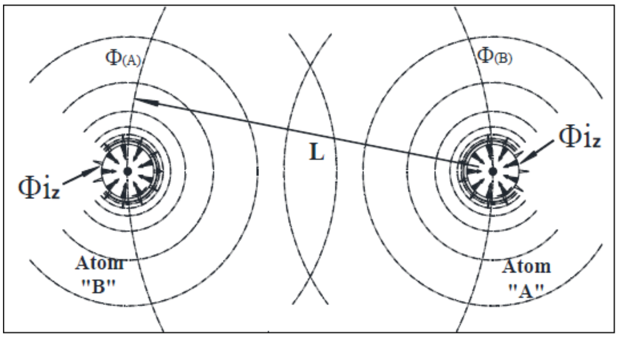

Figure 25. The Univers of two atoms

Traditionally we can obtain the Gravitational Potential (**GP)** on the Earth's surface with the eq. 13.1 of Newton, (or eq. 8.1 presented in chap. 8):

$$\Phi G_{\oplus} = -G.\frac{M_{\oplus}}{R_{\oplus}} \tag{13.1}$$

This **GP** greatness is highly reliable considering the amount of atoms involved (statistically analyzing) and the number of times that this measurement has been performed in the last hundred years (always on the Earth's surface).

By the gravity of Atomic origin, through eq. 13.2 below, we can also obtain this same result, which necessarily considers the influence of the **IP**'s of **all** the Earth's atoms (for this first approximation, we disregard the influence of any other object in the proximity).

$$\Phi G_{\oplus} = -\Phi i_Z \left(1-\frac{1}{\sqrt{1+\frac{\Delta\Phi i_{\oplus}}{c^2}}}\right)^3 .. \quad .. \left(1-\frac{1}{\sqrt{1+\frac{2.\Phi i_Z}{c^2}}}\right)^3 \frac{R_{\oplus}{}^2}{\sqrt{3}.r_Z.(R_{\oplus}+h)} \tag{13.2}$$

Where: Φi_Z is the **IP** of the standard adopted atom, $\Delta\Phi i_{\oplus}$ is the variation of the IP (sums) between the surface and the Earth's core, **h** = height of point which we want the **GP**. To facilitate the description and calculation we will separate the eq. 13.2 into four **Parts**, which make up the multiplication, by which we will find the **GP**:

- The first part: “ $-\Phi i_Z$ ...” is the **IP** of the reference atom “**A**”, or of the atom on the Earth’s surface, see Figure 26 (we should, for this case, from eq. 10.11, disregard (for the **IP** average) the cubic root of two of the dividend ($\sqrt[3]{2}$).

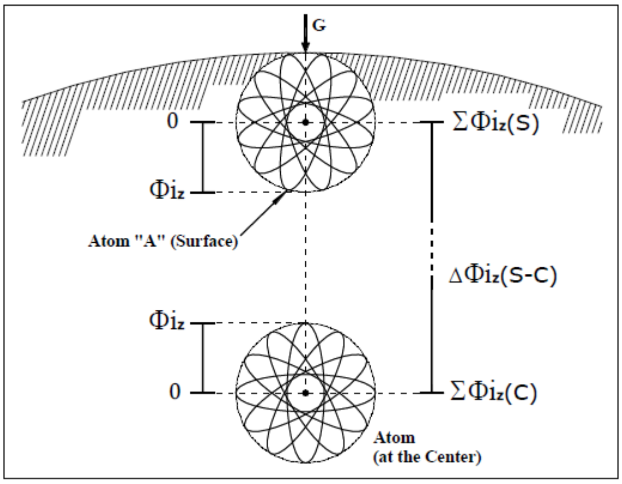

Figure 26. Considered inertial potentials

Let's put ourselves in the referential of the atom "**A**", on the Earth's surface, **more precisely at this atom’s nucleus.** And it is from this referential point that we will perceive the gravity of the set of all other atoms. This is our reference point in the flow of "time".

