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ABOUT THE ZERO MASS PHOTON

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Abstract—The photon, that is the messenger of the electromagnetic force, is considered with a zero restmass. Yet, just as there is no energy with a zero value, so we talk about a "Zero Point Energy", for the equivalence between mass and energy (datum point of the Theory of Relativity and foundation of modern Physics), there should exist also a "Zero Point Mass". That is, no particle, with energy, though extremely small, as the energy of the quantum of light, the Planck's grain, can have a zero mass. In other words, just for the equivalence Mass-Energy ($E = mc^2$), to any particle with energy should correspond a mass equal to the energy carried, divided the square of the speed of light. Of course when we consider particles like the photon this value will be extremely small, however it should be $\neq 0$. Thus, a lot of the behaviours of the photon, in which it shows a clear sort of mechanic action (see photoelectric effect, Compton effect, or the Raman effect), so far ascribed to a mere energetic effect, may probably be considered as real "mass effects".

1. INTRODUCTION

The photon (P) is the messenger (boson) of the electromagnetic force (EMF). This force has an endless ray of action and acts on all the particles electrically charged. The strength of the EMF is considered approximately 10^{-2} of the strength of the Strong Nuclear Force (SNF). The P carries the action of the EMF through the electromagnetic field which it generated. It is thought that every EM field goes to infinite, however the infinite shows a "singularity", this situation is not easy to handle in physics, thus it is better to say that the ray of action of the EMF "goes" to infinite. The EMF and the Gravity Force (GF) are the forces which we "feel" more during our everyday life: they rule the "macroscopic world", that is the one we manage to perceive. Whereas the "microscopic world" represented by all kind of atomic, nuclear and sub nuclear processes, is ruled, almost exclusively, by nuclear forces: SNF and Weak Nuclear Force (WNF).

It is known that the word "P" was coined by Einstein in 1905, when he applied to the photoelectric process the "grains, or packets of energy", which had first been hypothesized by Planck in 1900. We know in fact that as Planck was trying to find a solution to understand the phenomenon of the radiation of the black body, he guessed that the EM energy did not transmit with an uninterrupted flux, but through the flow of many "packets" of energy, one after the other, or "discrete quantities" which he called "quanta". Indeed, the energy was spread through the flow of a large number of quanta, extremely close one to the other so to appear as one continuous flux, uninterrupted. Actually it a series of a large number of quanta, well distinct one from the other (a photoelectric cell in fact manages to count them, one by one).

The quantum of light is our P; it propagates in the EM field as a wave: namely the electromagnetic wave (EMW). The word P comes from the ancient Greek (photon = light), however Einstein himself used it to talk about both the Ps of the visible band and the corresponding ones inside the Electromagnetic Spectrum. Thus the P indicates any wave of the EM Spectrum, from gamma rays to the extremely long radio waves. Since the P is a boson, it has an entire spin (in its case 1). The mass of the P, on its turn, is null, that is 0: the P is mass less.

2. DISCUSSION

Let's try to analyse some characteristics and behaviours of the P.

2.1. The Energy of the P

"The EM radiation is emitted or absorbed by objects with very low energy, called Ps" [1]. The energy of the P, that is the energy of a quantum of light (h), is $6,6252 \cdot 10^{-27}$ erg/sec. "Light cannot be considered as something distinct from particles. We know from Quantum Theory that the light is made of particles known as Ps. A normal luminous wave contains a large number of Ps, all travelling together. If we tried to measure with great accuracy the energy carried by the wave train, we would find that the number we get is always a multiple of a definite quantity, which we identify as the energy of a single P, really very small. The number of Ps emitted continuously by a light bulb is so high that they seem to melt together in a continuous beam: however a photoelectric cell is able to count the Ps one by one. Ps have zero mass and a null electric charge, however they are real: each one carries a well defined energy and momentum, as well as a spin, determined around its motion direction" [2]. It is known that the momentum (p) is directly proportional to the energy, that is the frequency: $p = m\nu$.

"In order to know the "mean energy" of each P [that is of the EM radiation] we multiply the value, the number of Kelvin degrees of the temperature of the universe times the Boltzmann constant (0,00008617 eV)" [3]. If we observe the EM spectrum we notice that the energy of the different EMWs present an extremely wide range of oscillation, going from an energy of 10^{-13} eV, as it happens with ELF (extremely low frequency waves), to 10^{10} eV of gamma rays highly energetic, till cosmic rays, where the energy reaches 10.000 billions of eV (10^{13} eV), or even higher. To give an idea of the energy contained and carried by Ps, since the beginning of the world, we can think that "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" [4]. That is the 2/3 of the energy spread in the entire universe was contained in the Ps: yet they are mass less! Despite the Equivalence Mass-Energy. The Quantum represents the minimum quantity of energy. We can only have entire multiple values of h, never fractioned: the quantum (h) is an indivisible unit. "Einstein wrote: $E = hf$, which says the energy contained in each "grain" (or quantum) of energy, microscopically observed as a continuous reaction of f frequency" [5]. The energy of each grain of energy is given by h, that is the quantum, the Planck's constant, observed as an EM "continuous reaction", that is a flux of h. The flux changes with the frequency. We need to keep in mind that "the extremely small value of the Planck's constant explains why the Quantum Mechanics hasn't appeared in the macroscopic world, where the Newtonian mechanics

dominate, where $h = 0$" [5].

2.2. The P "Feels" the GF

"Einstein's prediction based on his General Theory of Relativity, says that the light feels the GF. 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" [6]. Lord Eddinton, in fact, with his famous experiment in 1919, confirmed exactly the prediction of light deviation made by Einstein, confirming the General Theory of Relativity. We could object that it is the GF to bend the space around the star, so the light is bent too, appearing deviated. However this phenomenon, as Newton said, happens only on bodies having a mass, thus the light, which is mass less, should have gone straight on when close to the sun, without undergoing the gravitational attraction. Besides, as Hawking says: "gravity is a force which occurs between two particles having mass" [7]: the P may be energy, but in this case it is mass too. Besides, "All particles, including the mediator particles of forces, feel the GF" [8]. The sensibility to GF of a mass less particle, makes us think that the P conceals an extremely small mass, impossible to catch directly, but "detectable" indirectly, as when it undergoes the gravitational attraction. The same happens near a black hole: also in this case the P is attracted by the GF, till it is completely swallowed. On a scientific encyclopaedia we read: "The GF acts on all bodies but those mass less, such as the P" [9]. However it is clear that the P is sensitive to the gravitational attraction. It may be useful to state that "the mass determines the sensibility of a particle to the GF" [10]. Thus a mass less particle cannot "feel" the gravitational field. Chandrasekhar says: "it is the mass which gives weight to a particle, and to determine the way it moves when a force is applied to it" [11]. Thus, a force has to act on something material in order to move it. Thus the GF should act on a mass. Yet the P, which feel the GF, is considered mass less.

