CORRECT QUANTUM GRAVITY IS A MECHANICAL EFFECT INDUCED BY DYNAMIC–MASS OF LIGHT'S QUANTA

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A B S T R A C T

In its natural state the electron is represented by superimposed quantum states. This is the phase of linear unitary evolution, or ***U** Phase,* described by Schrodinger equation. Whereas, when we carry out a *measurement* (M), it took place a *reduction* of the state vectors(***R** Process*): we have the wave function *collapse* (WFC) of the measured quantum object (QO). The M, thus, produces a big changes on the physical properties of the observed particle. How do these changes happen?

What is the secret mechanism which creates the WFC? We don't know.

With this paper we try to introduce a new parameter, induced by the electro-magnetic radiation (EMR), which can help us discern the doubts about the ***R** Process,* and try to find a *continuity* in order to link the ***U** Phase* to the ***R** Process,* so contrasting at the moment.

The new parameter could be a *gravity and quantum effect*, when we try to make a M of a subatomic object. What is this effect represented by?

It is a *gravitational effect*, since it is a *mass-effect*, a *mechanical action* induced by *quanta* of EMR: therefore, it is also a *quantum effect.* The photon (P) is indispensable to carry out a M. No M can be carried out without using the EMR.

Calculus show that a P of the optic band hits an electron with a *dynamic-mass*, a *radiation pressure*, a *pushing momentum* equal to $1.325 \cdot 10^{-22}$[g·cm/s]. Thus, we can infer it is a *quantum gravitational effect* to cause the WFC of the QO undergoing the M.

In short, it could be essentially the *mechanical action* represented by the *gravitational mass effect* of light's *quanta* to induce the WFC and the Measurement's Paradox and, likely, make a starting point to a *Correct Quantum Gravity.*

1. I N T R O D U C T I O N

The question about the nature of light, wave or particle [1][2] [3][4][5][6], can be solved with the Quantum Mechanics (*QM*) living to the particles – rather, to *quantum objects* (QO) - a *wave function* (WF) of their own, indicated with Ψ, which describes correctly both their wave and particle character[7]. It is well known that de Broglie proposed to give each particle a its own wave length *(λ*) depending only on the *momentum* (***p***) of the particle itself[8]:

$$\lambda = h/\boldsymbol{p} \qquad (1),$$

where *h* is Planck's constant. We learn from Chandrasekhar "this dualism wave-particle has been demonstrated a number of times, not only for the electron, but also for protons, neutrons, atoms and molecules. This dualism is a universal and fundamental property of the matter"[9]. The WF is a *mathematical function* which depends on time (*t*) and on the position (*x*) of the particle it is referred to. "The function Ψ(x) is usually called *the wave function* because it more often than not has the form of a complex wave in its variables"[10]. Feynman adds: "The WF for a single particle *is* a 'field', in the sense that it is a function of position"[10]. The WF has all the properties of de Broglie *associated wave* related to the particle itself, in fact it can also be indicated as *de Broglie wave*. Lloyd states: "A consequence of the wave nature of *QM* is that each (*quantum*) *state* corresponds to a wave, and waves can be *superimposed"* [11]. *QM* equations imply a universal presence of *superimposed states*. The WF(Ψ), that is the *quantum state* of the particle, represents the way in which we can find the particle when it does not interacts, when it is not *disturbed*, measured , observed. Thus, indicating with *t* the time, and with $x^1,....x^N$ the possible positions or space coordinates of the considered particle, we have the formula:

$$\Psi = \Psi\,(x^1,........x^N,t) \qquad (2).$$

Before we search the particle, that is before we *measure* it, the particle is *spread* throughout the employable space, as if for each point there was associated a precise value of *probability density* we have to find. According to *QM*, before the *measurement* (M) "we are not able to say that a quantum system, before being observed, has well defined properties, since we cannot know them"[12]. The object we are examining is something, and shows a its own property only after the M. In other words, the probable undulating aspects of a particle, of its WF, remain such until we decide to carry out a M in order to detect and find the particle. But then we go back to a description of particle: with the M, emerges its corpuscular aspect. The *QM* tells us that the wave or particle aspects are not at all outlined: the *square of the modulus* of the, $|\Psi|^2$, has to be interpreted as a *distribution,* as the *density of probability* to find the particle, its quantum state, in one of the several possible positions. "It is more likely to find the particle where its WF is maximum in absolute value; so the probability to find the particle in the space is 1, that is $||\Psi|| = 1$(100% of probabilities), where:

$$||\Psi|| = \int_{E^3} |\psi(x)|^2 \, dx^1 \wedge dx^2 \wedge dx^3 \quad (3),$$

that is the integral of $|\Psi|^2$ on all the space gives the total probability to find the particle in a place of the 3-dimensional physical space, with coordinates x^1, x^2, x^3. Thus, the WF is *normalized.* "With the WF of a single particle the 'rule' is the quantity $||\Psi||$, defined as the integral of $|\Psi(x)|^2$ on all the space the particle can occupy"[13]. In the case of a particle having a spin, i.e. the electron, we can think of it as a two-state system. Suppose we choose for our base states |1> and |2> the states in which the *z*-component of the electron spin is $+\hbar/2$ and $-\hbar/2$. Penrose writes:"The *normalization* condition for Ψ is that $||\Psi|| = 1$, then $|\Psi(x)|^2$ is the *density of probability* to find, with a *position* M, the particle in the point x. This rule is related to the so called *linear unitary evolution phase* ***U*** of the quantum formalism; the same rule plays an important role in the ***R*** *phase*, or ***R*** *Process*" [13], thus determining all the *probabilities* which come out. "The *normalization* request makes us exclude the WFs of the *momentum states*, indicated with:

$$\Psi = e^{i\mathbf{P}\bullet\mathbf{x}/\hbar} \quad (4),$$

since $|\Psi|^2 = 1$ throughout the infinite space, so that the previous integral, being equal to the total volume of the space, diverges"[13]. The Eq.(4) describes the *momentum state* of the WF(Ψ) of the *quantum object*(QO) we are examining, considered in time $t=0$. The *momentum* is not localised, it is uniformly distributed throughout the employable space, as can be inferred from the second member of the equation which represents the *modulus* describing the *momentum* (*i* is the imagining unit and $\hbar$ Planck's constant rationalized, $= h/2\pi$). Thus, "since the integral diverges" [13], we have to consider the integral of the *momentum states* as unrealizable idealizations: that is as "it is not possible to carry out a M of the WF of the *momentum states"*[13]. Thus, it is thought that all M are reduced to *position* M(not of *momentum*). Indeed a WF can be *normalized* if the integral defining the $||\Psi||$ - as in Eq.(3) -converges. Only the WFs *normalizable* have a chance to be physically realized. The *probability density* to find the *position (x)* of a particle is given dividing the *quadratic modulus* ($|\Psi|^2$) of the WF by the integral of $|\Psi|^2$ throughout the space; that is:

$$|\Psi(x)|^2 / ||\Psi|| \quad (5).$$

Along with this probabilistic interpretation, the WF is called "probability wave". Before the M, the phase of WF gives to the QO its "undulating character", since the WF is *diffused* in the space occupied by the particle the WF is referred to. This condition of the WF, indicated as *unitary linear phase* ***U***, or ***U*** *Process*, has been brilliantly described by Schrodinger. The first difficulty he found, was that the WF was as a function of time. How to add the difference from the time (*t*)? Indeed the classical H*amiltonian* (***H)*** representing, as we know, the total energy of the examined physical system, is independent by the time. In the Hamiltonian representation the generalised condition *positions* (x^1,.....x^N) are associated to the *conjugated momenta* ($\boldsymbol{p}_1$,....$\boldsymbol{p}_N$), so the *momentum (**p**)* of a free particle is given by the velocity (v) of the particle, times its mass (m):

$$\boldsymbol{p} = m\,v \quad (6).$$

Thus, according to the Hamiltonian formalism, aiming to describe the total energy of the physical system we are examining, independently by the time, but by *momenta* and *positions*, we have the *Hamiltonian function* (***H*****):**

$$\boldsymbol{H}=\boldsymbol{H}\,(\boldsymbol{p}_1,....\boldsymbol{p}_N;x^1,.....x^N) \qquad (7).$$

As we know, along with the mathematical formalism of the *QM*, ***p*** can be identified by a Heaviside *differential operator* (*D*):

$$D = d/dx \qquad (8).$$

In this identification, between ***p*** and *D*, with the *QM* we have the *quantum momentum* ($\boldsymbol{p}_a$):

$$\boldsymbol{p}_a = i\,\hbar\; d/dx \qquad (9).$$

The new *momentum operator* ($\boldsymbol{p}_a$), typical of the quantum formalism, substitutes the *classical momentum (**p**)* in the *Hamiltonian classical function*, see Eq.(7), according to the process known as *canonical quantization*. The $\boldsymbol{p}_a$ in Eq.(9) was used by Schrodinger in his equation, occupying all the first member, adding the quantum state Ψ which varies according to the time (*t*):

$$i\,\hbar\; d\Psi/d\,t= \boldsymbol{H}\Psi \qquad (10).$$

The second member of the equation (10) expresses the energy of the examined system, that is of the Ψ. This energy is represented, as in the classical form, by the Hamiltonian *(**H**)*, but in that case it is a *quantum Hamiltonian function*, as:

$$\boldsymbol{H}=\boldsymbol{H}\,(i\,\hbar\; d/dx^1,....i\,\hbar\; d/dx^N;x^1,.....x^N) \qquad (11).$$

The WFs which can be *normalised* (that is the particles) constitute a *complex vectorial space* (an underspace of the state spaces **W**), known as 'Hilbert space', which we indicate with **HS**, to make a difference from ***H*** of the Hamiltonian. The **HS** is represented by the symbol |...>. We know that the complex number < Ψ|ϕ> is the *conjugated complex* of <ϕ|Ψ>. The action on |ψ> from a l*inear operator **L*** **,** is written ***L***|Ψ>**,** and the scalar product of the ket |ϕ >, with ***L***|Ψ>, is written:

$$\langle\phi|\boldsymbol{L}|\Psi\rangle \qquad (12).$$

In the Schrodinger *evolution* <ϕ|Ψ> is constant in time, that is:

$$d\langle\phi|\Psi\rangle/dt = 0 \qquad (13).$$

Thus <ϕ|Ψ> remains unchanged in time. Let's analyse some evolution modalities of a quantum state. Let us suppose we have, at time *t* = 0, the *quantum states* |ϕ> and |Ψ>, and make them evolve, according to Schrodinger description, till time *T*, when the *states* become respectively [13]:

$$|\phi\rangle \sim\!\sim\!\rightarrow |\phi_T\rangle \qquad (14),$$

and:

$$|\Psi\rangle \sim\!\sim\!\rightarrow |\Psi_T\rangle \qquad (15).$$

Then:

$$\langle\phi|\Psi\rangle = \langle\phi_T|\Psi_T\rangle \qquad (16).$$

Therefore the Eq.(10), or Schrodinger equation, is an equation of temporal evolution indicating how the considered physical system, the particle, represented in its quantum state or WF, can change, develop in time. It expresses the phase of *linear evolution* of the considered particle called '***U** phase*', since it is the process of *Unitary evolution* [13]. It could say that this ***U** evolution* indicates a particle when it is not troubled but it *develops linearly*, normally, according to the need of the particle itself and its parameters. This situation persists in time till we observe it, till we make a M, or till it interacts by chance with another particle or physical system[14].

2. DISCUSSION

2.1. The Measurement (M) of a Quantum Object (QO)

Let's examine as in the mathematical formalism of *QM* a M of a quantum system must be represented: a 'measurable quantity' of a quantum system is represented by a certain kind of operator ***Q***, called *observable.* Examples of *observables* are the 'dynamic variables': i.e. the *momentum (**p**)* and the *position (x)* of the particle we wish to examine. The theory requires that an *observable **Q*** is represented by a *linear operator **L***, so that its action in Hilbert space (**HS**) is to make a linear transformation of **HS**.

In the **HS** an analogue of the Liouville Theorem is applied. Just for the *unified* nature of the *temporal evolution* of ***U** phase*, according to Liouville Theorem, the *volume* of any region of the *phases space* must remain constant in the case of any *Hamiltonian evolution* [15]. Penrose adds: "As a *volume* element in the Phases Space it is considered the 2N-form:

$$\Sigma = \boldsymbol{S} \wedge \boldsymbol{S} \wedge \ldots \wedge \boldsymbol{S} \qquad (17),$$

where **S** are in number N, remembering that **S** is the symplectic 2-form given by $d\boldsymbol{p}_a \wedge dq^a$. Thus, **S** is preserved by the Hamiltonian evolution, that is, the Lie derivate of Σ *volume* is preserved by this evolution. This is the Liouville Theorem. Since $\{\boldsymbol{H},\boldsymbol{H}\}=0$, **S**, with respect to the vector field is zero:$\{\boldsymbol{H},\ \}$. Hence Hamiltonian itself is preserved, that is, it is constant along the trajectories, which is a reflection of the fact that the total energy of a *closed system* remains constant " [13].

Every time we want to study, and try to interpret the effects induced by a M, that is, when passing from the ***U** phase* to the ***R** Process*, we must bear in mind that WF (Ψ) must be *invariant*, that is, after M, after the WF collapse (WFC), the particle will have to go back to its previous state, as if, apparently, nothing had happened: this is due to the Noether theorem, according to at every *symmetry* corresponds a *conservation law* [16]. In fact, this theorem also applies to Quantum Field Theories (QFT), so WF (and theory itself) must be *invariant* for operations that change the *phase*. As it is well known, a QFT must be gauge-invariant. The conservation of various physical quantities comes from this *invariance*. Applying this procedure to the *fields*, we have that in case of a *gauge-invariance*, we will have a charge conservation: e.g. in the case of the *gauge invariance* of the electromagnetic field, we will have a conservation of the electrical charge, respect to:

$$\Psi \rightarrow e^{i\,\theta}\,\Psi \qquad (18).$$

This *unobservable* transformation is the most famous gauge *transformation* where Ψ represents the WF of a electrically charged particle or QO (such as the electron), and $e^{i\,\theta}$ is a complex unit number (with θ real), expressing a *complete* phase [17]. In fact "if the WF describes a charged particle, then we can make *gauge transformations* of the form expressed by Eq. (18) where θ is an arbitrary real position function, allowing us to change the way the phase varies!" [13].