We need to have an atomic nucleus as a reference (**the present**), after all, it is always from a certain atom, by which, any kind of measurements are performed. Any photon (or gravity variation) only manifests its existence through an atom.

No one has ever observed an isolated photon or its trajectory or its displacement (double slit), even so, we suppose that they exist (or we unknown that only the information exist at c speed).

That is, the Φi_Z is the square of the electron’s speed obtained by eq. 13.3 below:

$$\Phi i_Z = \sqrt[3]{\frac{3.Z}{4.\pi}}(\alpha.c)^2 \qquad (13.3)$$

For this case, the **IP** (obtained by eq. 13.3) is the <u>same</u> for all the atoms of the set that compose this gigantic sphere, for which we want to find the surface **GP**. That is, by the eq. 13.4 below we can use the average electron velocity, and we can rewrite the eq. 13.2 (with H = 0 on the Earth’s Surface) as:

$$\Phi G_{\oplus} = -\left(v_e{}^2\right)\left(1-\frac{1}{\sqrt{1+\frac{\Delta\Phi i_{\oplus}}{c^2}}}\right)^3 .. \qquad (13.4)$$
$$..\left(1-\frac{1}{\sqrt{1+\frac{2.\Phi i_Z}{c^2}}}\right)^3 \frac{R_{\oplus}}{\sqrt{3}.r_Z}$$

- The second part:

$$...\left(1-\frac{1}{\sqrt{1+\frac{\Delta\Phi i_{\oplus}}{c^2}}}\right)^3 ...(2^{\circ}\,p.) \qquad (13.5)$$

The second part (eq. 13.5) is the correction in 3D of the electron velocity, obtained by the variation of the **IP**s, sums, between the Surface (S) and the Center (C) of the sphere, due to the mutual influence of the **IP**s of all the atoms present at the sphere (we will disregard any external influence). Where: $\Delta\Phi i_{\oplus}$ is the variation (of the sums) of the **IP’**s between the Surface and the Center of the sphere.

We are dealing with a relatively large sampling of atoms. We can find the approximate total number of atoms (**tna**, eq. 13.6) that we have in this Earth size object. Considering an atomic radius (empirical) "$\mathbf{r_z}$" between 120 pm and 150 pm, we will have something like:

$$tna = \left(\frac{R_{\oplus}}{r_Z}\right)^3 \approx 10^{50}\,atoms \qquad (13.6)$$

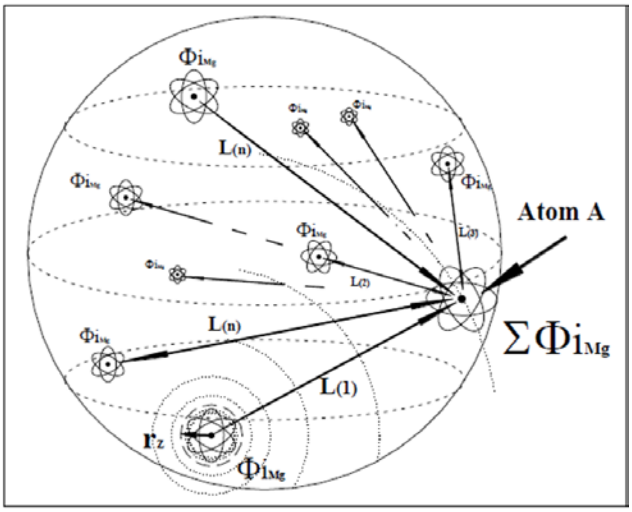

Figure 27. The Sphere of atoms

That is, to find out what is the apparent electrons speed, perceived in the reference of the "**A**" atom (or reference atom, see Figure 27), which is modulated by the presence of all the other atoms, are required the summations (eq. 13.7 below) which take into account, the **IP’**s diluted by the volume of the distance (**L**):

$$\sum \Phi i_{\oplus}(C\,or\,S) = \sum_{n=1}^{tna} \Phi i_Z(n).\frac{r_Z{}^3}{L(n)^3} \qquad (13.7)$$

Where: “**L**” is the distance between the atom "**A**" and the other atoms "**n**" of the sphere.