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 Ps is slightly diverted by the gravitational field: Sachs-Wolfe effect" [12]. Thus, if the path of the Ps is diverted they should have a mass, though it is thought that the GF 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, in fact going along its path with relativistic speed it might add to its energy also a "kinetic energy", this would allow it to hide more easily its probable mass. This way of thinking shouldn't be too fanciful, since

we think it has a meaningful certain base. Since our P is in motion, we can say it is a wave, namely an EMW, in this case it shows its "undulation aspect". It couldn't do anything else! Why? In order to respect the well known Complementary Quantum Principle, according to which a particle can show itself only with two "aspects": undulation o corpuscular. These parameters are "complementary", similarly to the complementary parameters of Heisenberg's Indetermination Principle: energy-time, or position and momentum of a particle. The more accuracy we have in knowing a parameter, the more uncertain the measure of the complementary corresponding parameter will be. Thus, according to the Complementarity Principle itself, the more information we have about the undulation aspect of the P, the less, in the same moment, we have of its corpuscular aspect. It shouldn't be hazardous to state that "the undulation aspect" coincides with the motion of the P, whereas "the corpuscular aspect" should coincide with the almost motionless P, while it is interacting with an other particle. In short the P in motion corresponds to the undulation aspect, whereas the interacting P corresponds to the corpuscular aspect. What does it mean? According to the Complementarity Principle, if the P is in motion we can catch its kinetic energy, adding it to its main base energy, but we will never be able to have news, simultaneously, about its corpuscular characteristics. From the P in motion (undulation aspect) we can have news about its energy, but we can never check its mass. Whereas when the P interacts, it slows almost completely its run (however without stopping completely: Heisenberg's Uncertainty Principle would not allow it to), thus the photon will stop showing its undulation aspect and will show us its corpuscular one, allowing us to determine its mass (in case it has some!). From CERN essays we quote "the GF acts on the speed of Ps in two different ways: 1) through the energy of the momentum of the gravitating matter. 2) Through the component of the space-time curvature, which is not determined locally by the matter: the so called "Weil bend" [13] It cannot be excluded that, still talking about the Newtonian law of Universal Gravitation, if a body or a particle feels of the GF, this involves that it has a mass, o "subtends" a mass, even if in that moment it is in motion, showing its undulation and energetic aspect. "With Newton the engine of the movement becomes the gravity, and the mass is the property of every body, which makes it sensitive to it: the more mass a body have, the more it attracts other bodies with mass" [10]. But if they do not have mass they should not feel the GF. "The GF is attractive, and acts among objects with mass. This effect depends on two things: 1) the mass of the two bodies; 2) the distance between them, as the equation of universal gravitation shows, the GF is directly proportional to the

product of the masses and inversely proportional to the square of the distance between the two bodies" [14]. Thus, no mass less body can undergo the effect of the GF, since if we multiply the mass of the first body times 0 (the mass of the second body, i.e. the mass less P), the result will be 0: this means that the GF is null, cannot be performed. In other words, the Universal Gravitation formula itself imposes that each of the two bodies must have a mass, and a mass different from 0. This means that the GF could not act on mass less Ps, and so it is much more likely that they have mass.

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 (Ps, pions, couples of leptons)" [15]. It is as to say tat the P already had a mass.

2.3. The P Contributes to the Gravitational Mass

"At the beginning of the history of universe, it was the total density of energy, of the various Ps, electrons, positrons, etc. to provide the source of the gravitational fields of the universe" [16]. Thus, if the Ps "with their energy" contribute to create the gravitational field, it may mean that they hide, "contain" a mass in their energy. We can still read: "relativity says that the space-time is incurved by the distribution of the mass and the energy contained in it" [17]. 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" [18]. Thus, if the energy rises the GF 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. In this case the energy has behaved like a mass. This is an other examples of how the P may hide an energy under its mass. "Any particle having energy (mass) creates a gravitational field" [19]. 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 dose not consider those having energy. Thus it should be the energy of the particle to subtend the mass. In this way it is likely that, according to the Complementarity Principle, the P in some cases shows the mass, in others the energy: it never shows both at the same time. Besides, "according to Einstein, in its gravitation theory (General Relativity), mass and energy are related, so any object having energy attracts gravitationally other object" [20]. 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. 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. A body with a zero mass would flee the GF, since the equation would be null, which would give the result of: $E_{gf} = 0$. Thus we think that when a zero mass is applied to a charged particle, the Principle of equivalence Mass-Energy is broken.

2.4. The Materialization of the Ps

"The quark model foresees that a P (colliding with an another P) is transformed in a couple of quark-anti-quark" [21]. Thus 2 Ps "materialize" in 2 mass particles: yet the P is mass less. We say that the Ps' energy materialized in the quarks. But it is fair to suppose that 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 (at least the kinetic energy). When the Ps start interacting they show (along with the "Complementarity Principle") the other aspect: the corpuscular one (which, we state again, is "complementary" to the undulation aspect, with which the P shows itself a an EMW). Indeed, "Wherever the EM radiation interacts with the mass, it has a corpuscular behaviour" [22]. What does this mean? When the P interacts it behaves like a corpuscle. Thus, first it was a wave: we are talking about EMWs. We can infer that: interaction = ± almost motionless position = corpuscle (or better: corpuscular behaviour, "corpuscular aspect"). Hence: non interaction = motion = wave (or better, undulation motion, behaviour, "undulation aspect"). In other words, when the P manages to show its corpuscular aspect, the mass "parameter" should appear too, which in this case generated a couple of quark-antiquark. Thus, it seems more natural think that the P conceals a tiny mass, the mass equivalent to the quantum of light, that is the mass equivalent to the energy of h, the Planck's constant. Thus the mass of the P would correspond to the energetic value of h, divided the square of the speed of light. T. Dorigo, who was part of the team which in 1994 found the quark top, says: "the measure of the mass of a particle is inferred from the energy of the generated particles" [23].

However more particles may come from Ps: "an electron emits a P which transforms in a couple electron-positron" [24]. Yet the electron has an energy of 0,511 MeV, to which corresponds a mass of $1,78 \cdot 10^{-27}$ g. How can a mass less P generate a couple electron-

positron? Feynman says that "it is also likely that the P turns into a couple of muon-antimuon, heavier than the initial electron from which it was emitted" [24].

