Quantum Vacuum, Gravitational Interaction and Electromagnetic Interaction Between Physics and Philosophy / Montanari, Massimo. - ELETTRONICO. - (2014), pp. 1-39.

WE FIND IN HIS *OPTICAL QUERIES*, AND IN HIS LETTERS TO BOYLE, THAT NEWTON HAD VERY EARLY MADE THE ATTEMPT TO ACCOUNT FOR GRAVITATION BY MEANS OF THE PRESSURE OF A MEDIUM, AND THAT THE REASON HE DID NOT PUBLISH THESE INVESTIGATIONS "PROCEEDED FROM HENCE ONLY, THAT HE FOUND HE WAS NOT ABLE, FROM EXPERIMENT AND OBSERVATION, TO GIVE A SATISFACTORY ACCOUNT OF THIS MEDIUM, AND THE MANNER OF ITS OPERATION IN PRODUCING THE CHIEF PHENOMENA OF NATURE".

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Quantum Vacuum, Gravitational Interaction and Electromagnetic Interaction Between Physics and Philosophy

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Abstract

The article develops hypotheses aiming to explain in a simple and alternative way as a macro-scale generalization of the Casimir effect: a) gravitation in quantum terms; b) inertia and rectilinear motion; c) the fictitious forces that appear in non-inertial systems; d) the speed of the universe expansion; e) the gravitational lens effect.

These hypotheses would also be able to predict the existence of a second reflected image of the stars observable near a large mass, in addition to the deflected commonly explained by the gravitational lens effect.

Keywords: Quantum vacuum – Gravitational interaction – Electromagnetic interaction – Science and Philosophy

SUMMARY: 1. Quantum vacuum and wavelength of the virtual particles which compose it. – 2. Behavior of an isolated body in the quantum vacuum. – 3. Mutual influence of several bodies immersed in the quantum vacuum. – 4. Effects of the quantum vacuum: inertia and tendency of matter to sphericity. – 5. A new interpretation of the Casimir effect. Possible experimental proof. Application of the exposed hypothesis to the calculation of the perihelion precession of Mercury. - 6. Influence of the quantum vacuum on the electromagnetic interaction. Beyond the concept of photon propagation. – 7. Space and time as quantum vacuum states. – 8. Conclusions.

1. Quantum vacuum and wavelength of the virtual particles which compose it.

The quantum “vacuum” can be imagined as composed of pairs of virtual particles which are born and annihilate continuously, and whose wavelength is indeterminate; hence their energy is indeterminate ($e = hv$), and consequently also their mass ($m = e/c^2$). The particles that constitute the quantum vacuum do not produce directly measurable effects because their duration of existence is less than the Planck time, which represents the minimum measurable. Thus, according to the Heisenberg uncertainty principle $\Delta e \Delta t \geq h$, if we know with sufficient accuracy the duration - which is less than the minimum measurable - there will be an absolute uncertainty on both their energy and their mass. In other words, if we involve the wave/particle dualism, it is fair to say that they can have basically any frequency.

We may be led to believe that such virtual particles vibrate at any wavelength in a space infinitively extended; indeed given that $\Delta t = 0$, the uncertainty relation becomes $\Delta e \geq h/0$ and reveals an energy greater than zero and indeterminate. Since the energy depends on the frequency v, which is inversely proportional to the wavelength, pure mathematical logic would suggest that the virtual particles which compose the quantum vacuum could be conceived as entities which vibrate at any wavelength in a space infinitely extended. However, this is not the case; mere mathematical logic alone does not solve such a problem.