Maxwell's equations do not change, that is, they are *covariant*, so Weyl believed that it was possible to extend this *covariance* to the gravitational field too, as well as to General Relativity, thus trying to unify electromagnetism (EM) and gravity [18]. In fact, bearing in mind the Noether theorem, in 1918 Weyl formulated a *gauge theory* [19] to be applied to General Relativity. "According to Weyl's theory, the way a clock measures time does not depend solely on its current position, but also on the previously positions. Likewise, the emission frequencies of a hydrogen atom will depend both on its current and past positions. It is like saying: the behavior of the atom will depend on its history, despite contradicting experimental evidence. However, Weyl's idea contained a fatal mistake, which Einstein clearly saw from the beginning"[18]. As Penrose points out, Noether's theorem shows various limitations in the case of Gravitational Theory: when gravity is included, there must be the *gauge invariance* appropriate to gravity, i.e. the *invariance* with respect to the coordinates, using the mathematical formalism of *tensors* [13]. In 1921 Weyl gave up, but we must remember that Weyl's *tensor* is part of the field equations of General Relativity.

2.2. The Hilbert Space (HS)

A primary request for the *quantum observables* is that their *selfvectors* cover the entire **HS**. That is, the *self-vectors* of the particle we wish to observe – its quantum superimpositions fluctuating inside the space occupied by the particle itself – must move inside the **HS.** It is the same as saying that the requirement of *QM* leads the real space occupied by the particle to coincide with the **HS**. According to these considerations, the **HS** should become a real space, not only hypothetical. In *QM* the **HS** coincides with the *phases space* of classical physics. "The Lagrangian gravitational of Hilbert, indicated with *S*, consists essentially of the scaled bend (*R*) divided by the constant 16π*G* (where *G* is the gravitational constant), multiplied by ε:

$$S = \frac{1}{\int_{\upsilon}(L-R)\varepsilon 16\pi G} \qquad (19),$$

where ε represents the quantity normally expressed as:

$$\varepsilon = dx^{\circ} \wedge dx^{1} \wedge dx^{2} \wedge dx^{3} \sqrt{(-\det \boldsymbol{g}_{ij})} \qquad (20),$$

L is the Linear Operator, which must be considered as space-time *density*, which means that the *invariant* entity *is the 4-dimensional **L**ε*. The integral of the action will be:

$$S = \int_{\upsilon} \boldsymbol{L}\varepsilon \qquad (21),$$

where υ indicates the quadrimensional (complete) volume of space-time"[13]. All of this should occur in the **HS** that, again, should correspond with volume of space occupied by a particle till it is not troubled, observed, measured: i.e. during the time in which the particle is *indeterminate, not localized*.

Therefore, when we make a M, we work on the particle, i.e. on the QO, not only interacting with its more external region, but also and more interacting with its internal structure, distrupting violently its inner configuration, its internal space, and so the arrangement and positioning (probably fluctuating) of *quantum superimpositions* that characterize the particle. It is the same as saying that M interferes with everything is in the **HS**, relative to the observed particle. So the M leads to the *collapse* of WF (WFC) of the observed particle, working in the **HS** relative to the same particle. However, the WFC, induced by M, could represent a real (not only hypothetical) event occurring completely in the reality, so that also the space in which the *collapse* happens could be probably a real space, not imaginary. And which is the space where the WFC occurs? It is of course the volume of space occupied by the particle before M, the space where the *superimpositions of quantum states* of the observed particle move. And this space could correspond to the **HS**. Let's analyze this space and its governing rules.

As Prigogine reminds us: "Hereafter we list some properties of **HS**; it presumes the existence of a scaled product (f^x is the *coniugated complex* of *f*):

$$<f\,|g> = \int dx\ \ f^x(x)\, g(x) \qquad (22),$$

and of a *norm*:

$$||f|| = \sqrt{<f|f>} \geq 0 \qquad (23).$$

The condition <f|f> = 0, implies f=0. The **HS** is then formed by the *summable square functions* (where the variation of integration *x* is substituted by the coordinates and *momenta,* when considering the *phases space*). An *operator,* acting within the **HS**, transforms a function of the space in another. We have: ϑ f = g. The added operator,Θ^+, is defined by:

$$<\Theta\, f|g> = <f\,|\Theta^+ g> \qquad (24).$$

The operator is considered *selfadded* (or *Hermitian*) when $\Theta = \Theta^+$. *Liouville* operator, ***L***, or *linear operator* ***L***, is *Hermitian*, so we have: $\boldsymbol{L} = \boldsymbol{L}^{+.}$ The *evolution operator* ***U***=e^{-itL} is unitary:

$$\boldsymbol{U}^+ = \boldsymbol{U}^- = e^{iLt} \qquad (25).$$

Besides, in **HS** the *time direction* does not have any influence.

Let's introduce a *orthonormal base* in this space; u_i functions which allow us represent an arbitral function *F*, of this space:

$$F = \Sigma\, c_n\, u_n \qquad (26).$$

Orthonormality is represented by the conditions:

$$<u_i|u_j> = \delta_{ij} = 1 \qquad (27),$$

with: *i* = j; or:

$$<u_i|u_j> = \delta_{ij} = 0 \qquad (28),$$

with $i \neq$ j.

We can write u_n as a *bra vector*, indicated with $<u_n$, or as a *ket vector,* indicated with $u_n>$. So the scalar product becomes a the product of a *bra and a ket:* $<u_n|u_n>$. As for the problem of *self values* and *self functions* of **HS** operators we know that *self values* γ can be *continuous,* or *discrete.* A fundamental theorem proves that *self values,* of Hermitian operators, are 'real' in **HS"** [20]: as 'real' is, we think, the **HS**!

According to the rules of *QM* the result of a M, related to an *operator* ***Q***, is always one of the two *self states*: this is the *jump* of the *quantum state* (or WFC) which occurs with the ***R*** *Process*. Penrose states: " Whatever the state before the M, it *jumps* in one of the ***Q*** self states, as soon as the state (that is the particles in exam) is measured (along with the ***R*** *Process*). After the M the state gets a definite value for the *observable* ***Q***, precisely the *self value q.* If the M is repeated, the second M will give the same *self value*, that is the same result we got with the first M" [13]. When the *observable* ***Q*** is measured on the state $|\Psi>$, the rule is that the *probability* tells us that the state *jumps* from $|\Psi>$ to one of the ***Q*** *self states*: $|\phi>$. The *jump* of the WF, or WFC, induced by any kind of M, is represented as follows: $|<\Psi|\phi>|^2$ (29).

This is not true, of course, for the macroscopic world. Miller states: "If we want to make a M, as to detect the position of a falling ball, we have to see or photograph, that is we need to *light* it up. In order to do so we have to hit it with light beams, that is with a number of photons (Ps): however the Ps hits do not modify the trajectory of the ball, nor its velocity. Thus, on a macroscopic body the observing process of the M, do not modify at all the observed system; actually both the *position* and the speed or *momentum* of the ball can be determined at the same time, with al the precision and accuracy we wish" [21]. On the contrary, in the macroscopic world *position* and *momentum* are not complementary values, so it is not possible to apply Heisenberg's Uncertainty Principle(HUP). "Let's see what would happen if the ball was a single electron. According to *QM* the falling electron can be in any position, since its WF is *diffused* throughout the space (the ball, instead, is localised since the beginning). It doesn't have any sense to wonder where the electron is, until a M is carried out, i.e. taking a picture of it: in this case we need to light it up, at least with a light quantum, which becomes part of the M system. The interaction of the single light quantum (one P) with the electron, localises it in that moment"[21], at the same time we have induced a particular phenomenon of the *QM* : the WFC. The contact of a single P with the electron in exam can collapse its *quantum states*, its WF.

Well, the interaction between the M's system (that is also a single light quantum) and the examined physical system (the electron) induces the ***R*** *Process*: that is the *reduction* of the electron WF (which was *diffuse*, till a moment before the M), so now it tends to converge to a certain, well defined, region of the space. That is "among all the possible positions which the electron WF can occupy, as a *diffused* wave in all the space, the M process chooses one. Thus, with the M, the *quantum state* of the electron is transformed from being potentially in any position to being in a well defined position. The HUP tells us that the cost of this localization is an enormous *uncertainty* about the *momentum* of the electron"[21]. According to *QM*, before the M, the particle may be represented by a combination of *quantum states* more or less *superimposed.* However it is thought that the M itself makes it pass to a particular state. Thus, if we consider that an electron is localized in this or that point, the *QM* tells us that it can *accumulate* the 2 possibilities, the 2 *possible states,* and become the sum of an electron which is in this or that point: with the opportunity then to pass through 2 close splits in the same time, until we don't observe it [22].

What kind of mechanism can be concealed behind the observation, behind the M, behind this kind of interactions? No one knows. Miller adds "both Schrodinger equation and the other *QM* fundamental equations remain mute!" [21]. However, what seems important is that "the WF does not evolve along with Schrodinger equation, after the M" [23].

2.3. Only using the Electromagnetic Radiation (EMR) we can make a M

This is the crucial point: the use of the electromagnetic radiation (EMR) results in a modification of the *quantum state* of the particle observed, since it undergoes, under the action of the EMR (this topic will be clarified farther), the *jump,* the *collapse* of its WF (WFC), thus the particle, the QO, that used to behave as a wave will now appear as a corpuscle. As we know this phase called ***R*** (or ***R*** *Process*), lasts just a very short moment, as the M effect ends the previous phase is resumed (present knowledge does not clarify why the WFC is so short). According to *QM* we will never be able to have information about the aspect and the property of a QO, until it is observed. It is thought that before the M the electron could be found potentially in one of the several points of its *wave volume*, each corresponding to probability amplitude, to a probability density. With the M the *collapse* of the WF takes place, so now our particle will be detectable in a precise point, and at the same time the other probability amplitude, will disappear, according to them the particle could be *spread* on other points in the space it could occupy (the WFC is also called *Amplitudes Reduction*). With the M the *state* of the particles *jumps* in a localised state: with the M the *quantum state* of the particle is an *auto vector* of the *position operator x*. Before the M, probably the particle was scattered in an undulating way throughout the space which could be occupied (*self-state of the momentum operator* ***p***). When the WF of the electron *collapses*, it is delimited in a specific point: the particle is localized, its *position* is detected. The electron will now show completely as a particle, it is in fact observed in its corpuscular aspect. A corpuscle is, indeed, something concentrated in a precise point of the space. "It is clear that the WF is something more *real* than a simple *probability wave.* Schrodinger equation gives us this entity (both charged and non-charged), a precise evolution in time, an evolution which depends critically on how the phase changes from a point to another. If we ask a WF where the particle is, carrying out a position M, we have to expect we will lose this information on the phase distribution. After the M we have to restart with a new WF. If the result of the M says that *the particle is here*, the new WF has to be a very high crest in *that* position, but then it disperses quickly according to Schrodinger equation"[13]. Thus, the M induces the *collapse* of the WF particle we want to examine, so it will pass from an undulating behaviour to a corpuscular aspect[24].

Physicists wondered what was the role of the observer in the M process of a physical system. Does the chance have a role, or it doesn't, in determining the results of the M? According to Bohr we cannot talk about a particle without taking in account the interaction we, observers, can have with it (in contrast with classical physics). Bohr suggests that it does not exist a reality independent by the M apparatus: it is not possible to trace a clear separation between the behaviour of the observed particle and the instrument of M. A physical theory can describe physical phenomenon only if it includes an experimental content, the observation, the M, which make these phenomena show (though there are modified). In this regard, Prigogine replies: "The *cosmic microwave background radiation*, distributed in the cosmos at 3° Kelvin, is witness to the beginning of the universe. But the idea that such radiation would be the result of M is absurd: in fact, who could or should *measure* it? It is therefore necessary in *QM* to have an intrinsic mechanism that leads to the observed statistical aspects: this mechanism is precisely instability, chaos "[20].

What is particularly relevant is that to carry out a M, to observe anything in the Universe, any macroscopic object or particle, it is necessary to use an EMR, having a wave length (λ) shorter or equal to the diameter of the object to be observed. In this way the EMR hits the object and, bouncing back partially towards us will give us the information about the object examined. On the contrary, if the wave length of the EMR is longer than the diameter of the particle or object to examine (i.e. a radio wave of a certain length), it will go around the object, jump it, and will not show it to us. In the same way since EMR will not hit the object the WFC will not take place. Hence, the smaller the object or particle to be examined, the smaller has to be the wave length of the EMR used, thus bigger its energy. Thus if we want to detect, observe, *measure* an electron, we need to light it, we need to point on it an EMR with a short λ. However in this case we hit it so deviate and modify its trajectory. Indeed, the *QM* teaches us that the observation of the microscopic world, the M, modify the physical system we want to examine. According to our opinion, it seems that the *main character in this enigma* (the M's Paradox) is the EMR. Why?

The main reason is that in order to observe, to see, or make a M, we always need to use the EMR. It is the only physical mean which allows us to detect a particle, analyse and study the physical system we are interested in. Only using the EMR we can acquire the information about the state and the property of the objects of the subatomic world. No M can be made without using the EMR. Without the EMR we wouldn't be able to observe the world: both at a macroscopic and a microscopic level.

The **EMR is the *wire*** which links the observer to the physical system to be observed. This *wire* allows us to get the M of the particle we are interested in. Without this *wire* we wouldn't have any information of the world, which would appear *dark* and unknown, and would never be able to *measure* it.