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 EM field in some ways. It is more likely that the P "hides" a mass, not at all for its own will, but because the Complementary Principle forces it to.

2.5. The P and the Equivalence Mass-Energy

As we all know in everyday life matter and energy are not created and are not destroyed, they are just transformed. It may be important, besides, to consider that "the movement, the motion, is a matter itself" [25]. Indeed energy and mass are correlated (Einstein). "Einstein's equation ($E = mc^2$), the energy is proportional to the mass" [26] 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 different from 0. Both Quantum Mechanics and Einstein's equation related to the equivalence mass-energy, suggest: $Mp = Ep/c^2$. Since the P energy corresponds to the quantum of light, to the Planck's constant, the mass of the P should correspond to: $m = h/c^2$. Besides, as Feynman says: "energy and mass differ just for a c^2 factor [27]. According Einstein's equation if we divide the value of the energy for c^2 we get the value of the mass ($m = E/c^2$): this is true for the P and for just any other particle. 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.

"According to the equation $E = mc^2$, each mass can be expressed as an equivalent energy" [28]. Thus the opposite is true too: each energy can be expressed as an equivalent mass. In this way we get that the mass of the electron is 0,511 Mev divided c^2, and the mass of the proton is 938 MeV divided c^2. These are the so called "rest mass" of the particles, that is the mass they have when they are not moving, or rather when their motion is almost null. When they move their kinetic energy is equivalent to the additional mass. With the speed of light, or close to it, that is at relativistic speeds, the kinetic energy is comparable to their rest mass. We know the equation from which probably Einstein developed his: $E_{Kin} = 1/2\,\mathrm{mv}^2$. With these velocities the mass is almost double. We already knew that the acceleration, especially if it is high, tends to raise the mass of

the particle in motion, in a percentage directly proportional to the velocity. Thus the kinetic energy gives the rest mass an additional mass with a similar value. What can we guess? Whatever is in motion has a kinetic energy and, according to the equivalence mass-energy, it should subtend an equivalent mass, a rest mass, which cannot be caught in that moment, this is because the Complementarity Principle: if a particle has a its own "undulation aspect", as in an EMW, we will not be able to catch in that moment its "corpuscular aspect", its "rest mass". We learn from relativity that mass is a form of energy extremely contracted. Thus, the energy of the particles, including our P, should subtend the mass, the rest mass. Besides 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" [29].

Also with the temperature, still along with the Quantum Mechanics (Heisenberg's Uncertainty Principle) It will never be possible to reach the absolute zero ($-273,15^{\circ}$ Kelvin), and thus talk about "Zero Point Temperature". It is likely that also for the mass of particles like the bosons, among which the P, to which it is attributed only energy (apart from the bosons of the WNF, found by Rubia and Van der Meer), there should be a "Zero Point Mass", that is a value, (infinitesimal) the lowest we can imagine, but different from zero. On the other hand, still for the equivalence mass-energy, 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 "Zero Point Energy", there should not be any particle carrying energy, with a zero mass. That is, still for the equivalence mass-energy, to a zero point energy should correspond a zero point mass: which is not possible. We just said that there cannot be an energy with a 0 value, both referred to a system and to a particle (the latter would not exist). Thus, there should not be real particles, having any energy, with a zero mass. If there are, they should "subtend" a tiny mass. Besides we read: "it is matter any body having mass (or energy) and occupying space. 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" [30] and vice versa. We still read: "the mass of the electron is influenced by Ps. And is given by the mass of the electron $\pm$ the Ps absorbed (+) or emitted (−)" [31). 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 "n", that is the number of Ps absorbed or emitted, at the moment of the measurement of the electron's mass. Of course these measurements vary at any moment, since the absorbed P, in a attosecond (10^{-18}), is put back by the electron. "Ps have "null rest mass": they exist only when they move (with the speed of light). When they stop, they disappear, and their energy is absorbed by an other particle" [17]. But this energy raises the mass of the particle which will absorb the P, this involves that the energy of the P should hide, subtend a mass. We can read: "The masses of particles are measured in energetic units (MeV or GeV), because in a relativistic way masses are equivalent to energies" [13]. Thus, if a particle has energy it should also have a mass, which may not be caught, may be for the Complementary Principle.

2.6. Probable Mass Effect of the P

Analysing a lot of physics phenomena, happening more or less ordinarily, it seems that sometimes the P, rather than a particle made merely by energy, behaves like a particle incorporating a certain mass, though infinitesimal, but not always insignificant or effect less. We think that several physic phenomena, in which the P is involved, are not completely explainable only with the energy of the P, but they make us think that the P under its energetic "shape", hides a mass too. Again, a mass which we cannot see when the P shows us its "undulation aspect"; indeed according to the Complementary Principle, only when the P stops travelling as an EMW it can show us its "corpuscular aspect", and in that occasion we can hope to detect the probable mass of the P (maybe not directly, that is observing its effects). This makes us think about what Hawking says: "when an electron moves from an orbit to one closer to the nucleon, 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" [32]. 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 an attosecond 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.

It is just the Quantum Mechanics to teach us that if we want to "see" an electron, we need to light it up, that is hit it with an adequate

energetic EMW, but the moment we see it, the pushed electron will have been moved, it will have changed its motion direction: it seems a mechanic effect, a "mass effect", rather than a merely energetic effect. That is talking about, "sufficient energy" may be the same as talking about "sufficient mass". We should keep in mind the well known "Superimposition Principle", according to which one of the most specific properties of the EMWs is the possibility to sum up their effects. We think there are many other examples of the alleged mass-effect of the P. The first one we can think about is the photoelectric effect (PEE). The first to talk about the mechanism at the bottom of the PEE was Hertz, back in 1887. He had observed that the energy of the light can be transformed in mechanic or electric energy (33). He had noticed that a metal pushed by UV rays, got a positive charge, with a later emission of a flux of electricity from the irradiated metal. Besides, (something considerable), this flux was more intense and the EM radiation was represented by UV rays, rather than the visible light. It was Thomson, in 1899 to show that this flux was made of electrons. But this was in contradiction with the knowledge of the time since the kinetic energy freed by the flux of electrons coming from the metal did not depend on the intensity of the EM incident radiation: in open contrast with the only undulation interpretation of the light. Let's suppose that Planck's quanta were really corpuscles with a their own individuality, Einstein called them Ps. The fact they had also a corpuscular aspect allowed Einstein to explain the PEE (1905). This effect, as we have already mentioned, 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 (the frequency of the EMW) is the same or higher than the energy relating the electron to the nucleon. The number of emitted electrons depends on the number of incident Ps, that is on the intensity (the frequency) of the EM radiation. Generally the threshold level corresponds to the frequency of the infrared rays, for some metals, (especially caesium and rubidium) or to the optic band for some others such as alkaline metals. UV rays, for instance, apparently have a better effect on targets having uranium or thorium, whereas x rays act on any kind of metal. That is, if the EMW carries a certain number of Ps it 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.