As a matter of fact, whatever the modern cosmological model adopted, space is not infinitely extended, as was assumed by the Newtonian model (which postulated a finite universe in an infinite space). For purposes of this discussion, the universe and the space-time are visualized as an expanding sphere. In such a scenario the wavelength of the virtual particles composing the quantum vacuum must be a submultiple of the diameter of the universe. In consistency with the Casimir effect, in fact the distance between the walls delimiting a given space affects the number of virtual particles contained therein. They are not infinite, but many submultiples of the distance between the walls themselves. On a mega scale the extreme edges of the universe will function as " walls ", and so the diameter of the universe necessitates that the wavelength of the virtual particles of the quantum vacuum must be an integer submultiple. Therefore, the possible frequencies of the particles of the quantum vacuum, though extremely numerous, shall never be infinite. On the other hand, if the possible frequencies for the particles of the quantum vacuum *were* infinite, we should conclude that the energy, and hence the mass, are similarly infinite, which is glaringly in conflict with all modern cosmological models[1].

However, it should be acknowledged that the concept of virtual particle poses difficult questions.

First of all, as is commonly acknowledged, the existence of virtual particles appears to conflict with the principle of conservation of energy, because during the lifetime of such particles, brief as it may be, the particle-pair system would contain more energy than at the times of initiation and annihilation. However, provided the lifetime, such fluctuation does not reach the minimum measurable time, and shall never be directly detectable. Moreover, even below the threshold of measurability, the particles that appear can be considered equivalent to those that annihilate, and then the energy on the universe's mega scale can be postulated, at least to a certain extent, conserved.

Another issue is central. At the basis of quantum physics is the idea that any particle can be regarded as a wave train, so the particles of the quantum vacuum should be conceived similarly. But what is their frequency?

The equations of Heisenberg allow the attribution to the particles of the quantum vacuum any possible wavelength that is an integer submultiple of the diameter of the sphere-universe, and therefore as many frequencies ($v = 1/l$).

It is conceivable, however, that the particles/waves of the quantum vacuum effects on the mass may change on the basis of the vibration frequency of each pair.

In order to describe in a simple way the interaction of virtual particles with matter, we can draw inspiration from optics and Young's experiments on the optical path. Therefore we postulate the pairs of particles constituting the quantum vacuum as several pairs of plane waves that arise from two sources S' (for all particles) and S'' (for antiparticles) placed on the same plane, and which move in the direction of a body placed in a point P at distances $PS' = x'$, and $PS'' = x''$. The annihilation can be seen, in undulatory terms, as a destructive interference between the two waves that occurs when such waves arrive in any point of the path towards P in phase opposition, according to the formula $x' - x'' = (2N + 1)\, l/2$ where N is any integer.

By extending and generalizing the meaning of such a formula, it indicates that, for any path between the origins of virtual particle pairs and any target, destructive interference can occur when two particles/waves meet in phase opposition, and such a number of points is inversely proportional to the wavelength. Therefore the possibility that the pair of virtual particles shall annihilate before reaching any body is inversely proportional to the wavelength and, therefore, directly proportional to the frequency.

It follows that, in the case several pairs of particles are released from any two sources (particles from one source and antiparticles from the other) with frequency x and as many with frequency $x + n$, the latter shall have to overcome a greater number of nodal lines of interference to reach any body at any distance. At each node a pair of particles will annihilate (the other pairs shall escape because several particles cannot be simultaneously in the same space, and thus are "saved" by the sacrifice of only one pair of particles). Therefore, the high frequency pairs of particles of the quantum vacuum able to reach the body of reference shall be less in number than the pairs of particles at a lower frequency. If this is correct, and assuming from the principle of equipartition that the particles of the quantum vacuum shall appear at any point of the space as in equal number of pairs for all frequencies, it follows that the interaction with a body is more likely for couples with lower frequency and less energy, since they shall have more easily escaped from the annihilation resulting from destructive interference.

Given the continuous emission of particles which replace those annihilated, with respect to any body the particles of the quantum vacuum shall therefore be conceivable as particles with higher frequency and higher energy, on the outside, while those with a lower frequency can be imagined as particles that penetrate the body and, on the basis of the wavelength, can also pass through it. We will later focus on the importance of such a point.