2.4. The Energy of the Photon (P)

Let's analyse shortly the nature of such a radiation. As we know it carries a large number of *light quanta*, or photons (Ps), second after second. The common visible light travels with an average oscillation frequency of about $5 \cdot 10^{14}$ [c/s]. The energetic values of each P, without considering its oscillating frequency, corresponds to the Planck constant, which is just an energetic value, corresponding to $6.626 \cdot 10^{-27}$ $[erg \cdot \sec]$. The P, of course, goes with the speed of light, this value (c) is know too, it is 299792.458(± 0.4)Km/sec [25]. Let's now consider the equation related to the Principle of Equivalence Mass-Energy(MEEP):

$$E = mc^2 \qquad (30).$$

That's how Einstein commented upon his MEEP: "The value of the considered mass refers to the value of an *inertial mass"* [26]. Let's apply Eq.(30) to the P, keeping in mind that one of the three parameters is well known, that is *c*, the speed of the P in the vacuum. The 2° parameter is the Energy of the P which, as described first by Planck [27] and later by Einstein [28], is expressed by the formula:

$$E = h \cdot \nu \qquad (31),$$

where h is Planck's constant and ν the oscillation frequency of the P. Here things get more complicated since the Eq.(31) expresses the energetic value of a P in motion, that is at the highest speed, oscillating a number of times per second, depending on the EMR band to which the P is associated. The Eq.(30), instead, represents the value of an *inertial mass*, just because it is involved the MEEP, it will express an *inertial energy*, as to say a *minimal energy* of the particle we are considering. Besides, as Chandrasekhar reminds us "it is useful to consider that a fundamental consequence of the quantum nature of the matter: the lowest energy possible for a system cannot be null, that is zero, but it needs to have a value different from zero, it is called *Zero Point Energy*(ZPE)" [9]. On the other hand, still for the MEEP, to an “energetic” particle, carrying energy, forces etc., should correspond a *mass equivalent* to the energy carried, divided c^2. Since there is no zero energy, for the ZPE, there should not be any particle carrying energy, with a zero mass. Thus, there should not be real particles, having any energy, with a zero mass. If there are, they should “subtend” a tiny mass, a *Zero Point Mass* [29]. Thus, in the case of a P at the *inertial state*, that is when it interacts with another particle, so it stops running, at least for that infinitesimal moment it will oscillate much less. We will never be able to know how much! We will never be able to know with *accuracy* how much an interacting P can oscillate, that is what could be the number of oscillations [c⁄s] in that moment. Let’s indicate this unknown value with 10^n[c⁄s],which is an *uncertainty factor*. The P stops running when hitting another particle, as it happens during a M, so it will not oscillate as when it was running, though it never stops running completely: it is the HUP to deny it, since in this case we would know simultaneously the *position* and the *momentum* of the particle [30][31]. Thus also in the inertial state the oscillating frequency (ν) of the P can never be 0, but always ≥1⁄s, that is ≥ one oscillation per second (if not even ½ oscillation per s., or a fraction of its). Thus, if we want to consider the Energy of the P in its *inertial state*, indicated with E_o, we should have:

$$E_o = h\cdot\nu = h\cdot 10^n \text{ [c/s]} \qquad (32),$$

that is:

$$E_o = 6.626\cdot 10^{-27} \text{ [erg·s]} \cdot 10^n \text{ [c/s]} \qquad (33),$$

hence:

$$E_o = 6.626\cdot 10^{-27+n} \text{ [erg]} \qquad (34).$$

This should be the Energy value of a P at an inertial state. We may say its *minimal energy value*; as we can see this value is not easy to determine, rather, it is *undetermined*, as stated by the *QM*. As the *erg* value is expressed in [g·cm/s²·cm], that is in [g·cm²⁄s²], we have Eq.(35):

$$E_o = 6.626\cdot 10^{-27+n} \text{ [g·cm}^2\text{/s}^2\text{]} \qquad (35).$$

2.5. On the *Equivalent* Inertial Mass (m_o) of P

In this way we can have information, with a certain approximation, about the 2nd parameter of Eq.(30), referred to the P. Hence we can easily have the 3rd parameter, the *equivalent rest-mass* or *equivalent inertial mass* (m_o) of the P:

$$m_o = E_o/c^2 = 6.626\cdot 10^{-27+n} \text{ [g·cm}^2\text{/s}^2\text{]} / (2.9979\cdot 10^{10})^2 \text{ [cm/s]}^2 \qquad (36).$$

Let us calculate this value following the *cgs* system:

$$m_o = 6.626\cdot 10^{-27+n} / (2.9979)^2 \cdot 10^{20} \text{ [g·cm}^2\text{/s}^2\text{]} / \text{[cm}^2\text{/s}^2\text{]} \qquad (37),$$

and we have:

$$m_o = 6.626 /(2.9979)^2 \cdot 10^{-27-20+n} \text{ [g·cm}^2\text{/s}^2\text{]}\cdot\text{[s}^2\text{/cm}^2\text{]} \qquad (38),$$

$$m_o = 6.626 /(2.9979)^2 \cdot 10^{-47+n} \text{ [g]} \qquad (39),$$

which follows:

$$m_o = 0.7372 \cdot 10^{-47+n} \text{ [g]} \qquad (40),$$

that is:

$$m_o = 7.372 \cdot 10^{-48+n} \text{ [g]} \qquad (41).$$

What we get is that the *inertial mass* of the P corresponds to 10^{-48+n} grams. Thus, if the value of *n* was 10^0, that is one oscillation per second, m_o would be 10^{-48}[g]. Whereas if *n* was 10^3 oscillation per second, we would have $m_o = 10^{-45}$[g]. Of course in all cases it is an extremely small value, but it is ≠0. Besides, as we know, one of characteristics of the P is to travel most of the time, so it also gets a *momentum* (***p***).

2.6. The Momentum (*p*) of P

As long as the P is considered, Fermi writes: “The P too, as other particles, is a corpuscle, a *light’s quantum* and has a its own *momentum* (***p***), through which transfers all its energy to the hit particle”[32]. Feynman adds: “Each P has an energy and a *momentum* (***p***)”[33]. This ***p*** is represented in the de Broglie’s formula[8]:

$$\boldsymbol{p}=h/\lambda \tag{42}$$

where λ is the wave length of the considered P (or other particles). The mean wave length of a P in the optical band corresponds to $\approx 5\cdot 10^{-5}$ [cm] and its ***p*** is:

$$\boldsymbol{p} = 6.626\cdot 10^{-27}[\mathrm{erg\cdot s}]/5\cdot 10^{-5}[\mathrm{cm}] \tag{43}$$

$$\boldsymbol{p} = 6.626 \cdot 10^{-27}\ [\mathrm{g\cdot cm^2/s}]\ /\ 5\cdot 10^{-5}\ [\mathrm{cm}] \tag{44}$$

$$\boldsymbol{p} = 1.325\cdot 10^{-22}\ [\mathrm{g\cdot cm/s}] \tag{45}$$

Let’s see how *heavy* an electron is: its mass corresponds to $9.1\cdot 10^{-28}$ gr, comparing these values, emerges that a running P is *heavier* than an electron. Thus, when we make a M, when we try to see and study an electron, and we shoot against it even a single P(the minimum quantity to be able to see it), what happens is that the electron is hit by a corpuscle with a mass bigger than its, most likely *succumbing* under its mass, under such a shot, thus it *collapses*.

2.7. *U Phase, R Process* and Wave Function Collapse (WFC)

Let’s try to understand what happens. It is likely that , before the M, the electron is *not determined* and should be characterized by a *superposition of quantum states.* Every time a M is carried out (always using the EMR), the observed particle undergoes a *probabilistic reduction of the state vector,* indicated as Reduction Process, or ***R** Process,* which corresponds to the “*Process* 1” described by von Neumann[34]. With the ***R** Process* the *state vector,* represented by |Ψ>, *jumps* to another stated vector, let’s say |ϕ>, which represents one out of two or more *orthogonal* alternative possibilities: the other can be |q>, | X >, etc..., which depend on the kind of observation, the kind of M carried out. Thus, with the M we move immediately from the phase ***U*** to ***R***, and the *jump of the quantum state* is induced, known as WFC. All related to the EMR. Now, with the M, thus with the WFC, it is possible to find and see the particle in a determined point. In the ***R** Process*, the particle shows as a corpuscle and gives us its position[35]. Whereas, during the ***U** Phase*(which corresponds to the “*Process* 2” described by von Neumann), that is before the M, the particle presented an undulating behaviour, and was not detectable: we did not have any information about its position, it was *delocalised*.

The M, thus, produces a big changes on the physical properties of the observed particle, of the measured QO, as well as on its morphological configuration. How do these changes happen? What is the secret mechanism which creates the WFC? We don’t know. We only know that these modifications happen any time we try to see how a physical phenomenon takes place, or when we want to study the behaviour of a particle: to do so we have to carry out a M. Thus, the WFC takes place every time M is carried out. Which mean do we use to carry out a M? An EMR with a short wave length.

Thus, it is automatic to link together the three parameters: 1)EMR; 2) M; 3)WFC.

In fact the WFC happens only after a M, and the M cannot be carried out without using the EMR: it is a *conditio sine qua non.* Thus, we can infer that the WF of the observed particle, |Ψ>, *jumps* in a different quantum state (|ϕ>) when the EMR occurs. Without

EMR it would not be possible to have neither the M, nor, as a consequence, the WFC! There is no other explanation. Someone may say: if it is so how does EMR induces the WFC? Well, we have stated that the EMR is not evanescent, ethereal, inconsistent, but it produces a mechanical action: the so called *radiation pressure* of Ps [36]. For example, "the solar light gives, on the earth surface, a *radiation pressure* having a weight of 1 mg per mt^2 per second" [37]. We know that if a single P hits an electron changes its journey and deviates it from its trajectory. In the same way, we think that the P is able to create the WFC of the hit electron!

2.8. Mechanical Effects induced by P

This is the core of our work. Besides, the *mechanical effect* carried out by a luminous P against an electron, against a QO, is not at all negligible: the electron is hit by a *crash force* equal to 10^{-22} [g·cm/s], that is 100.000 times bigger than the mass of the electron itself[38]. It is a considerable strike! There is no wonder if, after such a strike, the quantum structure of the electron (with its superimpositions of quantum states), and its morphological configuration, undergo a significant modification. It is as if under the hit with the P, the electron deformed immediately (thug just for a very short time), as if it *shrivelled* (as pinched balloon), *reducing* its quantum states: in this way showing itself as a corpuscle, a *localised* and observable particle. Just with a single P.

In short, the light really hit violently the electron and the atomic particles. Therefore, before being hit by EMR, in according to the *QM* the particle is a mathematical quantity known as a quantum state, or WF($|\Psi>$), that should contain all the information necessary to describe the considered quantum system. When it exists in this phase (***U** phase*), not disturbed, the particle will not give any information concerning its *look* and contents. To this purpose, Prigogine asks himself: "Does a unobserved nature, different from observed nature?"[20]. It seems so! In fact, as far as we try to see it, the observed particle immediately change its look, its quantum configuration and its trajectory. Therefore we can only try to imagine: it says that the particle occupies a volume, it goes like a wave, in a *combination of several overlapping quantum states* and widespread, spread in the whole space it can occupy, space that according to Penrose[13] should be the **HS**. Feynman said: "the WF for a single particle is a *field* in the sense that it is a function of position" [10]. This field could be the space occupied by the particle, when it is not disturbed, i.e. when it is in ***U** phase*. We don't think to be wrong in considering the **HS** like the field, the space occupied by each particle, that is by its quantum superimpositions both it is a lepton (like an electron) and it is a hadron (like a proton, for instance). Therefore the **HS** should be a real, *objective* space: the space to be occupied by a QO. "The space where an operator acts, characterize the operator in *QM*" [20]. As we know, an operator can be distinguished for its auto functions (the functions that he leaves unchanging) and its auto values: this is the *spectral representation of the operator*. Concerning the Schrodinger's equation (10), when we have the auto functions $u_n(x)$ of the Hamiltonian operator ***H***, we can develop the WF in these auto functions. Thus, Prigogine reminds us: "The formal solution to the Schrodinger equation is:

$$\Psi(x,t) = \sum_n c_n e^{-iEnt} u_n(x) \qquad (46),$$

where $\Psi(x,t)$ is the WF wideness in the time, the first part of the right member of the equation is the *superimposition of rotations* that go together with the particle (they are the simultaneous quantum superimpositions), and $u_n(x)$ corresponds to the auto function of the Hamiltonian operator. What is the physical sense of C_n coefficients? A basic postulate of *QM* is that C_n correspond to *probability wideness*. Thus, if we suppose to operate a M of energy of system described by WF, we obtain the auto functions u_1,u_2,u_3....of the energy, with a probability $|C_1|^2$, $|C_2|^2$, $|C_3|^2$..... It is praiseworthy that at the moment of M, the initial WF changes in a whole of WFs. Therefore a single WF become a whole: that is a superposition of functions. So, the Cn coefficients appearing in the WF can be considered like potentialities and the results of Ms given by the probabilities $|C_1|^2$, $|C_2|^2$, $|C_3|^2$....make actual some potentialities. But how is this possible, given that the Schrodinger Equation does only transform a WF in an other? It never happens a division of WFs. On the contrary a division will occur in the moment of M, i.e. when a WFC occurs" [20].

Therefore, with M, i.e. under the action of EMR, the particle, that is its WF, jumps in a particular quantum status (ϕ, for example), giving rise to the WFC. It seems more congruent the concept that the EMR itself induces the WFC, that is the jump of the quantum status. It doesn't look rash the hypothesis that **EMR can induce a *gravitational quantum effect*.**

It is a ***gravitational effect*** because it is a mechanical action, i.e., on our opinion, an effect induced by the *dynamic mass* of Ps, by the *pushing momentum* of EMR.

It is a ***quantum effect*** because it is the P itself to elicit this effect, the P that can be identified with the quantum of light, with the quantum of EMR, the Planck granule, which energetic value corresponds to *h*, the Planck constant [39].

We can suppose that all the described situation (or something very similar) occurs in the reality. We can say that WFC is a real event, that occurs in the realty of subatomic world, although a lot of authors suppose that WFC is only a mathematical, theoretical and not real representation. Our opinion can be overlapped with Penrose opinion, that supposes that WFC should be really realized: "The WFC is a real event, *objective*, not hypothetical.The space where the WFC exists must be real and represented by **HS**"[13].

Introducing the P in this **HS**, that should be the space occupied by QO that goes to M, and considered that the P carries a *dynamic- mass* (and so a mechanical action) bigger than the electron itself, see Eq.(45), we can try to imagine the confusion that it will bring to the hit particle, first of all disrupting the overlapped quantum layers and making them to collapse, fall down, just a moment, in a limited and circumscribed area (WFC).

The first consideration in these situations is to imagine that P hits the particle (for instance an electron) to be seen, measured in the meanwhile it is going undisturbed along its run, if anything along a occasional run mathematically represented according to the evolution equation of Hamilton, i.e. by the Hamiltonian $\boldsymbol{H}(\boldsymbol{p},q)$, that represents the energy of system in exam, expressed as *momentum*($\boldsymbol{p}$) and the position coordinates (q).