But if we give an insufficient energy to the ball which will at the most lay down on the ball, without moving it, or if we use a lighter ball, an empty one for instance, and we throw it with vigour, against the opponent ball, we will notice that it does not move, it stays where it is. It happens the same with EMWs: if we strike the target metal with lower frequency waves, such as radio waves, the PEE will not take place. Why? The answer is that the radio waves do not have enough "energy", in fact they are beneath the "threshold level". But 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 small balls (having probably a tiny mass), rather than as waves. Thus, the PEE seems more a "material" phenomenon, handled by corpuscles.

As we know, the dualism wave-particle is a fundamental and universal property of the matter: it involves all the particles, both fermions and bosons (as first thought by De Broglie), so it is true also for the EMWs. We get the last confirmation from Compton, in 1922, when he demonstrated that directing a flux of x rays against motionless 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." [34]. But the momentum (p), is given by $p = m\nu$ (where ν is the speed and m is the mass of the analysed particle). Hence, we should not be far from the truth if we infer that in the Compton Effect (CE) a mass is subtended, the one expressed by the large number of Ps travelling with the x ray. Besides, a particle to which is correlated a momentum, should automatically hide a mass. So, again, 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. The P gives a certain part of its energy in the hit, it has in fact a bigger wavelength, proportional to the deviation angle, according to the well known formula $\lambda_1 - \lambda = 0,024(1-\cos\delta)$, where λ_1 is the P deviated by the impact with the electron, λ is the P before the impact, δ is the angle of deviation of the P. "Thus in this case, EMWs behave like particles. This dualism is a property of all the nature" [34] It is important to underline that in the CE the P collides with the electron (probable mass-effect), but then it separates immediately from the electron and keeps travelling, deviated by the collision and, something remarkable, with a bigger wavelength, that is with minor energy. It is likely that

the P has left a part of its quanta on the electron (or they spread in the surrounding space during the collision with the electron), and/or, at the same time, it seems likely it has given the electron part of its kinetic energy (going along with the minor frequency the P will travel after the impact). Compton supposes that "in the collision with the graphite atoms, x rays behave like real particles, with energy and momentum" [35]. We can infer that when x rays move, they behave like waves, but when they interact with something, that is when they stop, even just for a moment (without never stopping completely), they behave like particles. Compton effect would have never been possible with the only undulation hypothesis of the light: he confirmed clearly the existence of also a corpuscular behaviour of the EMWs, at least those travelling with a certain frequency. We have seen, therefore, that Ps show the same behaviour as particles, in fact the Quantum Mechanics confirms that they are particle, corpuscles: they behave like not deformable balls when they are stroked, with infinitesimal dimensions (as happens with the CE), or they are absorbed or emitted, still entire, when they interact with electrons orbiting around the nucleon.

What Compton underlined was confirmed a year 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 o gaseous) undergo an inelastic collision with the molecules of the means they pass through, in this case they give or absorb energy. There are three possibilities. In the first one, the P can lose energy colliding against an electron of the atoms the material is made of, in this way the P pushes away the electron from its orbit: it seems to be a mechanic effect produced by the light. If the P loses some energy it will come out of the means with a minor energy — Stokes lines — along with the well known Einstein's formula: $E = h \cdot f$, where h is the Planck's constant, expressing the proportionality law between the energy (E) and the frequency (f). Why does the P lose energy? Because in the collusion with the electron the latter may not go back to its former orbit, but in an outer one, so the electron will keep its excitation and will emit a P with a minor energy and frequency. In the second case, much rarer, the P can acquire energy, since it has collided with a P which was already excited and which will be pushed in an outer orbit. Since it cannot stay in an instable orbit it can happen that the electron will not go back to its former orbit but will go down to an even outer orbit, and with a minor waste of energy. In this case the electron will emit a P with a frequency and an energy higher than the incident P (anti-stokes lines). In the third case, the most frequent, the stroked electron will go back immediately to the orbit from where

it was pushed away. In this case the P will have the same energy and frequency of the incident P (Reyleigh diffusion).

The RE cannot be interpreted in the classical physics, however it can be easily explained as a quantum effect. The first effect produced by this phenomenon consists mainly in pushing away an electron from its orbit: it seems a clear mechanic effect (as in the case of billiard balls), rather than a merely energetic effect.

In short, just as the PEE and the CE, the RE represents an other phenomenon of the corpuscular nature of the light, with a consequent possibility to carry out also a mechanic action, as though they were induced by a latent mass, probably concealed by the P, which get consistency when the number of Ps carried every second gets very high (threshold frequency): it seems just the application of the law of superimposition of the Ps.

Talking about x rays, the EMWs (or Ps) Compton used, "behave like bullets, since they are a million times more energetic than visible Ps, they pierce the parable of the antennas just as real bullets" [36]. Apparently X rays, with their "bullet effect" perform a real mechanic action (which cannot be explained just with the energetic effect), they simulate exactly the effect produced by a mass, a mass probably closed in the micro-sphere (non-deformable and indivisible) which the P is made of.

As the Quantum Mechanics teaches us, when two particles react to each other, exchanging a boson, they have a "recoil effect" just as when a bullet is shot. In this case too we can find a "mass effect", which involves both reagent particles. This is related with the main topic of our subject, since the P is the boson of the EM field.