That is, the total variation of the **IPs** is obtained by the difference of these two sums:

$$\Delta\Phi i_{\oplus} = \sum \Phi i_{\oplus}(S) - \sum \Phi i_{\oplus}(C) \qquad (13.8)$$

With some ease we can find the summation for the <u>**center**</u> point (here we have the highest **IP** of the sphere).

We divide the sphere into layers, or multiples of the radius "**k** $\mathbf{r_z}$" (as shown in Figure 28), and we make the sum of the **IPs**, diluted by the volume of the distance (or the density of the **IP** for each distance), multiplied by the numbers of atoms, present in the volume of each layer, to the center, or something like this:

$$\sum \Phi i_{\oplus}(C) = \Phi i_Z \cdot \sum_{n=1}^{\frac{R_{\oplus}}{\sqrt{3}.r_Z}} \left(\frac{3.n^2 - 3.n + 1}{n^3} \right) \quad (13.9)$$

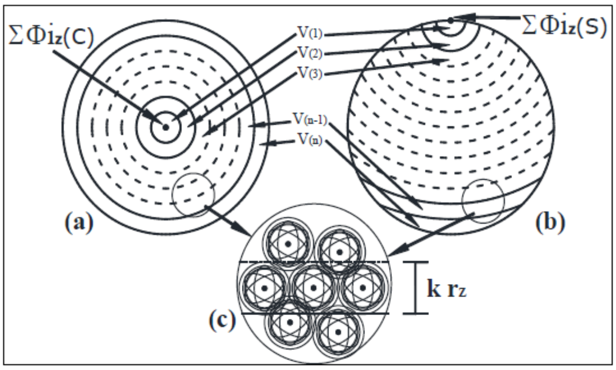

Figure 28. Division of the volume of the sphere in layers

And for the surface:

$$\sum \Phi i_{\oplus}(S) = \Phi i_Z \cdot \sum_{n=1}^{\frac{2.R_{\oplus}}{\sqrt{3}.r_Z}} \left(\frac{3}{2.n} - \frac{3.\sqrt{3}.r_Z}{4.R_{\oplus}} \right) \quad (13.10)$$

The "**k**" is chosen in order to achieve a better accommodation of the atoms in the layers, when analyzing the geometric we conclude that k = √3 (square root of three).

- The third part:

$$\ldots \left(1 - \frac{1}{\sqrt{1 + \frac{2.\Phi i_Z}{c^2}}} \right)^3 \ldots (3^\circ p.) \quad (13.11)$$

The third part (eq. 13.11) is the correction of the velocity of the electrons in 3D for the referential of the atomic nuclei or to the present (for both, the atom that originates the **IP,** as well, as for what perceives it). We need to reference the correction to the core. Because at the core of this atom "**A**", on the sphere surface, is where we have the time reference, or the present time referential. And it is from this "**A**" atom that we perceive the gravity of the whole set (in the surrounding) of the other atoms.

$$\ldots \left(1 - \frac{1}{\sqrt{1 + \frac{2.\Phi i_Z(A)}{c^2}}} \right)^3 \ldots (3^\circ p.) \quad (13.12)$$

The origin of the multiplier "2" (eq. 13.12) **of the Φi_Z(A): t**he "**2**" represents the relation between the potential energy "**U**" and the relativistic potential energy "$\mathbf{U_R}$". In a similar way as we verified the existence of equivalence between kinetic energy "**K**" is the relativistic kinetic energy "$\mathbf{K_R}$", where for "**K**" we have:

$$K = \frac{1}{2}.m.v^2 \quad (13.13)$$

While for "$\mathbf{K_R}$" we have:

$$K_R = m. \left(1 - \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \right) .c^2 \quad (13.14)$$