The Hamiltonian flow, indicated with Poisson parenthesis $\{\boldsymbol{H}\}$, which represents the Newton temporal evolution of system, is a vectorial field on the *phases space* **T**(**C**) [13]

[20]. Given $\boldsymbol{H}(\boldsymbol{p}, q)$, the runs of particles to be measured (and on which P engraves) will emerge from the Hamilton equation (completely symmetrical):

$$dq/dt = \delta \boldsymbol{H}/\delta p \quad (47),$$

$$dp/dt = -\delta \boldsymbol{H}/\delta q \quad (48).$$

Passing to a probabilistic description, it is proved that the *probability*, rho(ρ), obeys the Liouville equation [15]:

$$\delta\rho/\delta t = -\delta \boldsymbol{H}/\delta p \cdot \delta\rho/\delta q + \delta \boldsymbol{H}/\delta q \cdot \delta\rho/\delta p \quad (49).$$

According to *QM*, a physical phenomenon occurs if somebody is observing it. Therefore the act itself of observing, measuring a sub-particle, i.e. a QO, induces consequently a physical phenomenon. But in which way we can observe a particle? It is enough a EMR sufficiently energy. To this purpose Feynman said: “ To observe electrons, we need a light because the light rebounding on electrons make them visible. Nevertheless the light affects the result because the result of light on is different from that of light off. We can say that the light affects electron behaviour. The electrons are very sensitive. When light is sent on an electron, it makes the electron vibrate so that the electron because of light, behaves in a different manner"[40].
It seems that **EMR is the keystone to observe a particle, to make a M.** Similarly, only through the EMR we can try to reveal the mystery of Measurement Paradox (MP).
In which way? We explained above, it could be a mechanical effect induced by Ps to play a main role with the M and its *paradox*.
To this purpose it cold give us a help the legendary “Lectures with four hands” that Penrose had with Hawking to the students of Isaac Newton Institute for Mathematical Sciences of Cambridge University in 1994. Penrose said: “The P can be a combination:

$$P = z|A\rangle + w|B\rangle \quad (50),$$

where z and w are complex numbers. The state of the P is exactly the complex superimposition. We can consider that P active the movement of a thick mass that if it is in a delicate situation of unstable balance it can fall down only after a push of P" [41].
The *unstable balance* described by Penrose could be the unstable balance of a particle that we can go to M. This *unstable balance* concept brings to mind the *unstable dynamic systems and phenomena* described by Prigogine, who writes: "Our conceptual framework is: instability (Chaos) → probability → irreversibility. The essential condition is that the microscopic description of the universe is made through unstable dynamic systems. This representation gives us the approach to balance in Ljapunov’s time and includes *temporal breakdown of symmetry*"[20]. As known, Ljapunov's time describes the time limit beyond which predictions become impossible, so a dynamic system becomes chaotic: a typical example is the weather forecast, which over a number of days falls within the Chaos Mathematics. Prigogine adds: "The discovery of these new representations with broken symmetry constitutes, in our opinion, the solution of the *paradox of time*, as we obtain a formulation of the dynamics at the level of the distribution functions, which includes the time arrow. That's how we can correctly address the problem of the *breakdown of temporal symmetry* and demonstrate that the study of chaotic (or unstable) systems can effectively incorporate the 2nd principle of Thermodynamics. Without long-range correlations due to *non-equilibrium situations*, there would be no life, no brain, and the *constructive* role of time would not

be highlighted. Irreversible phenomena do not represent a merely increase in *disorder*, entropy, but they have a very important constructive role. The *QM* has a dual structure: on a side the Schrodinger Equation (*deterministic* and reversible in the time), on the other side the WFC, bound to M, that introduce a *symmetric temporal breaking*, irreversible, and deeply *probabilistic* breaking" [20].
How is it possible to carry out a M? *Only with* P! This statement is in perfect agreement with what we have reported: "a mass can fall down *only with a push of* P"[41]. The mass mentioned by Penrose can be represented by the mass itself of particle that goes to M: the electron mass, for instance. It is in fact, before M, in unstable balance as a *edge of hypothetical gorge*. So this mass, i.e. the particle we measure, *falls down* (in figurative sense), but it *collapses* in real sense. So we assist to WFC of particle itself. In other words, the *falling in the gorge of mass* (i.e. of massive particle) we have to measure, could be the WFC of particle itself in the meanwhile we are making the measure. Because Penrose considers that *this mass falls down* (that is to say 'collapses') under P push, we can say that the 'push effect' of P (i.e. the mechanical effect induced by EMR) makes the examined particle (and that we measure) fall down (collapse).
As Fermi reminds us "there is a *momentum(**p**)*, associated to the P: $\boldsymbol{p}=h\nu/c$, where c is the speed of light in vacuum , h is the Planck's constant and ν indicates the frequency of oscillation of the P. Thus affecting on a particle, the P gives it an impulse equal to its *momentum* " [32]. At this regard Feynman states: " A P has a certain *momentum (**p**)*, it is a vector:

$$\boldsymbol{p} = m\cdot \text{v} \qquad (51).$$

With Ps the *momentum (**p**)* and the velocity (v) are in the same direction, and the velocity is the speed of light (c). The *momentum* times the speed of light of every P is its energy (E):

$$\text{E} = \boldsymbol{p}\cdot c \qquad (52),$$

So these terms are the *energies* of each of the Ps" [33].
Now, inserting the *momentum (**p**)* from Eq.(51) in (52), we have:

$$\text{E} = m\,\text{v}\cdot c \qquad (53).$$

Since the speed (v) of the P corresponds to c, we have: $\text{E} = \text{m}\, c^2$!
This is Einstein's equation related to the MEEP [42]: see Eq.(30). The way we got to this equation is a confirmation that is possible to apply the MEEP to the P (though the P is considered massless). We described the remarkable *force* with which a P hits a particle in Eq.(45), since this value is 10^{-22} [g·cm/s]. Yes, these values express just a *radiation pressure* given by the P on the stroked particle. We wish to underline that this value is 5 order of magnitude bigger than the mass of the electron. Thus, according to Penrose, a single P can determine the falling of mass (moreover thick) that has an unstable balance, although it is considered that P is mass less. According to the basic principles of Mechanics, it should seem inconsistent that a massless particle can make a mass fall down. How can we explain this?
If we consider that P has a mass (given by its *dynamic mass*, i.e. its *momentum*: ***p***), everything seems more clear and congruent[43]. It could be the *dynamic mass* of P, its *momentum*, more heavy than the electron itself, to make fall down the particle considered by Penrose (that could be an electron), that is to make collapse its WF *reducing its vectors of state* in a circumscribed and localizable space: inducing, i.e., the WFC of hit particle. It is probable that the impact of Ps (also a unique P) against the electron makes, just in

that moment, the quantum states overlap, located into the space occupied by electron (or a QO) cannot freely sway into this real space (a real space represented by a **HS**), but they accumulate, by chance in a circumscribed, delimited point: *reduction of state vector* or WFC, or ***R** Process*. As Penrose says "it seems that the undulating aspects have to be kept until we decide to make a M to reveal the particle, then we go back to the description of the particle, where we find a discontinuous changing (*non* local) of the state – a *quantum jump* – when we pass from a description in terms of WF to the reality given by the M. Why? What is there inside the M showing process, which requires that a different (and strongly *non local*) mathematical process, different from the standard quantum evolution process given by Schrodinger equation, has to be adapted in case of M?"[13]. This *ungraceful event* could be induced by the stroke of the P(or Ps) against the electron.

However, as for the *hidden mass* carried by P, or the "*push effect* induced by P" described by Penrose [41], we will quote just a few ones (among a large number which can be found in literature).

2.9. On the Zero Mass of P

1) As Weinberg reminds us"34 minutes and 40 seconds after the Big Bang, 31% of *density of energy* of the universe is supplied by neutrinos and 69% by Ps"[44]. That is the 2/3 of the energy spread in the entire Universe was contained in the P_s : yet they are mass less! Despite the MEEP. We can still read: "At the beginning of the history of universe, it was the total density of energy, of the various P_s, electrons, positrons, etc. to provide the source of the gravitational fields of the universe" [44]. Thus, if the P_s "with their energy" contribute to create the gravitational field, it may mean that they *hide*, "contain" a mass in their energy. Adds Weinberg: "Besides not only are gravitational fields generated by the mass of the particles but by any form of energy too. The Earth is orbiting around the Sun with a speed slightly higher than the one it would have if the sun wasn't hot, because the energy in the heat of the Sun contributes (though slightly) to its gravitational force" [44]. Thus, if the energy rises the Gravity Interaction (GI) of a body (it doesn't matter if it is hot or cold), which moreover already emits a gravitational field, this should mean that the energy behaves like a mass: this explains why it contributes to enrich the source of a gravitational field [7].

2) During the evolution period of the Universe, following the Big Bang model, "when finally the radiation de-couples from the matter, the path of the P_s is slightly diverted by the gravitational field: *Sachs-Wolfe effect*"[45]. Thus, if the path of the P_s is diverted they should have a mass, though it is thought that the GI acts only on particles with "only energy". But in this case it means that there is an extremely small mass which goes with the energy of the P, making one body. This mass might be "concealed" during the motion of the P. What does it mean? According to the Complementarity Principle, if the P is in motion we can catch its main base energy, but we will never be able to have news, simultaneously, about its corpuscular characteristics. Whereas when the P interacts, it slows almost completely its run (however without stopping completely: HUP would not allow it to), thus the P will stop showing its undulation aspect and will show us its corpuscular one, allowing us to determine its mass (in case it has some!).

3) Apparently in the first evolution phases of the universe the P carried mass: "the excess

of mass (that is of energy) of the initial baryon will have to be carried away from other particles (P_s, pions, couples of leptons)"[46].It is as to say that the P already has a mass.
4) Kane reminds us: "Any particle having energy (mass) creates a gravitational field"[47]. Thus, an energetic particle, such as the P, should have a mass, otherwise it could not spread around a gravitational field: Newton's equation includes only bodies having mass, it does not consider those having energy without mass! Thus it should be the energy of the particle to subtend the mass. Kane adds: "According to Einstein, in his gravitation theory (General Relativity), mass and energy are related, so any object having energy attracts gravitationally other object" [47]. Thus apparently the energy has a "*gravitational effect*", that is an action induced by a mass (namely the ***equivalent mass***), a mass which should be intrinsic in that energy, it may be a very small mass, but it cannot be = 0 [48]. Otherwise that energy could not have a gravitational effect, as Einstein says. Why? Because the Newton's equation would not be satisfied: none of the two bodies in gravitational attraction will be able to have zero mass[49]. A body with a zero mass would flee the GI, since the equation would be null, which would give the result of: $E_{GI} = 0$. Thus we think that when a zero mass is applied to a charged particle, Einstein's MEEP is broken too! Kane adds: "Einstein's prediction based on his General Theory of Relativity, says that the *light feels the GI*. Thus during a sun eclipse it has been possible to observe that the light of far away stars, going pass the sun, rather than spread in a straight line, made a curved path towards the sun itself" [47].In this regard, Hack says: "As predicted by the theory of relativity, light is also subject to GI"[50]. Therefore, since the GI is exercised only between mass-bearing bodies (there is the symbol of mass in the GI equation), the P must necessarily *have* a mass value (otherwise the equation is reset). To comfort what we maintain, we report in Literature: "A body exerts a form of attraction on another body, provided that both are massive" [51].
5) Pacini writes:" the movement, the motion, is a matter itself"[52]. Indeed energy and mass (matter) are correlated (Einstein's MEEP). Yet the P, a particle which is continuously in motion, is considered massless.
6) We learn from an authoritative source: "According to the equation $E=mc^2$, **each mass can be expressed as an equivalent energy**" [36]. Thus the opposite is true too: each energy can be expressed as an *equivalent mass.*
7) Quigg states:" The quark model foresees that the energy of a P may transform in a couple of quark anti-quark" [53]. Thus 1 P *materializes* in 2 mass particles: yet the P is massless! We say that the P's energy materialized in the quarks. But it is fair to suppose that energy hides an *equivalent-mass*. Thus it is possible to imagine that when the Ps are in motion they show their "undulation aspect", where we can catch their energy. When the Ps start interacting they show the corpuscular aspect.
8) We read: " Atomic nucleus can be bombed also with high energy (EMRs), that is with massless light quanta. According to MEEP, the more a light beam is energetic, that is with high frequency, the more it will have the characteristics of a body having mass. High energy Ps are able to hit atomic nucleus and make them explode, just as bullets having mass" [54]. Thus we have the example of Ps behaving as though they had a mass. We also mentioned that, even though we light up an electron, a P can behave as it had a mass, it can even deviate it. In the same way high energy Ps even make the atomic nucleus

explode. This may be a further reason in favour of the idea that the P may have a mass, though extremely small: the one corresponding to the light quanta, that is the Planck's constant, *h*, divided the square of the speed of light.
9) We can still read: "We can substitute the concept of mass with energy, indeed according to relativity ($E = mc^2$) mass is a form of energy extremely condensed. To any form of energy corresponds a certain mass" [55] and *vice versa*.
10) Zeilinger wonders: "What is the deep meaning of a relationship like $E=mc^2$? What is hidden behind these symbols? For many physicists the equation $E=mc^2$ is to say that energy and mass are the same thing, two faces of the same medal; there is therefore *equivalence between mass and energy*: **energy is just another form of mass**, and vice versa, mass is another form of energy"[12]. Laughlin states: "Light and gravity are bound. According to the Principle of Relativity, that energy should have generated mass ($E=mc^2$) and from mass, in turn, gravity should be generated"[56].
11) Hawking writes: "According to Einstein's equation ($E = mc^2$), the energy is proportional to the mass"[57] and according to Relativity itself to every form of energy corresponds a mass. Thus to a very small energy, as in the case of P, corresponds a very small mass, however $\neq 0$ [7]. Feynman confirms: "energy and mass differ just for a c^2 factor, which is merely a question of units, so we can say energy *is* the mass" [33]. This is another authoritative confirmation of our concepts. Thus, it may be incongruous to say that a particle with energy does not have a mass, it does not "conceal", at least, a mass. It is Einstein's equation itself to show that this particle has a mass, otherwise the equation would be null, the result would be zero. Feynman continues: "Instead of having to write the c^2, we put $E=m$, and then, of course, if there were any trouble we would put in the right amounts of c so that the units would straighten out in the last equation"[33].