Atomic nucleon can be bombed also with high energy EM radiations (that is mass less light quanta). According to Einstein's equation on mass-energy equivalence, 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 nucleons and make them explode, just as bullets-nucleons having mass" [37]. 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 (or with high frequency) even make the atomic nucleons 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 (divided the square of the speed of light). Thus, when we apply a very light input to them, that is a minimum impulse is generated with the EM source, we get the emission of EMWs with very low energy, that

is with low frequency, as the radio waves. These EMWs, having a very little energy and frequency, hit lightly an electron, without deviating it (we cannot see it since we are hitting the electron with Ps which are not visible, so we cannot illuminate it). If we raise the energetic input of the EM source, we get the emission of more energetic and more frequent EMWs, as the visible Ps. In this way we can see the electron, but at the same time we divert it from its trajectory, we determine then a mechanic effect, a "push action", likely a mass effect. It was just necessary to raise slightly the energy of the EMW to have it behave like a mass. It may be more correct to say that above a certain limit the P shows a mass of its own, or starts acting with a "mass effect". If we raise further the energy of the EM source, we have the emission of high energy Ps (X rays, that is "hard" rays) with extremely high energy (gamma rays, that is ultra hard rays) with such a "mass effect" to even break or make explode the atomic nuclei, beside the cancerogenous effects due to the removal of the electrons from their atoms (this time, unfortunately from the molecules of the genetic code of living creatures: DNA).

The laser ray may represent an other mass effect of the Ps. It is well known that the laser, just made of Ps, can be used in metallurgy to cut thick steel plates, or in ophthalmology and in surgery in general, as a real scalpel. Through the laser Ps can even produce the nuclear fusion, making them meet on a deuterium target. It is well known that the laser ray is made of multitude of Ps, some billion times more frequent than the visible light and, this is peculiar, all the EMWs are "in phase", so that to strengthen their effect, till simulating a sword action, or an extremely tin and sharp scalpel. Just using mass less Ps. Nevertheless, "it is the mass to determine the way a particle moves under the action of a force" [11]. Thus, a force must act on something material in order to move it. That is a particle, "a substance", to be sensitive to the action of the force, must have a certain consistence, represented by its mass (even though concealed), maybe a tiny one.

A well known atmospheric phenomenon, the "stellar scintillation", may be the consequence of a mechanic effect produced by Ps. The star "trembling" we observe, comes from the interaction of the stellar rays with the atmospheric molecules, luminous Ps are deviated in several directions, thus the star appears "trembling, scintillating". It is possible to get this sight misperception also observing a terrestrial small luminous source. This phenomenon is due to the continuous Brownian motion of the moving air particles, which on their turn, will deviate the light path, so it does not appear straight, still. On the contrary, neutrinos do not react at all with the atmosphere, rather, not only are they not deviated from their path, which remains straight,

but they cross undisturbed the Earth getting out at the antipodes (but some rare oscillation between neutrinos). Before these oscillations were observed (thus an electronic neutrino can become muon neutrino or tau neutrino, or vice versa) neutrinos were attributed a 0 mass. It was just after the SuperKamiokande experiment in Japan (1998), somebody estimated a neutrino mass though infinitesimal. Nevertheless neutrino, despite their probable mass, do not interact at all neither with the atmospheric air nor with the terrestrial matter. Whereas Ps, which are deviated by the air molecules and do not pass through any millimetre of opaque material, are considered mass less. As neutrinos, Ps have a null charge, on the other hand they are different form EMF, towards which they are indifferent. It could be hazardous to say that they are exclusively EMs to determine the scintillation. It cannot be excluded that it is the probable mass of the P to deviate it, or preventing it from passing through the opaque matter. Why then a P manages to pass through the glass or the water? In these cases it is the thinner atomic structure, with scattered atoms to allow the P to pass. We need to remember we are talking about a probable mass with an infinitesimal value.

Let's now analyze an other phenomenon: the light pressure action which we can call "photonic pressure". "The 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" [38]. 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 $1\,\mathrm{mg/mt^2}$. 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. It deflects, in the opposite direction, the comet's tail. Chandrasekhar says: "there is not any obvious way to impute a wave (as we do with particles) a momentum and an energy. But we know waves have a momentum ($p = m\nu$) and an energy ($E = hf$), as demonstrated by some effects of the solar light. 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 comets' tail in the opposite direction of the sun (further in this text we will see how the Quantum Mechanics teaches us to associate momentum and energy to waves)" [39]. Since the momentum (p) is $m\nu$, and since we know that "waves have a momentum and an energy", this

should subtend a mass too in the wave, though infinitesimal.

We find an other example of "photonic pressure" in the so called "Casimir Effect". What happens is that two metallic plates, placed at a short distance one opposite the other, reflect (back and forth) in the intermediate space. If we consider the light as Ps, it is as though some of them were excluded in the space between the plates. The effect is that there will be more Ps outside than between the plates. It will be possible to observe a certain pressure of the external Ps which pushes the plates one against the other. Casimir observed that this phenomenon occurs also if the experiment takes place in a vacuum container, this showed the existence of virtual Ps. If we give enough energy virtual particles can become real, that is they "materialize". This phenomenon often occurs in particle accelerators, or in the Casimir system too when energy is given, shaking strongly one of the plates" [40]. Casimir effect gives us a very clear example of the Ps power, which apparently have a clear "mass effect" since they have a mechanic force on the metallic plates: mass less Ps manage to move a metallic plate. We can think that this phenomenon may subtend a mass in the Ps, a mass correlated to the h quantitative carried by the EMW (it depends on the frequency). We need to say that the so called "virtual Ps", giving energy to the system, "materialize" becoming real. Maybe it is more likely that the virtual Ps (just as other presumed "virtual" particle) are not that "virtual", that is they exist. How? They are real Ps, with so poor energy not be detected, they do not determine any kind of effect: Neither Casimir, nor photoelectric, nor Compton, nor others. The virtual P should be actually a real P, though with so little energy (and probably equivalent mass) that it is not possible to find it normally. However if we give them energy they "materialize". The "materialization" is actually an "energetic increasing". So that the virtual Ps become real. But this happens just because the Ps have increased their energy (increasing at he same time their equivalent mass too).

We cannot exclude that the Chlorophyllous Photosynthesis represents a consequence of the mechanic effect (more than just energetic) induced by light. The first process of the photosynthesis occurs in leaves pigments, where Ps react with the water molecules. The most important think to underline is that the Ps take two electrons from the molecules of the water: "water photolysis" (the freed electrons will be used in chloroplasts to induce some biochemical processes, useful to the surviving of the plant). As it happens in other circumstances, in the leaves too the Ps are able to produce an effect able to remove electrons. It is thought that it is just a phenomenon induced by the energy of the solar light, to free the electrons of the

water contained in the pigments of the leaves. But it could be a mass effect of the Ps to move away the electrons. It could be objected that Ps, as corpuscles, are very small compared to electrons, so they cannot move them just with a "push" effect, given by their own mass. However we need to consider that with a visible light ray travel 100.000 billions of Ps per second. That is in a second a light ray sends a huge quantity of light quanta: $10^{14}h$. We are talking about a large number of Planck grains which for each ray bombe every second water molecules in the pigments of the leaves. Considering these quantities we cannot exclude a mass effect induced by light quanta, that is a kind of mechanic effect. We should keep in mind the Superimposition Law of the Ps. More than an unspecified energetic effect given by the energy of the Ps, it may be the "push" given by a huge quantity of quanta of light to "pull away electrons", stuffed together in an extremely small space. Thus it is a strictly mechanicphenomenon, produced by the probable quantity of light quanta, rather than a phenomenon produced only by the energy of the Ps. Besides, photosynthesis do not occur with less energetic Ps, such as radio waves, which contain a quantity of h much lower. In this case in fact electrons are not pushed away from the water molecules.