In the minimum measurable time, the particles with higher frequencies, which hardly interact with matter as they are subject to a higher probability of annihilation, may be responsible for the weak indirect effects identified experimentally, such as the Lamb shift and the Casimir effect.

It is similarly hypothesized that the quantum vacuum particles of lower frequencies, which therefore have greater probability of interacting with the matter, are those which cause the gravitational interaction and the inertia of bodies.

These two frequency-dependent aspects of the hypothesis, make it unnecessary to posit that real escaping particles would be responsible for the inertia of bodies, and their mutual gravitational interaction; on the contrary, those same particles of the quantum vacuum that, at higher frequencies determine weak indirect effects, such as the Lamb shift or the Casimir effect, at lower frequencies would interact more easily with matter, determining the inertia and causing the gravitational interaction.

In a theoretical system of the «empty» universe, populated only by the energy of the quantum vacuum, we can represent mathematically the numerical series of particles waves of the vacuum, given the quantization of energy, by using integer natural numbers; the series would begin from the wavelength equal to the diameter of the sphere-universe up to the number corresponding to the first smallest integer submultiple of such a wavelength. This latter minimum of the vacuum energy is not represented mathematically with the number 1, because 1 is not a prime number. The importance of this distinction will be explained later.

If the above premise is correct, some further hypotheses may be formulated with regard not only to the gravitational interaction, but also to that due to electromagnetism.

2. *Behavior of an isolated body in the quantum vacuum.*

Here we consider the behavior of a body which exists in isolation in the "sphere-universe" constituted by the particles of the quantum vacuum.

Based on the similarly with what happens to gas inside a container at a constant temperature, the principle of equipartition means that the particle distribution of the quantum vacuum is substantially uniform, on a large-scale and in every part of our "sphere-universe".

Considering an object placed in the exact center of the "sphere-universe", such a body will remain at rest, because the particles of the quantum vacuum exert on it a force equal in all directions. In other words, the particles of the quantum vacuum which disturb the motion of the electrons in the atoms constituting the body shall be in each direction equal in number, consisting of the same integer submultiple of the radius of the "sphere-universe", that is the distance between the body and the outer limit of the system. In force terms the body would be subject to a balance of vectors and hence remain at rest.

Postulating that some force removes the body from the center of the "sphere-universe"; immediately the distance of the body from the surface of the sphere will begin to diminish in the sense of motion and correspondingly increase in the opposite direction. The particles of the quantum vacuum vibrating between the closest wall (or surface) of the sphere-universe and the far wall shall no longer be equal in number; the net force exerted on the body draw it away from the center and hence push it towards the surface. As the body's distance from the center the centrifugal force grows steadily, leading to a constant acceleration of the body along the axis center-surface. In other words, the resultant acceleration which the particles of the quantum vacuum exert on the body shall increases with the distance from the center of the “sphere-universe”, reaching the velocity maximum value near the surface or on the outer edge of the sphere.

At this point a first conclusion may be purposed. In a universe consisting of a sphere of quantum vacuum a body undergoes an acceleration from the center outwards; for multiple bodies, those closest to the surface of the sphere moving away from the center with a higher speed. However, the acceleration in the centrifugal direction would be the same for any body, depending only on its distance from the center and independent of its mass. This is because for a variation of the mass, there would be a corresponding variation of the number of particles of the quantum vacuum affecting the body. According to Newton’s second law of dynamics, in fact, it is obvious that since $a = F/M$, if the force exerted by the quantum vacuum particles increases in proportion to the mass of the body, then the acceleration remains constant and independent of mass.

The kinematic behaviour of bodies arising from this small-scale model of a “sphere-universe” made of particles of the quantum vacuum is, in fact, quite similar to that shown in the most recent cosmological models based on astronomical observations. According to these the galaxies closest to the edge of the universe move away from the center with a speed greater than those which are closer, because of an energy (defined by some "dark") that accelerates the expansion.