2.10. The Materialization of P

More particles may come from the *materialization of* the Ps. In this regard Feynman writes: "This theory of equivalence of mass and energy has been beautifully verified by experiments in which matter is annihilated –converted totally to energy: an electron and a positron come together at rest, each with a rest mass m_0. When they come together they disintegrate and two gamma rays emerge, each with the measured energy of m_oc^2. This experiment furnishes a direct determination of the energy associated with the existence of the rest mass of a particle"[33] and *vice versa*. This clarification of Feynman is another very prestigious confirmation that energy particles, such as γ Ps, must also carry a *mass-equivalent*, so much that they can be generated by a couple e^- e^+ and, in turn, create it. Feynman adds: "An electron emits a P which transforms in a couple electron-positron" [58]. How can a massless P generate a couple electron positron? Feynman says: "It is also likely that the P turns into a couple of muon anti-muon, heavier than the initial electron from which it was emitted" [58]. The muon is about 200 times heavier than the electron. Thus from a P two particles are generated which summed up give a mass of 400 electrons! It remains unexplained, either it is not true, or (very rare possibility) the P acquires energy from the electro-magnetic field (EMF) in some ways. It is more likely that the P "hides" a mass, not at all for its own will, but because the Complementarity Principle forces it to. Feynman states:" the mass of the electron is influenced by Ps and is given by the mass of the electron ± the Ps absorbed (+) or emitted (−)"[58]. We can infer that if the mass of an electron depends also on the Ps absorbed or emitted, that is the presence of the Ps in its mass, this involves that the Ps give or take mass from the electron. That is the mass of the real electron depends on the value of the number of Ps absorbed or emitted. In short: the electron with 1 P absorbed weighs more, and with 1 P emitted weighs less! Yet, P is still considered massless.

Dorigo says" The measure of the mass of a particle is inferred from the energy of the generated particles"[59]: which is a very valid confirmation of our concepts.

Hawking states: "The Quantum Field Theory (QFT) demonstrates that when electron and positron collide, they are annihilating each other with a large discharge of energy, creating a P. The latter in turn releases its own energy, producing another pair electron-positron"[60]. That is, a pair of massive particles is completely transformed (without even the slightest dispersion of energy or mass) into a massless particle, which is P, which in turn will *materialize* in a similar pair of massive particles: electron and positron. Thus, we have the following steps: a pair of massive particles is completely transformed into a massless particle, since the P is just energy. After that this massless P, will *magically* give rise to a new electron-positron (massive) pair. That is, the steps are the following: 1) It starts with 2 particles, each weighing $9.1\cdot10^{-28}$ grams. 2) It is passed for an energy particle, but with zero mass, as it is thought to be P. 3) The massless P will again give rise to a pair of particles, weighing each $9.1\cdot10^{-28}$ grams. In short, there is something wrong: ends do not meet. The same mass values, present in phases 1) and 3), *vanish*, are cleared by passing to step 2), when P appears.

In fact, considering the values of the masses, in these particle transformations, we have:

$$2\cdot(9.1\cdot10^{-28}[g]) = 0[g] = 2\cdot(9.1\cdot10^{-28}[g]) \qquad (54).$$

It is evident that, written in this way, this equation is wrong. The first and third members are described correctly, as they represent both an electron-positron pair. What is incongruous is the value 0 of the second member. From an arithmetic point of view, since the values of the 1st and 3rd members are identical, the equation (54) requires that the 2nd member too has the same values. That is, the value of the mass corresponding to that P must also be equal to $2\cdot(9.1\cdot10^{-28}$ [g]). It could be said: P is an energy but massless particle, so in these circumstances its value should be 1.022 MeV/c^2. However, in Eq. (54) it is to be inserted the value of the equivalent mass, which is exactly equivalent to this energy value. Therefore, it is incongruous to insert 1.022 MeV at the second member of the Eq.(54) therefore along with the *cgs* metric system, we will write: $2\cdot(9.1\cdot10^{-28}$ [g]).

Even if we to continue to describe only the energy values of P, the Eq.(54) shows us categorically that it also contains values of *equivalent mass*, which are not shown for the Complementarity Principle. The mass is *concealed*, but it is there! On the other hand, the momentum (***p***) can be *hidden* too.

To this purpose, Feynman states: "The momentum, as a mechanical quantity, is difficult to hide. Nevertheless, momentum *can* be hidden –in the electromagnetic field(EMF), for example. This case is another effect of relativity"[33].

It seems appropriate to point out that Eq. (54) describes real events, which are reproduced continuously, so that it is a concrete example that P may also not easily show its mass, but it is a profound mistake to continue to consider that the P can be massless! It is evident that P illustrated by the 2nd member of (54) will never have a 0 [grams] mass: in that case

the mass values of the electron and positron should also be reset! Instead, we know that they are massive particles first.
In short, we can say that all pieces meet if we accept the concept that P, in addition to being an energy particle, is also a massive particle thanks to Einstein's MEEP. This mass, in turn, along with the quantum Complementarity Principle will be concealed (i.e. unexposed, not detectable) when the P is in motion (most of the time), but this does not mean that P does not have its own mass. The Complementarity Principle (formulated by Bohr, inspired by the dualism wave-particle proposed by de Broglie) states: each particle can show either its corpuscular or wave aspect, and always one at a time separately, never simultaneously. What does it mean? That if a particle is in motion we will only get its wave aspect. In that case we can know its propagation speed, its wavelength, its frequency of oscillation per second, but it is quite clear in such circumstances that we will never know anything about its mass. It is possible to have this kind in information only when the particle, and thus the P, interacts with matter, with another particle: only in that very short moment it will show us the effects of its *corpuscular aspect*. That is why we can say that P hides its mass, which, when the P is in motion, is enclosed in its *momentum*.
In this regard, we have the very prestigious endorsement of Feynman who says: "The momentum of P can be hidden in the EM field (EMF)"[33]. It's like saying that momentum carries, albeit *hidden*, a dynamic-mass. In short, the P cannot be considered massless. Its mass is simply, to say it with Feynman: "hidden". And it's not easy to challenge Feynman! At this point, Penrose adds: "In a conference held in Japan in 1922, Einstein said:'If a person falls freely he will not feel his own weight'. In fact, when you are in *free fall* (like when you launch from a plane, before you open the parachute) you have the impression that the earth GI is *suspended*: the Earth's gravitational field seems to have *disappeared*. Where's the GI? Actually the GI has not vanished, it is *hidden*"[23]. Well, in these circumstances, we seem to be able to see a significant behavioral analogy between EMF and gravitational field. That is, it is as if in both of them something disappeared, temporarily concealed, *hidden*, during the event: 1) the dynamic-mass, transported by the momentum of the P (in the EMF); 2) the GI (in the gravitational field).

2.11. On the Dynamic-Mass carried out by P

Let's now analyze another phenomenon: the light pressure action or "photonic pressure", or *radiant pressure*. These are mechanical effects induced by the light's quanta, by the light's *dynamic-mass*, by the *momentum* of P. We think there are many examples of the alleged mass-effect of the P.
1) The first one we can think about is the photoelectric effect (PEE). Let's suppose that Planck's quanta were really corpuscles with a their own individuality. The fact they had also a corpuscular aspect allowed Einstein to explain the PEE [61]. This effect is carried out by Ps with a certain frequency, thrown against a metallic surface with the result that electrons from the atoms of the target metal are pulled away. It is fundamental that the Ps have a frequency higher or equal to a certain value (threshold or cut level), which changes slightly as the target changes. The PEE is performed only when the energy carried by the P, that is the frequency of the electro-magnetic wave (EMW), is the same or higher than the energy relating the electron to the nucleus. Generally the *threshold level* corresponds to the frequency of the infrared rays, for some metals, (especially cesium and rubidium)

or to the optic band for some others such as alkaline metals. That is, if the EMW will have enough power to push away the electron from the atom, just as a billiard small ball, thrown with the right energy, pushes away the opponent ball. It could be a suitable example, since the kinetic energy of the small ball is given 100% to the pushed ball. The PEE is a phenomenon of "corpuscles" (Einstein) more than of waves. That is a P which manages to push away an electron from its orbit, seems more a *mechanic effect,* that is a *mass effect of the P*, namely a "*push effect*", rather than a merely "energetic effect". In other words the Ps involved in the PEE behave like ultramicroscopic spinning small balls (carrying probably a tiny mass), rather than as waves. We get the last confirmation from Compton, in 1922 [62], when "he demonstrated that directing a flux of X rays against motion less electrons, it was shown that these rays behaved like particles, since (rather than going around the obstacle, as the radio waves would have done) they bounced against the electrons conserving (an energy and) a *momentum*"[9]. But the *momentum* (***p***), is given by ***p*** = mv (where v is the speed and m is the mass of the analyzed particle). Hence, if a *momentum* is correlated to a P (i.e., a X ray), it should be contradictory not to give it a mass too. Also in CE the comparison with the billiard small ball fits perfectly. The P after striking the electron (opponent ball) will keep moving, just as a billiard small ball. Compton supposed that in the collision with the graphite atoms, X rays behave like real particles, with energy and *momentum*[62]. CE would have never been possible with the only undulation hypothesis of the light. CE confirmed clearly the existence of also a corpuscular behaviour of the EMWs. What Compton underlined was confirmed later (1928) by Raman. The Raman effect(RE) occurs when the Ps of an intense monochromatic beam of light, with a specific frequency, passing through a material (mainly liquid or gaseous) undergo an inelastic collision with the molecules of the means they pass through[63]. In this way the P *pushes away* the electron from its orbit: it seems to be a *mechanical effect* produced by the light. The RE cannot be interpreted in the classical physics, however it can be easily explained as a quantum mechanical effect[64].
2) Chandrasekhar writes: "The energy of the solar light is converted in kinetic energy of the electrons, in the current produced by solar battery. In the same way its *momentum* pushes the comet's tail in the opposite direction of the sun"[9]. Since the momentum (***p***) is mv, and since we know that "waves have a *momentum* and an energy"[9],this should subtend a mass too in the wave.
3)As Feynman reminds us "An EMF has waves, which we call light; it turns out that light also carries a momentum (***p***) with it, so when light impinges on an object it carries in a certain amount of ***p*** per second; *this is equivalent to a force,* because if the illuminated object is picking up a certain amount of ***p*** per second, its ***p*** is changing and the situation is exactly the same as if there were a force on it***. Light makes a pressure*** when it collides with an objects. It is a very small pressure, but it can be measured with extremely sensitive instruments" [33]. This phenomenon is interpreted as an "energetic" phenomenon of the Ps (it would be only energy without mass). We are talking about a pressure action, so it should not be unreal to think it is something "real", material, concrete, to produce the *pressure effect*. Even though it was energy it could be the *equivalent mass of the energy* to determine the *mass effect* which hides behind the "photonic pressure". It has been reckoned that the pressure solar rays have on Earth is 1

mg/mt^2. The effect of this pressure induced by solar rays, known as "solar wind", can be observed in the cosmos, when this "wind" gives an impulse to the surfaces it hits.
4) An other surprising effect induced by the *radiation pressure* of light happens in the star's core, where Gravity Interaction(GI) and *radiation pressure* of Ps can *fight* for a long time. In fact "In ordinary stars as our Sun, the inward GI is balanced by the outward hydrodynamic pressure of the hot gasses and, to a lesser extent, by the radiation pressure of Ps"[36].Thus, the Ps contribute to counterbalance the huge gravitational pressure which pushes from the outward external layers of the star to the internal layers. In order to perform this action, this compression, Ps have to "base it on something", as though they had an *equivalent mass* (equivalent to the energy of the Planck's grain, the light quantum, divided c^2). That is, it could be the *equivalent mass* of lots of billions of billions of Ps, which summed up may contribute, together with the "hydrodynamic pressure of the hot gases", to prevent the Sun from collapsing or the collapse of the other stars, at least for a long time. Ps therefore have a mechanic effect, likely a *mass effect* acting as "counter pressure" to the considerable GI expressed by the remarkable gravitational mass which inexorably pushes towards the inside of the star.
5) Einstein writes to his friend Conrad Habicht: "It has come to my mind a consequence of the study of Electrodynamics. The Principle of Relativity, in association with Maxwell fundamental equations, requires that the mass is a direct measure of the energy contained in a body; ***the light carries a mass***" [26]. In this regard, Galison adds:" Einstein was unsatisfied: he was not satisfied of the analyses of the light. **Einstein stated that *to any kind of energy is associated a mass***" [26]. Thus, according to Einstein there should be a mass associated to the P. Galison continues: "Planck stated that also the transfer of heat adds a mass" [26]. What is heat made of? We know it is made of EMR, that is Ps. Thus, according to Planck, a transfer of radiation, of Ps, from A to B will cause an increase in the mass of B. "It seemed that a hot pot was heavier than a cold one, although exactly the same size. It was a new idea: in Newtonian physics there was nothing suggesting a variation in mass as a consequence of the energy" [26]. Thus wherever there is a body, or particle, having energy, there should be in a way (visible or hidden, concealed) a certain mass too, and *vice versa*: this is what comes from Eq.(30). Einstein adds that based on the calculations of its article containing precisely the Eq. $E=mc^2$ [42], it emerges that a body that emits EMWs necessarily loses mass. Klein adds: "Einstein attributes to this result a universal value, claiming that mass of a body represents a measure of its energy content. Consequently, if this body loses energy, under any form, it also loses mass! The mass, contained within a body, now measures its energy content. Each body having a mass equally has a *mass energy*. Even at rest, a body having mass contains energy"[65] and *vice versa*. "A lighted light, illuminated, radiates light, then energy, thereby undergoing a mass loss" [65].
6) Hawking states:" When an electron moves from an orbit to one closer to the nucleus, it will emit a real P, observed as visible light, so if a (real) P collides with an atom, it will move an electron on a more external orbit. This movement uses the energy of the P" [57]. Why cannot we suppose that at the bottom if this phenomenon there is a strictly mechanic action of the P, which with its energy-mass would raise the kinetic energy of the orbiting electron from which it was absorbed? This goes along with the fact that just after 10^{-8} sec

the electron get free from the mass-energy of the P and goes back to its previous orbit, the one with a minor waste of energy. Thus the excitation and the un-excitation of the electron and therefore of the atom, should not depend on a merely energetic effect, but also on a specifically mechanic effect, as a consequence of the probable mass of the P [7].