Apparently the common denominator is always the energy, the number of h contained in the EMW (but to the energy of every h may correspond a mass, though very small). This should be true both for the chlorophyllous photosynthesis and for the PEE, or the CE and the RE, or in other circumstances. What we can all agree is that the energetic effect determined by Ps occurs for a mechanic effect induced by the right quantity of h carried by the EMW. It is important to underline the so called "threshold limit value" to elicit a certain effect. For instance the right wave length (the right frequency), in order to have the photosynthesis take place, is the visible light's. In the case of PEE, the EMW must have a frequency higher than radio waves and microwaves. Infrared rays are able to induce the effect only if they interact with some materials. Whereas talking about CE, the right EM band is the x rays. Therefore many of these phenomena will be elicited only starting from a certain EM frequency because a higher frequency carries, in the unity of time and space, a large amount of quanta. It could be argued that a high frequency EMW indicates a high energy as well. But we can state again that the so called "energetic effect" induced by Ps may happen, as an intimate mechanism, through a mechanic action given by the high number of quanta carried by the EMW. That is the mechanic action is not given by a low frequency EMW (that is carrying few quanta), the action occurs only if the wave carries thousand of billion of Planck' grains (of course without changing the unity of time and space), which hit all together a particle (electrons

in this case), and push it away. The extremely small equivalent mass of an h, multiplied some hundred billion of these units of equivalent mass, for each second, may be at the bottom of all these mechanisms. These may probably be just an effect of the Superimposition Law.

Just a note about the several biological phenomena induced by Ps, starting from the vision mechanism, occurring at a retinal and retro-retinal level, always freeing electrons, or the mechanism of the induction of the synthesis of the precursors of the D vitamin, or the process which activates the light-dark mechanism, both in inferior and in superior animals, or the circadian rhythms, till pathological processes, as the induction of carcinogenesis. In all these cases too, the intimate light mechanism happens through a "push effect" on electrons. The "push" is easier to understand if we recognize a mass to the Ps.

In all the situations so far mentioned, in order to have a motion, such as the removal of the electron, it is necessary a "push force" [41], apparently this is the effect produced by Ps. This "push effect" can be interpreted as a real mechanic effect, rather than energetic. Actually it is more probable that it is still the P to elicit this effect, to "push the electron", though not through an energetic effect of its (in these circumstances it would not be clear its intimate mechanism of the phenomenon) but, through a real mechanic effect, probably fostered by the latent mass of the P. A mass which comes out as soon as the P slows down and do not show its "undulation aspect" any more, because the P interacts with the electron. Only when the motion almost stops (and/or its undulation aspect disappears) the P will be able to show its "corpuscular aspect", as imposed by the Complementarity's Principle. Only then, as a corpuscle, the P will show us, at last, its probable mass: maybe indirectly, showing us the probable effects (it is like trying to localise a Black Hole: always only through its indirect effect, and without being completely sure!).

We can now examine the evolution model mostly accepted by cosmologies. "When 100.000 years after the Big Bang the Universe temperature went down to 3000° Kelvin, the energy of the P decreased, so they were not able any more to keep electrons away from the nucleon: atoms started forming" [12]. Apparently Ps perform an extremely valid mechanic effect (probably comparable to a mass effect), moreover they last 100000 years. However we could also see a valid example of the "Mass Energy Equivalence": indeed, as the universe temperature lowered, and consequently the energy of the Ps, the probable mass effect the Ps had performed till then with high intensity lowered too.

It could be useful to make a comparison between the GF and the EMF: "the GF between only two objects is extremely weak: the GF between two electrons is 10^{-40} or 10^{-41} times lower than the electrical

force. Since the GF is purely attractive, it grows as the number of atoms increases, when we consider bodies with a sufficient ponderous mass, such as the planets, it is possible to detect the effects" [42]. The graviton effect is felt when many of them sum up. Apparently the P behaves in a similar way: its "mass effect" is felt when there are a huge number of them, as happens in the laser ray which is able to cut the steel. Thus, there is an analogy between the P and the graviton, strictly dependent on the number of involved bosons, which is worth for both forces (Superimposition Law). But he GF and the EMW, due to the effect produced by the "radiation pressure" of the P, can "fight" for a long time as it happens in the star's core. We read: "in ordinary stars as our Sun, the inward force of gravity is balanced by the outward hydrodynamic pressure of the hot gasses and, to a lesser extend, by the radiation pressure of photons" [43]. 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 billion 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, probably a mass effect acting as "counter pressure" to the considerable GF expressed by the remarkable gravitational mass which inexorably pushes towards the inside of the star. In short, the EMF, through its bosons (Ps), in some cases may behave similarly to the GF, it is apparently extremely weak, but it can become remarkable if it is multiplied for billion of billions .times as the number of "pushing" atoms, till dominating the asset of the whole universe. Besides the equations showing the two forces are exactly alike.

Let's analyse now in details "the light" and its way of behaving. Let's do it with Feynman, one of the most expert in the secret of light. "Newton thought that light was made of particles, which he called "corpuscles", and he was right". Today we know that the light (meaning all the EMWs) is made of particles, because if we take a very sensitive tool, making a clicking when hit by the light, if we make the light dimmer, the intensity of every single click remains unchanged: they are just less frequent. Light is made of Ps. We use the photomultiplier to detect a single P. When the P hits a small plate it causes the emission of an electron from one of the atoms of the plate" [44]. This shows the assumed "mechanic effect" determined