3. *Mutual influence of several bodies immersed in the quantum vacuum.*

We now suppose that in our “sphere-universe” there is another body. Along the straight line between the two bodies a space is created, closed at the origins of the line by the two bodies themselves, in which the particles of the quantum vacuum vibrate with frequencies lower than in any other direction. In other words, along the line connecting the two bodies there will be a number of virtual particles, and therefore energy, lower than at any other point on the surface of the two bodies. Hence the two bodies will be subject to a vector tending to draw them closer, and increasingly stronger as the distance separating the two bodies reduces. In other words, the two bodies accelerate toward each other with an apparent attraction, as in the law of gravitation of classical physics, but really they are pushed one toward the other by two external forces.

Supposing further that the two bodies have unequal masses, with one much greater than the other, it is possible to verify the situation as described in the explanations of general relativity. An observer placed on the body with a greater mass (for example a planet), will be subject to the same force that the particles of the quantum vacuum exert on any other point on the surface of that body, and then shall remain at rest with respect to it. The greater the observed mass, the greater will be the force. This explains why, if a body is in contact with another of greater mass, it has a weight proportional to its mass. There are also particles of quantum vacuum vibrating outside of the body with a greater mass. A certain number of theirs can pass through this body, resulting in a distancing effect on the body with a smaller mass. The greater the mass of the first body, the lower will be the number of these particles, and so correspondingly the distancing effect, acting as a vector in opposition to the apparent attractive force between the two bodies, will be smaller. This finding makes us understand why the gravitational interaction between two bodies depends not only on their distance but also on their masses, and furthermore why a body in contact with another has a weight proportional also to the mass of the body on which it is located.

In contrast to this, as explained in the previous section, all bodies undergo the same acceleration towards a large mass body in their proximity, since as their mass changes, so correspondingly the force varies exerted on them by the particles of the quantum vacuum vibrating outside of the area of separation, and so the acceleration is constant for all bodies.

An observer at rest on the surface of the body with great mass, experiences a sensation of being attracted to it, as with a minor body seen to be approaching with increasing speed that body on which he is located. An observer *inside* the body with a smaller mass which accelerates towards the first (for example, a spacious cabin in free fall) will see instead all objects within subject to the same acceleration, having the sensation of being at rest in the absence of gravity.

In order to allow this cabin experiment to explain the phenomenon with the same coherence of the theory of general relativity, we have first to introduce an important assumption: that the particles of the quantum vacuum shall be represented as a train of waves going through, at least in part and on the basis of the frequency of vibration, the bodies with which they collide.

The vibration frequencies of these particles shall be numerous, and we can assume that the thinner the wall of the cabin is, the greater will be the number of particles able to cross it without interacting with it; in our case, almost all the particles of the quantum vacuum shall cross the thin walls of the cabin.

Of course it is not possible to have knowledge of how virtual particles that constantly emerge from the quantum vacuum behave, since they exist for a time too short for them to be directly detected. However, we assume that as with electromagnetic waves, so the extent to which the waves/particles of the quantum vacuum tend to penetrate inside a body will increase with greater wavelengths, so that a thin separation surface (the wall of the cabin) will reflect mainly the particles with a higher frequency, the rest penetrating inside the barrier. Thus, since the wall of our cabin is of a thickness much smaller than the distance between the cabin and the edge of the «sphere-universe», we can conclude that a large percentage of the particles that act on it by pushing it toward the planet shall be able to cross it; therefore these particles exert on all the objects inside the cabin a force that will be almost equal to that exerted, in the direction of the planet, on the wall of the cabin. Similarly, particles vibrating between the inner walls of the cabin will be negligible in number, and therefore in energy, compared to the external ones[2].

In conclusion we can assume that the same phenomena of gravitational interaction between bodies explained by general relativity, can also be interpreted as being the effects of a quantum vacuum.