2.12. On the Value of the Planck constant (*h*)

Barrow says: "The non-null value of the Planck constant (*h*) is important for the stability of matter. In the impacts between the atoms and the EMR, the value of *h* is large enough to take a rather strong '*stroke*' to push the electrons to the immediately higher permissible level"[66]. It seems exactly the same *stroke* given by the P (to the electron, or other QO) in the Measuring Process (M), or that described by Penrose [41]. As it is known, *h* identifies with Planck 'grain, with the quantum of light, that is with P. And yet, a massless P is capable of inferring such a *stroke*, besides giving "stability to matter" [66]. Unless the P is not so massless.

Another astrophysical phenomenon in which the *Planck constant* can be involved is the Temperature (T) and Specific Heat (SH) of black holes (BHs). Hawking says: "Apparently in the case of a BH there is quite a simple way to violate the 2nd Law of Thermo-dynamics, such as throwing in BH some matter with a certain entropy (*S*), for example a container full of gas"[57], resulting in an increase in the *S* of BH. It was Bekenstein to suggest that the area of the *event horizon* (EH) was a measure of the BH's *S* [67]. This concept is mathematically represented by the formula of Bekenstein-Hawking:

$$S_{BH} = \frac{Kc^3 A}{4G\hbar} \qquad (55),$$

where A is EH'superficial area of the BH, *K* is Boltzmann' constant, *c* is the speed of light in vacuum, *G* is the gravitational constant, ħ is Planck's constant written in Dirac's way, *S* is the entropy. It was extremely convenient to adopt for all these *constants* the unitary value, i.e. 1:

$$G = c = \hbar = K = 1 \qquad (56),$$

That is "measured in *Planck units*"[68].

Hence, the Eq.(55) can be reformulated in following way:

$$S_{BH} = \frac{1}{4} A \qquad (57),$$

that is the entropy(*S*) of a BH, according to Bekenstein-Hawking's formula, it will just be one fourth of EH's area of the BH we took in consideration. Thus every time the matter (carrying some *S*) fell in a BH, the area of the EH would increase, so that the total *S* (that is the *S* inside and outside the BH) would not decrease. In this way the Second Law of Thermodynamics was not violated. However, a BH having *S* implies a thermic radiation, an inside temperature, so it should behave as a *black body*[69]. In fact a body with a particular temperature must emit radiation with a certain rhythm. This radiation is required to prevent the violation of the Second Law. Hawking specifies: "It is shown that quantum mechanical effects cause BHs to create and emit particles"[70] and adds: "It seems that any BH will create and emit particles such as neutrinos or Ps at just the rate that one would expect if the BH was a body with a temperature of $(k/2\pi)(\hbar/2K) \approx 10^{-6}(M/M)K$, where k is the surface gravity of the BH"[71]. Hawking says: "According to *QM*, BHs are not completely *blacks* but emit particles and radiation of all kinds, like glowing bodies" [60]. This radiation emitted by the BHs is now known

as *Hawking Radiation* (*HR*). Hawking adds: "as time flows the BH loses its energy (and then mass for $E=mc^2$)" [60]!
It is indeed an indispensable, as well as very prestigious confirmation of one of the fundamental concepts we have advocated in this work, that light is not just and exclusively energy: no. Light is mass too! Hawking continues: "So, as time passes, the BH evaporates and decreases in size" [60]. In this regard, Penrose says: "Through *HR*, BH loses energy. By losing energy, BH loses mass (for the equation of Einstein $E=mc^2$) "[35]. It is clear that with Penrose we give a further and very strong confirmation in support of our concepts. Yet, it is still taught that the mass of light is zero, that the P is massless. The peculiar astrophysical phenomenon highlighted by Hawking is the negative value the SH of a BH absorbing EMR acquires. As the EMR absorbed by BH increases, proportionally the value of temperature (T) and of the SH of BH decrease.
If we apply heat to an ordinary body, its T will increase and its SH will have a *positive* value. Whereas, if we apply heath to a BH its T will decrease and so its SH, so that the SH acquires a value really negative, according to Hawking's relation:

$$T_{BH} = \frac{8\pi}{m} \qquad (58),$$

related to a Schwarzchild's BH, where T is its temperature and *m* its mass.
How can the SH of a BH be negative? The application of heat to BH. Thus, it is the heat to give mass to the BH, to make it more massive. Which mechanism explains that? It is well known that heat is thermic energy, that is *quanta* of EMR. Thus, it is photons(Ps) which provide mass to the BH, although it has always been stated that P's mass is zero[7]. We need to keep in mind that any *quantum* of EMR, any P, whatever its frequency, has a ***p***. Since we are considering thermic Ps, that is infrared rays, their λ can correspond to $5\cdot10^{-3}$[cm], thus from de Broglie formula - see Eq.(1)- we have:

$$\boldsymbol{p} = 6.626\cdot10^{-27}[\text{erg}\cdot\text{s}]/\ 5\cdot10^{-3}[\text{cm}] \qquad (59),$$

$$\boldsymbol{p} = 6.626\cdot10^{-27}[\text{g}\cdot\text{cm}^2/\text{s}]\ /\ 5\cdot10^{-3}[\text{cm}] \qquad (60),$$

that is:

$$\boldsymbol{p} = 1.325\cdot10^{-24}[\text{g}\cdot\text{cm/s}] \qquad (61).$$

This is the value of the ***p*** of a P of the infrared band, which, as Fermi and Feynman remind us, transfers its energy to the hit particle [32][33][72].
Thus, in Eq.(61) we have that a *quantum* of infrared radiation carries with its ***p*** a *dynamic-mass* almost equal to the mass of a proton. Moreover, if we consider that a single EMW of the infrared band carries Ps oscillating about 10^{13} times per second, will have a certain value, being able to make more massive our BH, decreasing its T, and make its SH become negative. This is in agreement with Eq. (58), since the mass value is at the denominator. Therefore: BH acquires thermic energy (in addition to other EMRs) from the surrounding universe. The EMR *quanta* transfer mass to BH atoms (through their own ***p***) with the result, in the long run, of decreasing the overall T of the BH, and making the value of its SH negative.
All of this, in our opinion, is also a direct consequence of the energy value of Planck's constant, which divided by the square of the speed of light in the vacuum, gives us the value of its *mass-equivalent*, equal to $7.37\cdot10^{-48}$ [g], as already indicated in Eq. (41).
It is interesting what Eddington said in 1919: "The simplest interpretation of the deflection of the light beam is the one that considers it as an effect of the weight of light"

[73]. At the dinner of that meeting, Eddington read out some verses he had composed; we will quote the last quartine: "*We will compare the measures taken, One thing at least is* certain, light has weight. *One thing is* certain *and the* rest *debate.* Light *rays, when* near *the* Sun, do *not* go straight".Thus, Lord Eddington clearly points out the *mechanical effect* exerted by light, fully in accordance with our conviction that light carries with it also a mass (the *dynamic-mass* of P). In fact, as he himself says, "light has weight" [73].
We can not miss the Einstein and Bohr 's light box. It is well known that in the VI Solvay Congress (Brussels, 20-25 October 1930) Einstein proposed a new mental experiment to Bohr, represented by a box full of light. On a wall of the box there is a hole, with a shutter that could be opened and closed by a mechanism connected to a clock placed in the box. First we weigh the box, then we set the clock so that it opens the shutter at a certain time for a short moment, but enough to let a single P out. Then we weigh the box again. "To calculate how much light had gone out, enclosed in a single P, Einstein used the amazing discovery he had made in 1905: $E=mc^2$, so ENERGY IS MASS and MASS IS ENERGY. Thus, by weighing the light box before and after the P escape, it was very easy to calculate the variation of the mass, using the equation $E=mc^2$!"[74].
Lastly, it seems very interesting to quote what Penrose writes: "Actually, the mass of P, if it is not zero, should be $<10^{-20}$ electronic masses"[13].The mass of the electron is $9.1\cdot10^{-28}$ gr, so if the P is $<10^{-20}$ electronic masses, we have: $9.1\cdot10^{-28-20}$ gr, thus according to Penrose a P which is not massless must have a mass very close to $\leq 9.1\cdot10^{-48}$ [g]. Penrose's calculations, among the greatest living mathematicians, are completely superimposable on ours: $7.372\cdot10^{-48}$ [g].
This is of great honour for us and greatly comforts us.

2.13. The Mass Breaks the Symmetry.

One could easily object: it is not possible to attribute a mass to the P, because according to the Standard Model (SM) the mass breaks the symmetry!
In fact the technical basis of the SM of elementary particles is made up of a basic principle, known as local *Gauge Invariance* or local G*auge Symmetry*. That is, as Emmy Noether [16] had already realized the behavior of Nature is invariant under certain transformations on its fundamental constituents, such as the fields of fundamental particles. Thus the introduction of a simple mass parameter, necessary to describe the mass of a particle, is in contradiction with the existence of this fundamental symmetry: it is said, that is, that *the mass breaks the gauge symmetry*, thus risking to make insubstantial the entire theory of the SM, and thus preventing to comprise, at a fundamental level, the origin of the interactions between the particles. According to SM the problem can be solved by assuming that all particles have a null intrinsic mass and postulating the existence of a *complex scalar field* permeating the space. The re-introduction of the mass parameter causes the gauge symmetry to be no more explicit, but that is spontaneously broken: *Spontaneous Symmetry Breaking*(*SSB*) [75],[76],[77][78].
It is in this case a *symmetry hidden from the mass*. So it was conjectures more or less at the same time, and independently by Englert and Brout, [79] by Higgs [80], Guralnik, Hagen and Kibble [81] that particles would tend to interact , to mate with this *complex scalar field*, now known as Higgs field (HF), acquiring an energy at rest which is not null, which for almost all respects is analogous to a value of mass at rest, then describable as a parameter mass. As it is

well known, the mechanism just described is the so-called *Higgs Mechanism* (HM). The HM requires the intervention of a permeating particle the HF, i.e. the Higgs Boson (HB). It is interesting to note that the coupling between the various particles ("among bosons only those bearers of weak charge" [82]) and HF (steeped in weak charge) complies with the *gauge symmetry* and explains the presence of non-null rest masses.
Later the close similarities between Electro-Magnetic Interaction (EMI) and the Weak Nuclear Interaction (WI) were highlighted. As Witten reminds us that electromagnetism (EM) is described by Maxwell equations where WIs are described by a very similar but non-linear equation system (Yang-Mills equations) [83] [84]. Thanks to this close resemblance, today they are called electro-weak interactions (EWIs). According to SM, immediately after the Big Bang (BB) there was a perfect symmetry between the P and the bosons W and Z °. That is, at those very high temperatures, definitely> 10^{16} °C, there was a perfect symmetry between P and bosons of WI, as to say that at those very high temperatures EMI and WI were equivalent [83]. Then, with the cooling of the Universe, according to SM, about 10^{-12} seconds after BB, there was a *phase transition*, so that pre-existent *symmetry* (between P and bosons W and Z°) *breaks spontaneously*(*SSB*). So, as SM proposes, following this *SSB*, Ps and bosons W and Z ° begin to behave differently, as the WI bosons acquire mass. The key to the breakdown of electro-weak symmetry (EWS) is Higgs Boson (HB). At the very high temperatures generated by the BB, the HB moved with random motions. But as the Universe temperature drops to 10^{15} °C, the HBs combine into a Bose Condensate, that is, an ordered state where many particles have the same WF. So the EWS broke in the direction of Bose Condensate, that is, in an abstract space describing the forces of different particles [83].
Although the *SSB* is the prevailing theory, various physicists and mathematicians, even authoritative, do not approve it. To this purpose, we read: "In the SM it is assumed that WI and EMI are unified in electroweak theory (EWT), where there is a special symmetry that connects the particles W^+ W^- and Z ° to the P: not only are these on the same plane, but they can continually be 'rotated one to the other'. It seems that this EWS is very odd and thin, since pure electromagnetism is *invariant for reflection*, involving both zig (left-handed helicity) and zag (right-handed helicity) components. In contrast, WIs only involve zig-shaped parts of the particles. Moreover, it seems that the P is clearly distinct among all the bosons of the theory, since it is a massless particle. Actually, the mass of P, if not 0, should be $<10^{-20}$ electronic masses for good observational motives, thus it is $<5\cdot10^{-26}$ of the measured mass of bosons W and Z. In addition, the bosons W have an electric charge, while the P does not have a weak charge. It would seem to emerge the impossibility of a complete symmetry between all gauge bosons. Moreover, the first point to understand is that in Feynman Diagrams there is much more hidden symmetry than what is immediately apparent; in fact, if viewed appropriately, they exhibit symmetry U(2), i.e. EWS. The asymmetry we see in the real world, compared to these particles, is born in EWT just because Nature chooses that certain particular combinations are realized as real free particles. But what about the other asymmetry, related to Feynman Diagrams, so that the W and Z particles can only attach to the *zig-shaped* lines of the particles, whereas the P attaches to both *zig* and *zag*? What criteria does Nature adopt in allowing us to find certain particulates as free particles, and not others? In the case of a free