That is: $K = K_R$

We can verify that, in the case of the U, we do not have this equality, since:

$$U = m.g.h \quad (13.15)$$

Or, we can do:

$$U = G_{\oplus} . \frac{M_{\oplus}.m}{R_{\oplus}^2} .h \quad (13.16)$$

To find the $\mathbf{U_R}$ we need to know, which is the GP variation that we have on the Earth's surface, for that height "**h**", for that we do:

$$\Delta \Phi G_h = \left(\frac{G_{\oplus}.M_{\oplus}}{R_{\oplus} - \frac{h}{2}} \right) - \left(\frac{G_{\oplus}.M_{\oplus}}{R_{\oplus} + \frac{h}{2}} \right) \quad (13.17)$$

So, for the "$\mathbf{U_R}$" we have:

$$U_R = m. \left(1 - \frac{1}{\sqrt{1 - \frac{\Delta \Phi G_h}{c^2}}} \right) .c^2 \quad (13.18)$$

In order to have equality between the energies it is necessary to double the variation of the **GP**, that is:

$$U = 2.U_R = m. \left(1 - \frac{1}{\sqrt{1 - \frac{2.\Delta \Phi G_h}{c^2}}} \right) .c^2 \quad (13.19)$$

Summing up: $U/2 = U_R = K = K_R$

For this reason, in order to conserve the energies, both, the real and the virtual (which is out of time), for the correction in time, the atom's IP variation in the electron sphere must be considered twice. The "mass" (or an amount of energy defined in time) hides a virtual energy, when at relative motion, (and / or) as well as in the presence of a potential.

- The fourth part:

$$\ldots). \frac{R_{\oplus}}{\sqrt{3}.r_Z} \quad or \ for \ h > 0 \quad \ldots). \frac{R_{\oplus}}{\sqrt{3}.r_Z} . \frac{R_{\oplus}}{(R_{\oplus} + h)} \quad (13.20)$$

The fourth part (eq. 13.21) is the relationship between the rays, or the ratio of proportionality, whereby we bring linearly the **GP** of the nucleus of the "**A**" atom to the surface of the sphere, or to the point of measurement on the surface. Or, from somewhere distant point "**h**" to the surface of the sphere.

And with the complete eq. 13.2, we can obtain with Z = 17.05355 the PG on the Earth's surface (with h = 0, eq. 13.21):

$$\Phi G_{\oplus} = -\Phi i_Z \left(1-\frac{1}{\sqrt{1+\frac{\Delta\Phi i_{\oplus}}{c^2}}}\right)^3 \left(1-\frac{1}{\sqrt{1+\frac{2.\Phi i_Z}{c^2}}}\right)^3 \frac{R_{\oplus}}{\sqrt{3}.r_Z} \quad (13.21)$$

We found, $\Phi G_{\oplus}$ = -5.523(15).10^7.m^2.s^{-2}, and for a distance of h = 50 AU with eq. 13.22:

$$\Phi G_{50AU} = -\Phi i_Z \left(1-\frac{1}{\sqrt{1+\frac{\Delta\Phi i_{\oplus}}{c^2}}}\right)^3 \cdots\cdots \left(1-\frac{1}{\sqrt{1+\frac{2.\Phi i_Z}{c^2}}}\right)^3 \frac{R_{\oplus}^2}{\sqrt{3}.r_Z.(R_{\oplus}+50AU)} \quad (13.22)$$

We found: ΦG(50AU) = -53.545(38) m^2.s^{-2}.

14. Cosmological Potential

We verified, at gravity of atomic origin, the existence of a relationship between gravity and heat (or electromagnetic radiation), electrons tied to the atom generate gravity, while electrons when scattered, generate electromagnetic radiation. That is, gravitational activity or disturbances generates electromagnetic radiation.