4. *Effects of the quantum vacuum: inertia and tendency of matter to sphericity.*

The inertia of a body can be seen as a further effect of the "pressure" exerted on it by the particles of the quantum vacuum. We postulate the body as being isolated in the “sphere-universe”, that is without taking into account the differential of pressure exerted in the direction of other close bodies due to the lower number of particles in the space of separation. This body will tend to remain at rest (compared to a hypothetical observer integral with the system of the body) due to a nearly uniform pressure exerted on it by the particles of the quantum vacuum that vibrate in any direction toward the edge of the sphere-universe or the nearest great mass. These particles have a number of frequencies so high as to be considered equivalent, while in order to move the body a force overcoming the resistance of the quantum vacuum would be required.

When such a force ceases, the body would retain such a state because it is subject again to a uniform "pressure" of the quantum vacuum. In classical physics is defined uniform rectilinear motion.

Eminent physicists consider the "principle of inertia" almost inexplicable[3].

However, according to our present hypothesis, we posit that it may be explained in a simple way. The bodies are always subject to the influence of the particles of the quantum vacuum. Assuming a region of the universe in which the pressure exerted on a body by the particles of the quantum vacuum is uniform in every direction and does not change in function of time, the body would remain in that state, so it appearing to be at rest. If a force is then applied on it, it will move, and immediately on the cessation of the force, will maintain the status it had previously. In other words it would appear to be in uniform rectilinear motion.

It is incorrect to argue that if a body is moving through the particles/waves of the quantum vacuum, the pressure they exert should be greater in the direction of motion, so creating a "wind" of particles that decelerates the body to make it stop. This objection does not consider that to measure a motion of the body through particles of quantum vacuum would take two measurements separated in time of the position of the body (Δt) with respect to the term of reference of the motion (the particles of the quantum vacuum). Glaringly this is impossible because they exist less than the minimum measurable time.

Not even you could overcome this objection by noting that, although each particle of the quantum vacuum exists less time than it takes to measure any motion of a material body, yet when a particle annihilates, another appears, and then there would still be a detectable entity at the beginning and at the end of the minimum measurable time (Δt).

This reasoning would perhaps be correct for classical physics, but actually neglects the quantization of the energy of the quantum vacuum. In fact, each form of energy can be imagined as a wave interacting with the matter by a mechanism of nonlinear "shots" (instead of linear as in classical physics). So to measure any effect each wave must initiate and conclude its period of oscillation in the minimum measurable time, which is obviously impossible for the particles of quantum vacuum.

Therefore, no motion of a material body with respect to the quantum vacuum can be directly detected.

Moreover, uniform rectilinear motion is configurable only with respect to a narrow portion of space, within the system of reference of the body at rest. However, if we introduce a hypothetical observer at rest with respect to the center of the sphere-universe, whatever the direction engendered on the body by the accelerating force, even after such a force ceases, the body will be exposed to a constant acceleration towards the surface of the sphere-universe. The proviso, we repeat, is that this is compared with the above hypothetical observer.

So uniform rectilinear motion can only be relative to a determined system of reference. We now consider the entire system of the sphere-universe from the point of view of an observer at rest in the center, or an observer outside the system-universe. Uniform motion cannot exist, because it is impossible that the pressure exerted on the body by particles of the quantum vacuum, which determine their condition once other forces have ceased, is uniform in all directions towards the surface of the sphere-universe (or toward the closest great masses), as explained in par. 1.

Here we digress to point out that this finding introduces the first element of doubt about the configurability of the motion of light c as a universal constant, on which we will return more comprehensively. In fact, if we imagine the measurable particles (and matter itself) as "sponges" or "foam" of the quantum vacuum, there can be no mass if the particle is not disturbed by the quantum vacuum. But if it is affected by the effect of the quantum vacuum, in the light of what we said it cannot move in uniform motion, as the photons should normally move according to the common conception. The common opinion that the photon is a massless particle at rest, does not solve the problem, because according to the view here explained a particle placed in space-time can exist only when subject to the effects of the quantum vacuum, and the quantum vacuum necessarily determines the mass on the bodies which are immersed in it. If there were no pressure on the body of the quantum vacuum, in space-time there would not be a body without mass, instead there would be nothing, because there is nothing that is not affected by the quantum vacuum.