particle, it must be a mass *self-state*, so we need to know what determines the mass of the particles. In this case, we cannot expect complete symmetry over U(2).
In other words, the mass implies some sort of *symmetry rupture*. Such asymmetry is the result of a *SSB*, which is supposed to have occurred at the very first stages of the Universe. According to EWT at the very high temperatures of the universe immediately after the BB, the EWS, like U(2) symmetry, was *exactly* valid, so that the W, Z and P particles were completely equivalent"[13]. At those temperatures, definitely > 10^{16} °K, the kinetic energy and momentum of the P were very high [85], so in the relativistic sense the P might have gained a considerable mass! "But already at ≤10^{16} °K, at ≈ 10^{-12} seconds after the BB, the W, Z and P were *frozen* by this *SSB* process, so only P remains massless while the others gain mass. Maybe it is the HB to give masse to these particles, as well as to itself and quarks. And how? Really great and ingenious ideas "[13], Penrose comments. Witten adds: "This proposal of the *spontaneous breaking* (SB) of electro-weak symmetry(EWS), or *SSB*, though simple and confutable with known facts, probably does not tell us the whole story" [83].
Penrose chases: "**I question the reality of SSB**! There are various *difficulties* in this idea of *SSB*. So, about 10^{-12} seconds after the BB, throughout the Universe the temperature fell just below critical value; At this point a special choice was made (W^+, W^-, Z°, and P) from the whole $\mathcal{G}$ with U(2) symmetry of possible set of gauge bosons. We do not expect this to happen in exactly the same way throughout the space, at the same time throughout the Universe, but in some regions a particular choice will be made, whereas in others there will be different choices. The $\mathcal{G}$ space of the possible gauge bosons is, at each point of the space-time completely U(2)-symmetrical, before the symmetry reduction occurs.
As implied in the *fibrate* concept, there isn't any particular way to make an identification between the $\mathcal{G}$ space in a certain point and the $\mathcal{G}$ space in another point completely different. Therefore, there isn't a rule that tells us what element of $\mathcal{G}$ in a point is the 'same' element of some other element of $\mathcal{G}$ in another point. It seems to us that this gives us the freedom to observe the notion of 'same' as the one provided by the particular choice that *SSB* offers us. According to this point of view, the particular set (W^+ W^- Z° and P), which is *frozen* in a point can be identified with the corresponding (W^+ W^- Z ° and P) in any other point. Thus, it seems that we should not have that kind of 'inconsistency' between *symmetry breaks* (SBs) in different points, which occurs with the iron magnetization domains. However, this point is in open contrast to the idea behind the gauge theory, according to which not only the $\mathcal{G}$-spaces are the *fibers* of a $\mathcal{B}_{\mathcal{G}}$ *fiber*, whose base space is the space-time $\mathcal{M}$, but where the particular theory of gauge, in this case the *unbroken* electroweak theory (EWT), is defined in terms of a *connection* on this fibrate. This *connection* defines the locally significant identification (parallelism) between the various $\mathcal{G}$-spaces when we move along any $\mathcal{M}$ curve. In general, this identification is not globally consistent when we move on closed circuits (due to the curvature of connection, which expresses the presence of a non-trivial gauge field). In any case, the randomness involved in *SB* in different points implies that local parallelism between the $\mathcal{G}$-spaces will not, in general, be consistent with the choices made in *SSBs*"[13].
In short, following the description of the SM, we find that the *breaking* of the *electroweak symmetry* (*EWSB*) is totally *asymmetric*, since the *SSB* (related to the "phase transition"

triggered by the lowering of the temperature of the primordial universe) alters also the symmetry of the HF. That is, the *EWSB* means that only the W and Z° bosons acquire mass, while the P will remain massless forever. Why do we have such a dichotomous and asymmetric behavior, in a model based primarily on symmetries? According to SM the more a particle interacts with the HF, the greater its mass. The P, on the other hand, does not interact with the HF at all, so it will remain massless. But how is it possible to state it with such a determination? Based on what preexisting phenomenon, or assumption? How is it possible to confirm and prove this particular behavior of the HF in favor of some particles, compared to others, closely related? Why can't we apply the mathematical formalism used in favor of the bosons W and Z ° [78] [79] [86] to P too?
Unless we try to think that there may be another type of HM, working likely in that HF portion, asymmetric as compared to the HF, which gives mass to the bosons of the WI. This asymmetric portion of the HF might interact with the Ps, so that even these can gain mass (though very small), and *without breaking symmetry*. It could be assumed that in such circumstances, the temporary acquisition of mass by the Ps would *overshadow symmetry*. In short, following SM criteria, before the phase transition (resulting in *SSB*), the bosons of EMI and WI were equivalent, the two forces were unified and the HF behaved ubiquitously homogeneously, without asymmetry. Then, with the primordial *phase transition*, and consequent *SSB*, also the symmetry of the HF is altered, which starts to behave differently, i.e. asymmetric, so that it gives mass only to the bosons of the WI and not to the Ps.
In integration with SM, and to try to justify the massive particle behavior many times shown by P, such as, for example, in the Photo-Electric Effect [61], Compton Effect [62], Raman Effect [63] and in many other cases, we dare to think that – through a Higgs Mechanism (HM) - the asymmetric portion of HF may succeed in give mass to P. In this case, it would be necessary to understand whether P and the W and Z ° particles gain mass through a single HB, or two distinct HBs occur: one interacting with particles with no weak charge, nor electric charge, nor color charge, as the P, whereas the other is well known. In this regard Randall states: "We have no certainty about the precise set of particles involved in the HM. For example if the *breaking of the electroweak symmetry*(*EWSB*)was to be attributed to 2 Higgs fields, rather than to one"[82].
This may be in accordance with our assumption (if we considered *SSB* as real), as well as having a consistent and congruent (symmetrical) application of HM to SM, so as to also explain the mass of particles such as P, as a result of *SSB*. In conclusion. why these diversity of behavior, so that HM would interact with the weak field (EWF) and not with the electromagnetic field (EMF)? As it is known, EMF is a quantum field capable of preserving a *local gauge symmetry*, which persists even after partial transformations of the field itself. Likewise, it seems more appropriate to assume that with the lowering of the primordial universe temperature and the subsequent *phase transition*, the HF behaved symmetrically with respect to the pre-existing EW Interaction, so as to induce also the *SSB* of the EMF, so as to give a *mass parameter* to the P (though of very modest entity), just as the *SSB* of the EWF gives that big mass to the bosons W and Z°.
Therefore, it should not be surprising that the P can carry a mass, a dynamic mass, given by the HF, using the same mechanisms described by the SM in order to explain the

remarkable mass the bosons of the WI acquire. In addition, as for the mathematical description of the EWF's *SSB*, also in the case of the EMF's *SSB*, just separated from the EWF, there is a similar mathematical formalism, in which the Lagrangian (or Hamiltonian) defining the physical system would be *invariant* with respect to a *group transformation*, such as rotation or translation. In this regard we report the Lagrangian globally invariant gauge (L):

$$L = \tfrac{1}{2} (\delta_\mu \boldsymbol{\varphi})^T \; \delta^\mu \boldsymbol{\varphi} - \tfrac{1}{2} m^2 \boldsymbol{\varphi}^T \boldsymbol{\varphi} \quad (62),$$

where φ is a scalar field vector, and T is the matrix that indicates the generators of the group $O(_n)$, that is, the n-dimensional orthogonal group. Randall adds: "However, there are other models that hypothesize more complex *Higgs sectors*, with even more articulated consequences. For example: Supersymmetric models provide higher number of particles in the Higgs sector. In that case we would always expect to find a Higgs Boson, but its interactions should be different from those deducible by a includes only model that one Higgs particle "[82].

Therefore, it is not possible to exclude *a priori* that another HB, other than that found at CERN, may possibly allow the P to gain mass, according to an HM analogous to that proposed by SM. On the other hand, Ugo Amaldi, who has worked at CERN for many years, is also rather puzzled and writes: "Even if HB identified at LHC had all the intended properties, physicists would never say that SM is entirely satisfactory. It is not in fact able to explain why HF's interactions with matter fields (which determine the great mass differences between the particles) are so different from one case to another "[87].

Even Feynman was very upset by the problem of particle masses, and so he wrote in 1985, that is 23 years after the theory proposed by SM: "I am convinced that at the fundamental level the origin of mass values is a very serious and interesting problem, to which an adequate solution has not been found yet" [58]. Witten adds: "Solving the riddle of how this EWS breaks can determine the future direction of particle physics"[83].

In short, along with Witten and many other authors, it seems that there is a need for a new Physics, yet to be understood, able to describe in what ways and by what precise mechanisms the particles can gain mass.

2.14. Remotion of Infinities and Renormalization

As it is well known, *quantum electro-dynamics* (QED) is a *Quantum Theory* of the EM field (EMF), which also includes *Relativity Restricted*. The QED describes all phenomena relating to electrically charged particles interacting through EM Interaction (EMI). It seems interesting to note that m*athematically* the QED presents the structure of an *abelian* gauge theory, with a group of gauge U(1), where, *physically*, it means that charged particles interact with each other by the exchange of null-mass particles: the Ps. The spinorial QED is represented as follows:

$$L_{QED} = -1/4\, F^{\mu\nu}\; F_{\mu\nu} + \bar{\psi}(1/2\; i\, \partial - M + e\, A\!\!\!/)\, \psi \quad (63).$$

It describes the interactions between a quantized material spinorial field (i.e. the electronic field) and a non-massive vector field that describes the EM radiation (EMR), i.e. the EMF managed by the Ps (considered massless).

The first formulation of a *quantum theory* describing the interaction between radiation and matter (i.e. between Ps and electrons) is Dirac's [88]. Later, in the 30s of the last century, scientists began to notice that in the equations of perturbative development of the

QED infinites emerged, which were considered un-eliminable. Oppenheimer demonstrated that at the origin of the infinite there was the term expressing the interaction between the electronic current and the EMF produced by the electron [89]. That is, the self-interaction of the electron, considering the processes in which the electron emits and resets a P, causes an infinite shift (with quadratic *divergence*). Obviously this occurs because in the equations a point value for the radius of the electron (a) is introduced, thus $a \rightarrow 0$ (which is as to give the value a = 0). Consequently, the calculation results in an infinite shift: for $a \rightarrow 0$ diverges as $1/a^2$ [90].
As it is well known, other *divergences* (in the perturbative development of QED) emerged from Feynman's diagrams. In fact, 'an integral on a loop', a *closed path* in a Feynman diagram, leads to clearly divergent expressions. These divergences are due to the "non-integrable" behavior of the integrating function for high *momenta*: these are *ultraviolet divergences*, correlated to *vacuum polarization*. Other types of divergence, due to singularities in expression, emerge in theories like QEDs that provide non-massive particles: the Ps [91]. In this case, *infrared divergences* appear, for *momenta* tending to zero. Obviously, to give mathematical and predictive meaning to Quantum Field Theories (QFTs), these problematic terms had to be removed. To this end, so-called *renormalization* techniques have been studied.
Yet, the classic radius of the electron (r_e), or Compton radius, corresponds to:

$$r_e = 2.818 \cdot 10^{-13} \text{ [cm]} \quad (64).$$

It is clear that the more the electron is accelerated, the more its size is reduced, but never reaching – in our view - a point value (so $r_e \rightarrow 0$). In this way the infinites would disappear too.
We read from Feynman: "In computing terms by interactions between electrons and Ps we need to consider all the possible points where interaction can take place, including the case where the Ps emission and absorption points overlap, that is, when the distance is null. But if you push the calculation too far away, the expressions *explode* in our hands and give meaningless answers, for example, infinite amounts. This caused a lot of problems in the early days of the QED: every magnitude was infinite! (The consistency of the mathematical provision implies that the distances are void, but in this case the problem arises, since no value of the mass of the electron or its charge leads to sensible results "[58]. On the contrary, in our view, the 'consistency of the physical order' should take over. It is known, in fact, that the particles can not approach each other beyond a given distance (d_o), below which a repulsive force appears: *Levy Interaction* (*LI*) [92]. Between two nucleons, for example [93], *LI* expresses its maximum power to:

$$d_o < 0.532 \cdot 10^{-13} \text{ [cm]} \quad (65).$$

This value corresponds approximately to 0.5 times the nucleon diameter. Obviously, the electrons are much smaller and yet, being massive particles, they can in no way occupy a void or punctiform volume of space, that is, equal to 0. Besides, considering the value of the minimum distance two particles can come close, no infinites should emerge from perturbative calculations of QED. Feynman specifies: "But if instead of including all the possible points of interaction until a 0 distance, the calculation is cut off when the distance between the points is very small, there exist defined values of the mass of the electron and of the its charge, such that the calculated mass coincides with the value of the mass of the electron measured experimentally, and the calculated charge coincides with the experimental value of the electric charge of the electron "[58].

Feynman adds: "Maybe the idea that two points may be infinitely close is incorrect, it is false the assumption that geometry will continue to be invariably unchanged"[58].

In addition, we read: "With reference to the *problem of infinites,* just think about the energy of the electric field of a charged sphere, which radius (r) tends to zero: $r \rightarrow 0$; i.e. the energy $\rightarrow\infty$, diverges, such as *1/r*. For the theory of Special Relativity, part of the mass of the sphere comes from the (divergent!) energy contained in the surrounding EMF. However, one might think that no electrical charge is actually *punctiform* and that the problem is simply due to a *mathematical abstraction* "[94].

As for other *divergences* that emerge from perturbative calculations of QED, such as when a P is given a 0 mass (the most striking example is *infrared divergence*), in order to eliminate the infinites it would be necessary to replace a massless P, with the value of the Planck constant (*h*), equal to $7.372 \cdot 10^{-48}$[g], multiplied by the value of the frequency of the considered P: see equation (41).

3. C O N C L U S I O N S

To try to describe the most relevant features of the quantum gravity (QG), we believe that it is necessary to meet the various requirements demanded by most Authors in order to reach a *correct* QG (CGG).

Therefore, along with what has been amply set out in the various paragraphs of the “Discussion”, we hope to have created the premises to sketch a more or less comprehensive answer to the most frequent requests. Let's list the main ones.

3.1. CQG should help solve the problem of particle masses.

In order to build a satisfactory response to this request, we devoted so much space and depth to the search for the mass of light, as well as to the description of the various mechanical effects exercised by light, by Ps.

The light, the EMR, should, in fact, be the crucial element in order to trace an adequate path to try to describe a CQG. To this end, the fundamental step should be to no longer consider the P as massless, just because of Einstein's MEEP.

We read from Penrose: "At present there is no good theory able to explain why particle masses must be exactly what they are, although *mass* is a concept intimately connected to that of *gravity*. The mass, in fact, only works as the *source of gravity*" [35].

Feynman states: "Throughout this story there is a particularly unsatisfactory aspect: the observed values of particle masses. There is no theory that adequately explains them; they are constantly being used in the accounts but there is no idea what they are and where they come from" [58]. Penrose adds: "Maxwell electro-magnetic field (EMF) delivers energy. For $E=mc^2$, it must also have a mass. Maxwell's EMF is therefore also matter! Now we must certainly accept this notion"[35]. It is pleonastic to specify that Maxwell's EMF is constituted and operated by Ps!