We can understand this mechanism when we consider that each and every electromagnetic wave is a gravitational disturbance, which has its origin in the atom when, in this, we have an electron level transition, through which the generation of gravity is altered, that is, for any gravitational alteration we will have an electromagnetic disturbance in space.

We can verify that the **sum** of all gravitational potentials, generated by all the atoms of the Universe, give rise to a Cosmological Potential (CP), which should, theoretically, have a constant greatness in any point of the Cosmos.

To find this greatness we can find help in the cosmic microwave background or CMBR. NASA's COBE (Cosmic Background Explorer) mission, launched in 1989, aimed to accurately measure diffuse radiation between 1 micrometer and 1 cm around the entire celestial dome, and the value (T) found was 2.7260 ± 0.0013 ºK [16,17].

If the Cosmos has a temperature, radiated equally throughout the cosmos, it has a gravitational activity that must be proportional to a given **energy** which, it has a magnitude proportional to a mass, which can be found with the Bekenstein-Hawking radiation equation (14.1) given below.

$$Mass = \frac{h.c^3}{8.\pi.G.K_B}.\frac{1}{T} \quad (14.1)$$

Where K_B is the Boltzmann constant and G is the Newton constant obtained on the Earth's surface. Solving, we found: (4.5024 ± 0.0022) .10^{22} kg.

This equation must be in accordance with the black hole (BH) entropy law, which was derived from theoretical considerations of both Classical Thermodynamics and General Relativity, remembering that this is a concept of geometric origin, but equivalent to interpretation given in chap. 3 with the relativity of time.

Instead of modulating space by the intensity of gravity, we modulate it by the rate at which time flows. Atoms vibrate more in a time flux at higher rates, generating more gravity.

To understand this mechanism, we must remember the interpretation of relativity given in chap. 2, and imagine the Cosmos for this case as being a type of inverted BH, or a type of Universe with mass tending to infinity and which, consequently, will have a temperature tending to absolute zero.

This hypothetical cosmic mass (or **energy**) is equivalent to the temperature of the cosmos observed in the reference of the Earth's surface (or very close to it, 900 km). With the Wien dispersion equation (14.2), below, we determine the equivalent wavelength (λ_T), of this same temperature obtained by COBE, in the reference of the Earth's surface:

$$\lambda_T = \frac{K_W}{T} \quad (14.2)$$

Where: K_W is the Wien dispersion constant in [ºK.m]

Solving, we find: λ_T = (0.0010639 ± 0.0000005) m

Considering that this wavelength (λ_T) is in the reference of the Earth's surface and not that of the CP (λ_C), we must consider the variation of the GP between the Earth's surface and the PC, doing (with eq. 2.21):

$$\lambda_C = \frac{\lambda_T}{\sqrt{1+\frac{\Delta\Phi}{c^2}}} \quad (14.3)$$

Continuing, with eq. 7.10 (it's the same philosophy), we determine the Cosmological Potential equivalent (Φ_C) perceived on the Earth's surface.

$$\Phi_C = G.\frac{Mass}{\lambda_C.\sqrt{1+\frac{\Phi_C-\Phi_{ES}}{c^2}}} \quad (14.4)$$

We find Φ_C = (2.7831 ± 0.0027). 10^{15} m^2/s^2 and for λ_C = (0.0010469 ± 0.0000005) m.

This CP fills the entire Cosmos almost homogeneously, and must be added to the GP of the analyzed object, as well as the GP of all objects in the vicinity, in proportion to the distance.

For cases in which the sum of the object's CP and GP in relation to the Earth's surface is greater than "$\mathbf{c^2}$" these will not be visible.

$$Limit = c^2 - \Phi_C = 8.71.10^{16}\,\frac{m^2}{s^2}$$

Radiation as well as gravity cannot overcome the barrier $\mathbf{c^2 = 8.988\ 10^{16}\ m^2.s^{-2}}$ and do not reach the Earth, this happens with any other object in a similar situation.