Uniform rectilinear motion cannot exist, even in theory, and at great distances from other masses there are rather weakly accelerated motions as opposed to supposing the possibility of a state of rest or uniform motion. In reality, any system within the universe's sphere is subject to some accelerating force, which is the resultant vector of the actions exerted on it by the quantum vacuum particles.

We now address the fictitious forces that appear in a non-inertial system. These can be explained in a simple way as a result of the overall force exerted by the quantum vacuum particles on the bodies enclosed within the accelerated system, to which the accelerating force is not applied. Introducing again a container of the system (e.g. a cabin) and thus, not being subject to the accelerating force, but only to the inertial force exerted by the quantum vacuum particles, such bodies in it remain in the state they were in before the accelerating force was applied to it. Hence they tend to remain in the previous state, appearing to an observer outside the system and its acceleration, to be subject to forces of which the cause is not understood.

Probably, we suggest, the influence of quantum vacuum on any body can explain the tendency of matter to arrange itself in a spherical form when there are no other measurable forces acting on it in a relevant way. Examples of this are the celestial bodies or, secondly, a liquid poured into space, which tends to the formation of spherical drops.

We now consider a body in space, far enough from other bodies and which no force is measurably affecting. It will still be subject to the influence of the quantum vacuum particles present between the surface of the body and the outer limit of the universe. It will therefore be subject to a very high number of vectors coming from the walls of the "universe sphere", i.e. a zero-point energy produced by particles that vibrate around it, basically equal in every direction.

At this point, we assume that the position of the body in the "universe sphere", and its distance from two opposite points on the surface of the sphere (necessarily different), does not significantly affect the effect described. Having made this assumption, our main point explains the tendency to assume a spherical shape. In practice there will always be forces exerted by bodies in close proximity, due to the smaller number of particles of quantum vacuum that vibrate between the body and the one close by, compared to those that vibrate between the body and the outer limit of the sphere universe or compared to a third body at a greater distance from the first. However, if these forces are sufficiently small, the effect can be neglected, and in time the body will assume a nearly spherical shape.

5. *A new interpretation of the Casimir effect. Possible experimental proof. Application of the exposed hypothesis to the calculation of the perihelion precession of Mercury.*

It may be hypothesized that the Casimir effect, studied by experimental physicists with the well-known experiment of the metal plates, can be explained as a particular form of quantum vacuum effect on matter; simply an effect in addition to those, described above, resulting, more in general, in the inertial mass and gravitational mass of bodies.

It can be assumed, in fact, that since the quantum vacuum particles penetrate inside the appliance, they exert a force on both plates. The plate opposite to such input will be subject, with respect to the particles arriving perpendicularly to the surface, to an action only slightly smaller than that exerted on the first; the particles that will interact with the second plate will only be those which, having a greater wavelength, did not interact with the first plate, but have crossed it.

The result will be that, with an equal number of incident particles, the ones having a greater frequency will interact with the first plate and the ones having a slightly lower frequency will interact with the opposite plate. The quantum vacuum particles therefore produce a greater pressure from the outside towards the inside of the two-sheet system, with an apparent attractive effect.

In other words, each plate will be subject to an attractive force towards the other equal to the difference between the opposing vectors, one from outside the two-plate system towards the inside, and the other from the inside toward the outside, always due to the same incident particles, decreased of those absorbed by the first sheet ($F\rightarrow = Ft - Fs$, where t is the total pressure exerted by the zero-point energy on the plate from the outside, and s is the effect on the first-impact plate due to the thickness)[4].

This effect is commonly interpreted as gravitational attraction between the two plates.