Therefore, since the P is a *quantum of energy*, according to the MEEP, it must inherently have an *equivalent mass*, though *concealed* and not easily detectable. Penrose specifies: "The *mass of P* is an impalpable type: it is pure energy" [35]. In fact, a well-known principle of *QM*, the Complementarity Principle, states that each QO can show both its corpuscular and waving behavior but, *conditio sine qua non*, only one at a time: never simultaneously! Therefore, until the P is in motion, it can show only its waving side. On the contrary, in the very short time the P interacts, we may indirectly detect some aspects of its corpuscular behavior through its quantum-mechanical effects: *push effect* induced by the P, as well as the *radiant pressure*, or the 'solar sail', or the substantial "*stroke*" with which a single P blasts an electron into another orbit, as Barrow reminded us [66].

In short, we think that we cannot longer ignore the value of the Planck constant, which as indicated by Eq. (41) corresponds to $7.372 \cdot 10^{-48}$[g], multiplied by the frequency of the considered P. These values are perfectly consistent with those described by Penrose, which states that "If the mass of P is not 0, it should be $<10^{-20}$ electronic masses" [13], that is $\approx 9.1 \cdot 10^{-48}$ [g].

In this regard, one might object: the mass of P *breaks the symmetry*! For the related *discussion* see paragraph 2.13. In addition, it seems to interesting to add along with Penrose: "All these attempts by Physicists to exploit this type of *symmetry breaking* (*SB*), regardless of their popularity, still have to be judged very speculative. We should be very critical and skeptical about propositions of this nature, to avoid to be dragged too easily " [13].

In turn, Feynman reminds us: "With a bit of skill any experimental result can be shot so that it seems like a predicted consequence, a bit like it happens in Psychology. In Physics we have examples of this kind. We have these *approximate symmetries* that work roughly like this. You have an *approximate symmetry* and count a number of consequences, assuming it is perfect, but when compared to experiments it does not work. It is obvious: the *symmetry* you have to expect is *approximate*, so if the result is pretty good you may says: nice! On the contrary, if it is not good you may say: Well, this must be particularly sensitive to the *symmetry breaking* (*SB*). Just laugh! The same thing happens for the proposition of *symmetry* in Physics and Psychology. It's easy to fall into the mood with this kind of vague theory: it's hard to prove it is wrong, and it takes some skill and experience to avoid being tricked "[40].

3.2. CQG *remuves infinities.*

This issue has already been discussed (paragraph 2.14.). We could add from literature, with Penrose: "The supreme QFT is the QED, that is, the theory of electrons and Ps. However, QED is a somewhat confused - and not entirely consistent – theory, since it gives *infinite solutions* at first, which make no sense. These must be eliminated, what happens through a procedure, known as *renormalization*, but not all QFTs can be *renormalized* [35].

Feynman, who for Renormalization received the Nobel Prize, almost 40 years later writes: "This *compass game*, made with the value of the electron rest mass and the value of its 'charge' (i.e. its amplitude of interaction with Ps), is called with a technical language *renormalization*: a fine name for what remains an absurd process! Having had to resort to such prestigious games made it impossible to prove the internal coherence of QED. It is, in fact, surprising that this coherence is still undemonstrated and personally suspect that renormalization is not a mathematically legitimate process. What is certain is that we do not have a good mathematic basis to formulate QED theory "[58].

On the contrary, in our opinion, the *removal of the infinites* emerging from the perturbative study of QED and the other QFTs, can be obtained with 2 modes:1) replacing in the equations of such theories the value of 0 of a P massless, with the real energy value of P, as represented by Eq.(41); 2) replacing in the equations of the QFTs the point value attributed to the radius of the electron, therefore $\rightarrow 0$, with the real value of its radius.

3.3. CQG shows a *continuity* between *U Phase* and *R Process.*

With this paper we try to introduce a new parameter, induced by the EMR, which can help us discern the doubts about the ***R** Process*, and at the same time try to find a *continuity* in order to link the ***U** process* to the ***R** process*, so contrasting at the moment. The contrast comes both on the physical side and on the mathematical formalism. Indeed, as we read "the quantum mechanical equations, including Schrodinger's, are *mute* about the ***R** Process"*[21], not being able to interpret it.

The new parameter could be the ***gravity and quantum effect***, represented by the *mass effect*, the mechanical action induced by the P (the *quantum* of EMR), when we try to make a M of a physical system of the subatomic world (topics widely discussed in paragraphs 2.8. and 2.11.).

It is not easy to find the right mathematical formalism to introduce this parameter, the ***gravity action of the light***, of the P's *dynamical-mass*, influencing the particle we want to observe. It may be easier, and more congruous at the same time, "to write Schrodinger's equation for a single particle with a mass *m*, moving in an external field, which energy contribution indicated with *V*, where V = V(x,y,z), considering x,y,z the three space coordinates"[13]. We have:

$$\boldsymbol{H}\Psi = i\,\hbar\, d\Psi/d\,t = -\,\hbar^2/2m \cdot \nabla^2\,\Psi + V\,\Psi \qquad (66),$$

where ∇^2 is the differential operator of 2° order, called *Laplacian.* In 3-dimentional field it is represented as follows:

$$\nabla^2 = d^2/dx^2 + d^2/dy^2 + d^2/dz^2 \qquad (67).$$

In Eq. (66), it is also likely to find that highly sought-after **continuity** between ***U** Phase* (illustrated by the first and second member of the equation) and ***R** Process* (third member) separated just from a sign of equality. In addition, this sign of equality, which represents the transition from ***U** Phase* to ***R** Process* (and *vice versa*), could also express **reversibility**, as saying a bi-directionality between ***U*** and ***R***. Moreover, it is known that, immediately after *Measurement* (M), i.e. after the ***R** Process*, the *measured* particle retrieves the previous quantum state (as stated by the Noether theorem[16]) restoring the ***U** Phase*. In Eq. (66) it may also not be possible to find that marked incompatibility between the two basic *QM* procedures: the ***U*** and ***R*** procedures. Incompatibility represented by the unitary *deterministic* linear evolution (brightly described by Schrodinger) of the ***U** Phase*, and the peculiar *reduction of* the strictly probabilistic *state vector* of the ***R** Process*, induced suddenly by M, with immediate WFC of the examined QO. The QO, in fact, with M collapses immediately, and indeterministically, in another WF, represented by Ψ. It is as if, probably, Ψ travelled backward along the equation, moving from the third member to the previous ones. That is, terminated (in a fraction of a second) the ***R** Process*, illustrated with the 3th member, a situation similar to the previous is restored, so it is as if from now, Ψ (again in ***U** Phase*) was described through the other two members (where it is likewise represented), namely through the Schrodinger deterministic mathematical formalism.

3.4 CQG could highlight a temporal asymmetry between *U Phase* and *R Process*

Therefore, it seems important to note that, instead of a specific asymmetry of time between the two phases, there is only, or essentially, a ***quantitative temporal asymmetry*** between the real duration of the ***R** Process* (which we have with the WFC) and the duration of the ***U** phase*. In fact the ***R** Process* is very short, just the time the WFC is carried out. After that the particle goes back to its quantum representation typical of a ***U** phas**e***. From a corpuscular behaviour it goes back to a undulating behaviour. On the contrary the ***U** phase* lasts all the time until the particle is observed, disturbed, measured again!

So, with our paper, we try to highlight both a possible *continuity* between ***U*** and ***R** Process*, as well as a *quantitative temporal asymmetry* between the two processes. One could also find, through Eq.(66), a *continuity* between Newtonian Mechanics, Relativistic Gravity and *QM*, that is, to relate the classical level to the relativistic and quantum level of the physical description of the world.

3.5.The CQG should highlight a gravitational effect (induced by EMR)

We can see that the 1st and the 2nd member in Eq.(66) corresponds exactly to Schrodinger equation: see Eq.(10). The first member, as we know, represents the energy of an examined particle, i.e. an electron, considering Ψ its WF, whereas ***H*** indicates the energy. The 2nd member, of course, indicates as this "undisturbed" particle evolves normally, *linearly,* in the time. This evolution is known as ***U** phase**,*** or Schrodinger *linear unitary evolution.* In fact the 2nd member follows the *quantum momentum* ($\boldsymbol{p}_a$) represented in Eq.(9), which later Schrodinger develops in his equation.

Penrose stresses that: "all this replacing *momentum* and energy with differential operators, seems an incomprehensible mathematical ritual, it is important to wonder if it has something to do with the *momentum* given by the punch of a boxer. Yes! According to *QM* the key topic about the *momentum* is that it is saved, and the effect of a stroke is just an inevitable consequence. The *momentum* has to move somewhere, it cannot just disappear, because it is saved. It is the same for the energy" [13].

We think this is just what happens with the Measurement (M): the *momentum* of P is transferred to the stroked particle (according to Fermi[32] and Feynman[33],i.e.), respecting the Momentum Conservation Law. It should just be the moving of the P's *momentum* to the particle undergoing a M, to make the collapse of its wave function (WFC) and make less enigmatic the Measurement's Paradox (MP).

Let us consider now that our electron, or another QO, represented by its WF(Ψ), is disturbed during its ***U** phase*, thus forced to interact. What does it interacts with?

In order to see the electron, we need to use the light, the Ps, thus the electron will interact with the P. Let us try to represent mathematically the interaction between the electron and the P. Eq.(66) is helpful; the 3rd member can represent the particle interacting with our electron (Ψ): *m* shows its mass and *V* the energy. Thus the P modifies – just for a moment – the *linear **U** phase* of the electron, that is the particle we are measuring.

We may think that this is not possible because the particle in the third member in Eq.(66) has a mass, whereas the P is mass less! This is correct. But if we start not to consider the

P as massless any more, since calculations show that the P has an *inertial mass* of $7.372 \cdot 10^{-48+n}$ grams, see Eq.(41), and that an optic P hits the electron with a *dynamic mass* of $1.325 \cdot 10^{-22}$ [g·cm/s] –see Eq.(45) – then we can introduce the P in Eq.(66). We have:

$$\boldsymbol{H}\Psi = i\hbar\, d\Psi/dt = -\hbar^2/2(10^{-22})\ [\text{g}\cdot\text{cm/s}] \cdot \nabla^2\Psi + V\Psi \qquad (68).$$

Let us try to represent mathematically the action of a particle as a luminous P which interacts with an electron during its *linear evolution phase* ***U***. This interaction induces the WFC of the examined electron which, just after the M, will return to the previous phase, as in the second member of (66). At the same time with the 3rd member of (66), we have a sort of ***quantum gravitational effect*** which operates on the particle undergoing the M.

What is this effect represented by? By the *light radiation pressure*, by the *momentum* carried by each single P. It is a ***gravitational effect***, since it is a ***mass-effect***, a ***mechanical effect*** on the measured particle, the QO which is lighted with the M. Especially if the incident particle has a total mass bigger than the hit particle.

Feynman confirms: the momentum is "a *mechanical quantity*"[33]. As it happens when the P interacts with the electron (Ψ). It is also a ***quantum effect*** since it is carried out by the P, that is a quantum particle, the *Planck's grane*. Thus, we can infer it is a ***quantum gravitational effect*** to induce the WF collapse(WFC) of the QO undergoing the M.

3.6. CQG could explain WFC and Measurement's Paradox (MP)

With Eq.(68) we try to introduce the *dynamic mass* of light, relative to the *momentum* of a single P of the optical band, since the EMR has proved indispensable and irreplaceable to make a M.

This is just a *conditio sine qua non*: without using the light you will never be able to examine, frame, *measure* a QO! It happens, however, that light, as Feynman (one of the deepest connoisseurs of light) has repeatedly mentioned, vibrates the illuminated electron, deviates its trajectory, removes it, alters the state of its WF, that is, Ψ[40]. Obviously, the values of the *momentum* (***p***) of light are to be introduced into the 3rd member, since the other two, together, perfectly reproduce the Schrodinger equation describing the ***U*** *Phase*. They are values that are not meaningless, but correspond to a mass of impact of various orders of magnitude greater than the electron *restmass*, as shown in Eq.(45). That is why the *push-effect* induced by a P is so violent, to induce the immediate WFC of the measured QO [95]. Moreover, these described are not isolated calculations.

Feynman specifies: "Suppose that light is coming from a source and is acting on a charge and driving that charge up and down. The magnetic field (***B***) acts on the charge (say an electron) only when it is moving; but the electron is moving, it is driven by the electric field, so the two of them work together and there is a force on it. But in which *direction* is this force? It is in the direction of the propagation of light. Therefore, when light is shining on a charge and it is oscillating in response to that charge, there is a driving force (*F*) in the direction of the light beam. This *F* is called *radiation pressure*.

Let us determine how strong the *light pressure* is. Evidently it is:

$$F = \boldsymbol{B}\, q\, v \qquad (69),$$

where *v* is the velocity of propagation of the light beam and *q* is the electronic charge or, since everything is oscillating, it is the *time average* of this: $\langle F \rangle$. Therefore the force (*F*) is the ***pushing momentum***, that is delivered per second by the light"[33].

In short, it could be essentially the ***mechanical*** action represented by the momentum (***p***) and ***gravitational mass effect*** **of light's *quanta*** to induce the WFC, and *light* us on what happens during a M and make a starting point of a CQG.
The *momentum* of P (say the ***P's pushing momentum***) may explain the WFC [95] and the Measurement's Paradox (MP) in the subatomic world[96].
The MP is the most intricate puzzle of Quantum Physics, a problem still unresolved. Basically, when we try to make a measurement (M), we involuntarily but inevitably modify the subatomic system we are trying to measure. To measure (M), observe a subatomic particle, we are forced to frame it, to illuminate it.
In our view, it is just the light, the EMR to trigger these phenomena, that is to induce the MP, since it is clear from our calculations that the visible band Ps, rather than behaving as massless particles, affect the measured particle with a impact force determined by their momentum (p), equal to 10^{-22}[g·cm/s]. That is, the particle is hit by a radiation pressure equal to that of 100 protons all together, or comparable to that of over 100000 electrons. That is why, in our view, the measured particle undergoes such a drastic change in its physical properties and, likewise, of its morphological and structural configuration.
There is, then, a clear mechanical-relativistic and quantum effect, driven by the *dynamic mass* transported by the light quanta. This could be used to represent a unification between Newtonian Mechanics, General Relativity and QM, as well as to show a possible continuity and reversibility between the unitary linear evolution phase of a QO (***U** phase*) and the Reduction of Status Vectors (***R** Process*) and, probably, constitute the foundations for a *Correct Quantum Gravity* theory.

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