even by a single P, and able to hit a motionless electron and move it away. Yet the P is mass less. How can a particle, without the least mass, have the same effect of a billiard small ball which hits and moves away the opposing ball? The latter is certainly bigger than the small ball, just as the electron compared to the P? It seems more likely that it is a body having mass to move the electron from the metallic plate. We already saw these phenomena with the PEE, with the CE, and with the microscopic observation: in this case too the P deviates the electron, in order to see it. In fact if the energy, therefore the frequency of the P, is not enough, the electron cannot be seen, and it is not deviated. The observation of a phenomenon modifies the phenomenon itself, as it happens with the deviation of the electron. We can infer that the corpuscular nature of the Ps, verified by now, is not the same for all, otherwise (as we said earlier) also a radio wave would move the electron, but it doe not, since it does not have enough energy to move it (direct consequence of the frequency of the energy): it has a very weak mechanic effect on the electron (a "mass effect", we may say), too weak to the purpose. Therefore, the higher the frequency of the EMW, and consequently the number of quanta travelling with the wave, the bigger the mechanic effect induced by EMW. A confirmation comes from the well known "penetrating effect" of the x and gamma rays, which move away electrons from most of the objects they hit, unfortunately from organic molecules too. Let's go back to Feynman: "the freed electron is attracted by a second plate, with positive charge, hitting the plate the electron will free three or four more electrons" [45]. It is important to point out that the P behaved just as the electron it freed, with the only difference that the P freed only one electron, whereas the electron frees three or four. We can conclude that there is only a quantitative difference between the mechanic power of the electron and the P's. There is not a qualitative difference, since they both behave in the same way: they are able to move electrons. That is to say they have an analogous corpuscular behaviour, with analogous mechanic effects (or "mass effect"). There is only a difference in the intensity, due to the different masses, (if we may): much higher the electron's. "This will repeat as in a chain reaction, till the last plate is reached by billions of electrons, enough to make a measurable current. The latter sent to a loudspeaker will make an audible clicking. Every time a single P, of a certain colour, hits the photomultiplier, it is possible to hear a "click" of uniform intensity. Besides, from experiments with photomultipliers acting at the same time around a luminous source, it was possible to ascertain that the light is not divided in "half particles": that is the P is indivisible. Again: the light comes as particles. Light is made of particles. The light behaves as a flux of particles" [46]. Let's analyse

now the behaviour of the light through a slit: "It is important to observe that the arrow related only to the straight path, (that is the shorter path), is not enough to give an account of the probabilities with which light reaches the detector. Also the paths almost straight and nearby give important contributions. So the light do not really travel along a straight line: it "smells" the nearby paths and uses a little area all around .... If we make a slit with two blocks, interposed between the light and the photomultiplier (the detector), leaving a cleft, a path for the light not too narrow, we get that the space between the two blocks is enough to allow the light (besides the straight shorter path) lots of close paths (to the latter or between them). The light do not follow only the straighter path, but also all the closer paths. Thus if we have added a second photomultiplier, away from the first one, so that to make 40° angle with the first (the slit being the vertex), it will not click" [47]. That is the passage for the light, through the slit, was enough to let pass all the luminous rays. We can wonder: why didn't all Ps follow the shorter path, since this is their natural tendency? Instead they "smell" the near path? The answer may be in the fact that Ps have mass, the shorter straight path saturates. Should Ps subtend, under their energy, a little mass (an equivalent mass, that is equivalent in a relativistic way to their energy), we could understand why they "move" automatically to the next straight path, the shortest left: that is the closest to the one already taken and "occupied" in that same moment by other Ps. In a way we can compare this phenomenon to what happens with electrons orbiting around the nucleon: if the energetic levels with a less waste of energy are "saturated", in order to keep in orbit, the electron will shift" automatically, it will "jump" on the external permitted orbit, the closest to the previous orbit, already saturated. It could by objected that electrons behave like this because they are fermions, so they have to respect Pauli's Exclusion Principle, whereas Ps, being bosons, do not undergo this principle, so a large number of them can stay in the same point. But if we assume that Ps have a little mass, then just a certain number of them will be allowed to be stuffed in the same little space. In this case there would be a saturation limit of the space also for the grains of Planck. Let's go back to Feynman: "but if we bring the two blocks near to each other, at a certain point the second photomultiplier starts clicking! When the slit between the two blocks tends to close (or is restricted), having so only few paths near by (which can be travelled by the light), the second photomultiplier will click almost as the first one. If we squeeze the light too much (in order to be sure it follows a straight line), it refuses to cooperate, or starts to scatter" [47]. The fact that the light "scatters", and makes the second photomultiplier

click almost as the first one, when we restrict the slit, may represent the confirmation that Ps, since they cannot pass all together through the slit, restricted by now, are forced (because of the energetic push given by the luminous source) to go onwards, to propagate, so they deviate beyond the blocks. They make a considerable deviation to keep their march. During their propagation, still as close as possible to, (when the path is not saturated) the straightest line (the one with a less waste of energy) Ps tend to scatter gradually, with the result that they will make the second photomultiplier click too. One more observation should be made, concerning the Quantum Mechanics and the probability concept. The "probability, at least in this circumstance, seems to respect perfectly the behaviour of the P, if this had a mass. If we analyze the "probability amplitudes" regarding the probable behaviours of the P through a quite narrow hole, it is possible to notice that these "amplitudes" coincides perfectly with what actually happens. Indeed straighter, shorter paths have more "probabilities". (Apparently they are those which saturate first). Afterwards, as the shorter paths saturate, those less short saturate too, Ps are forced to follow more and more inclined paths. In this circumstance the calculus of the amplitude of probability is made in the same way. However the way Ps go through a narrow hole shows a kind of behaviour as they had a probable mass. If this is the case, the "probabilities" of Quantum Mechanics appear as direct consequence, it seems an application to the behaviour of the Ps, if these had a mass. In the mentioned examples the calculus of the "amplitudes" of the Quantum Mechanics, and the real behaviour of the Ps fit perfectly.

After all — Feynman defines — Quantum Electrodynamics represents a considerable step forward respect to the classical physics, it gives a very real interpretation of events, much closer to all probabilities given by nature, but it is not able to explain why nature behaves that way ... the way we know to describe the nature, results, in general, incomprehensible" [48] If we try to insert the concept that the P may have a little mass, nature may appear more understandable. Thus, giving a mass to the Ps, we have that because of the "saturation of the spaces", the Ps will travel through more paths, from the straightest one to the most oblique, following a precise rate decreasing proportionally. This coincides with the "probabilities" of the behaviour of the P, as introduced by Quantum Mechanics. Therefore, if we consider the P as having a mass, and as a consequence the progressive saturation of the paths that can be travelled over, starting from the shortest, we have a precise interpretation of real events, at the same time it is possible to foresee the results of the calculus of the "probability amplitude", offered by Quantum Mechanics, in respect

of this event. In this circumstance it is not necessary to go into the complex calculus drawn up by Quantum Mechanics to try to foresee the way the light will organise (get ready) to go through a narrow hole, since the behaviour of the Ps should be a direct consequence of their probable mass. In this circumstance the concept of "probability", which rules the subatomic world, and most of the description of the nature, would become a corollary of the mass of the P and of the saturation of the path Ps can travel over. Feynman himself says: "The aspect which is more impressive in the Quantum Mechanics is its absurdly description of phenomena based on width (amplitudes, that is on probabilities, which may make us think of some basic difficulty (but physicists, who have been handling with "amplitudes" for more than 50 years, have got completely used to their use" [49] Who knows? May be the "basic difficulty", hidden by the introduction of the probabilities, may be really in the fact that it has never been considered that the P may have an equivalent-mass: if we give it a mass we can explain a lot of the behaviour of the P, without the need of Quantum Mechanics, in the treated subject.