We can still verify that the proportion between the CP and c^2 is:

$$\frac{\Phi_C}{c^2} = 0.0309 \rightarrow 3.1\%$$

which represents the amount of visible energy [19]. Recalling that the CP was obtained with the G of the Earth's surface.

As an example, let's analyze the BH of Galaxy M87, which even has a assembled image [18]. It is estimated that it has a mass of 6.5 10^9 $M_\odot$ (solar masses) and an observable radius of approximately 40 to 60 AU, with these data we can obtain an approximate GP of: 1.10^{17} $m^2.s^{-2}$. This is without considering the sum of the GP's of the stars in the surroundings that contribute to increase the GP. That is, we can certainly say that in the dark central region of M87 the GP present is higher than c^2.

In the most cases we do not know what the radius of the object is, in these cases it is difficult to estimate the GP. Is the case of Sagitarius A or the BH at the center of the Milky Way, it is known that its mass is 4.10^6 $M_\odot$ but the radius in which this mass is concentrated is unknown.

And we still have a big unknown, we do not know exactly how the stellar core is constituted, or what is its density, and what would be the equivalent GP.

We can affirm, from this theoretical development, that any object that has a grandness, in which, the sum of the GP (adding the GP's of neighboring objects) with the CP, is greater than $\mathbf{c^2}$**,** will not be visible on the Earth's surface.

We can see, in Table 3, below, as an example, the GP of several stars (the biggest ones) that are visible and will always have a GP + CP less than $\mathbf{c^2}$.

Table 3. ($M_\odot$ e $R_\odot$ represents the mass and the solar radius)

Object	Aprox. Mass	Radius	GP [m^2/s^2]
Sirius A	$2,2.M_\odot$	$1,5 . R_\odot$	2,79 10^{11}
VY Canis Majoris	$17(\pm 8) . M_\odot$	$1420(\pm 120). R_\odot$	2,28 10^9
R136C	$230 . M_\odot$	$20 . R_\odot$	2,19 10^{12}
UY Scuti	$1708 . M_\odot$	$192 . R_\odot$	1,69 10^{12}

We know that, in star formation, the amount of initial mass determines the type of star that will emerge. As this material collapses, due to gravitational attraction, it is consumed by nuclear fusion, the atoms of H and He that fuse into larger atoms, and the density gradually increases, as does the GP.

Three situations can occur: in the first, $\mathbf{(GP + CP) < c^2}$, the initial mass quantity is not enough to overcome c^2, here we have the formation of small and medium stars.

In the second, $\mathbf{(GP + CP) \geq c^2}$, the mass is enough to overcome $\mathbf{c^2}$ but not enough to hold the internal pressure, until the limit of the hydrostatic balance is broken at this point the star explodes in a Supernovae.

And the third, in which the initial mass quantity is extremely high, the sum of $\mathbf{(GP + CP)}$ **is greater than** $\mathbf{c^2}$, however the internal pressure does not exceed the gravitational pressure, so we have the formation of a BH.

Eventually, one that another particle can escape from the star furnace (accelerated by GP), and we call them cosmic rays.

15. Conclusions

The initial idea of gravity of atomic origin emerged more than three decades ago, and proved to be very efficient in solving several problems in physics, initially it seemed to be just another simple philosophical idea, but little by little AG was gaining theoretical and mathematical support.

Considering what was seen in relation to the GP differences for each point in space, and its constant variation, considering the influence of several celestial objects in relative motion, we can understand the difficulty in measuring the constant G, a measurement that is always complex and every attempt made always gets a different result, maybe we should pay more attention to it.

The CP gave us a better idea of the characteristics of the Cosmos, with which it is possible to understand several mysteries of stellar evolution as well as to visualize the proportion between visible matter and invisible energy. This new tool can be very useful in understanding the dimension of the Universe.

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