In short, we have seen that "if we squeeze the light too much — in order to be sure it follows a straight line — it refuses to cooperate, and starts to scattering". "Ps travel freely. We need to take in account that the light scatters as it travels" [50]. If we consider that Ps apart from energy have a slight mass, equivalent, in a relativistic way, to Planck's grain, that is to Planck's constant, divided for the square of the speed of light, we need to consider that each luminous ray contains a large number of these grains, so it is not possible that to many luminous ray are one on the other in the same space, since a huge quantity of grains "makes a mass", it occupies space and "saturates" it: so the other light rays, being full of Ps too, will be force to "slip" on the closest space, that is they will travel on the most contiguous allowed path, that is still free from light grains. More Ps emitted from the source will be forced to travel along more and more lateral paths and proportionally more and more oblique (thus satisfying also all the paths foreseen by Quantum Mechanics). Is this hypothesis will not turn out wrong, it could explain why the light cannot be squeezed too much and why it scatters. Thus, "if the light is "squeezed" too much, the rules of the natural world are not valid any more, such as that the light travels on a straight line". Rather "the idea that the light travels on a straight line is only a comfortable approximation" [51]. The latter statement confirm completely the subject of the progressive "saturation" of the paths Ps can travel, from those with a minor waste of energy, the straightest, to those less straight. The light, indeed, travels initially in a straight line, of course it does not follow a logic of its own, but

it respect a fundamental principle of natural phenomena: the rule of the minor waste of energy, in taking an action. Thus the light tends to travel on the shortest path, the straightest. But it is not possible that all the rays pass through this path (as the nature would like to) avoiding the less straight, that is the longer ones. This does not happen because a P, probably having a mass, determines the phenomenon of the "progressive saturation of the straighter path". Thus it occurs the unforeseen phenomenon of the scattering of the light, just because it will not be possible to "compress" it in only one very narrow ray. It can be worth to mention two experiments: "two very small hole with a diameter less than one tenth of millimetre (with a distance between them of some millimetre), one of which on the straight line, let the light pass in the same way: that is if we close the hole of the straight line so that the light passes only through the other, the photomultiplier will click almost in the same way as when only the hole on the straight line is open" [52]. Feynman concludes: "in all this story (of the physic) there is a particular unsatisfactory aspect: that is the observed values of the mass of the particles. No theory explains them adequately; they are continuously used in reckons (the values of the mass) but we do not have any idea of what they are and where they are from. I am sure that, at an experimental level, the origin of the values of the masses constitutes a very serious and interesting problem [53]. Who knows, let's hope that a glimmer of light has been opened.

3. CONCLUSIONS

We mentioned several times an important quantum principle, the "Complementary Principle", because it is it which forbids us from detecting at the same time the undulation and corpuscular aspects of our P, and of any other particle. Now, since the P is often in motion, we see it as a wave. Besides, when in motion the P expresses its energy (without energy there would not be any motion) to which, of course, is added the kinetic energy. So we see its corpuscular aspect very rarely, only when it interacts and/or when it carries out a mechanic effect (it strikes the electron pushing it away), as it happens with PEE, CE, with the RE etc. This is why it is even more difficult to catch a probable mass of the P, just because it could be seen only in the very short time in which the P interacts. We mentioned an other important character of the nature: the "Zero Point Energy", that is, namely, there can never exist a particle which, in a specific moment, has zero energy.

Besides we know we can never get to a temperature of $-273,15°$ Kelvin, that is Absolute Zero: not even in the most distant sidereal spaces, nor in any laboratory. It is still the Quantum

Mechanics to give us an explanation. With such temperatures the motion stops, and we would be able to know, at the same time, the position and the momentum of a particle. However we know from Heisenberg's Uncertainty Principle that it is not possible to know simultaneously, and with accuracy, two "complementary" parameters of the same particle, as the position and the momentum. Thus, we can infer that just as there is no "Zero Point Energy", there is not a "Zero Point Temperature" (Absolute Zero).

Besides, following the Eequivalence Mass-Energy, which we cannot leave out, just as there is no Zero Point Energy, in the same way it is automatic to think that there is not a "Zero Point Mass", that is a particle with a mass equal to zero. Maybe the smallest mass we can think of is the P's, which energy, as it is well known, is the light quantum, that is Planck's constant. Thus, still following the equivalence mass-energy, coming from the famous equation of Einstein ($E = mc^2$), we can get the mass of the P. $M = E/c^2$, that is $m = h/c^2$, the mass of the P may correspond to the Planck's constant, divided the speed of light, to the power of two. It will be certainly a tiny value. But it is something; at least it is different from zero. An EMW sums a large number of h, in relation to its frequency, so in a very fine ray of light repeats continuously, every second, a flux of billions, or billion of billions of light quanta. Besides, it has not been found yet an explanation to the "scattering of the light", (when it passes through a narrow hole) but a "settlement" explanation which as Feynman himself admits: "indicates a basic difficulty" [54]. The introduction of the concept of giving a mass to the P, of course extremely small, corresponding to h/c^2, would explain perfectly the phenomenon of the scattering of the light, without just following the straightest path. There is more! The behavior of a P having mass, going through a narrow hole, coincides perfectly with the "probability amplitudes" model of the Quantum Electrodynamics. Maybe even more: it can give an explanation, offering a physics, real, "mechanic" substrate, to the quantum concept of "amplitudes", of "density of probabilities" (at least in this circumstance). Besides, introducing the concept of giving a mass to the P, may help us understand some "anomalous phenomena of nature", which worried so much Feynman. In conclusion, our hypothesis may explain some very common phenomena, as some peculiar ways of behaving of the light, in full respect with the Quantum Mechanics.

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