We now assume, instead, that the attractive effect is *always* due to the pressure exerted on the plates by the quantum vacuum. The Casimir effect, in which appears an attractive force being added to the gravitational attraction between the plates, so may be described simply as a special case of the same effect of the quantum vacuum that causes the attractive “gravitational” force.

When the distance between the plates is shorter than the smallest integer submultiple of the distance between the plates and the greater mass in their proximity (or, imagining the system of plates isolated in the “universe sphere”, of the distance from the edge of the universe), no particle coming from the outside of the system can interact with the plate opposite the one analyzed, because the wavelength of all the particles that interact with the plates from the outside is larger than the separation space. Within the system, only the particles born therein will vibrate with negligible effects. All particles interacting with each plate from the outside will be absorbed by it; none will cross it, resulting in a distancing effect, albeit minor, on the opposite plate[5]. Therefore the appearance of an attractive effect will be increased at very small distances between the plates.

In this scenario, the attractive effect is always caused by an action of the particles of quantum vacuum, rather than by a reciprocal gravitational attraction. The so called gravitational attraction is always due to the differential pressure exerted on two neighboring objects by the particles of quantum vacuum. This force is necessarily smaller between the objects than it is on their outer surface facing the edge of the “universe sphere” (or the nearest great mass).

If the premise is correct, the Casimir effect should depend - hitherto neglected point - not only on the surface, but mainly on the thickness and density of the plates. At equal distance, it should increase with the thickness and density of the plates’ material.

A further consideration is possible.

The attractive effect is not determined by some kind of effluvium originating from bodies, neither by their ability to modify the structure of space-time. The attractive effect, instead, is created by the differential pressure exerted on the bodies by the particles of quantum vacuum, which is lower on the surface facing the other body and greater on the opposite surface, facing towards the greater mass in the vicinity (or towards the edge of the “universe sphere”)[6]. The effect exerted by the particles of quantum vacuum thus depends also on the thickness of the body which is affected, not only by its overall mass. Therefore the gravitational attraction should vary, for example, when a body in the shape of rectangular parallelepiped facing another body is rotated 90° in order to change the thickness, i.e. the quantity of matter, on which the incident particles can have effect[7]. A simple torsion balance like that used by Cavendish should already detect a variation of the gravitational interaction if the weights used in the experiment were parallelepipeds (rather than spheres as Cavendish made), and they were made to rotate 90° on the axis that connects the two centers of gravity.

Therefore the Newton’s law should be modified, like it was not only in relation to the mass of the two interacting bodies, but also to their conformation.

Experimental tests never were made about this, and when the gravitational interaction is most clearly to perceive, i.e. in the motion of heavenly bodies, their almost spherical shape cancels the importance of the correction just assumed. In fact, compared to a secant line[8] any rotation of a sphere does not change the length of the segment that crosses it. In rare cases, however (like when the astral body has the shape of an irregular ellipsoid), there may be a disruption of the orbit as calculated using Kepler's laws and the Newtonian theory of gravitation. In such a shape might be the planet Mercury. It might be elliptical at the equator, or might have an irregular distribution of the internal mass, so resulting denser in the hemisphere facing the sun for a longer time.

In classical physics the precession of Mercury's perihelion was the subject of an attempt of description by using the laws of Kepler-Newton (thanks especially to the astronomers Le Verrier and Hall). They suggested a small modification of the equation that expresses the gravitational force, but could not find a justification of the additional term that was introduced.

According to the above ideas, the gravitational interaction is given by the difference in pressure between the quantum vacuum particles vibrating outside of the two masses, and those vibrating in the space in between. Therefore the gravitational interaction depends not only on the masses, but also on their average thickness along the axis that joins the centers of gravity, as well as on the density of matter of the bodies.

The equation that expresses our hypothesis *nondum potuimus deducere*. We think it should include two correction terms of the Newtonian formula, the first expressing the average thickness of each body measured along the axis joining the centers of gravity, the second the matter density of the bodies[9].

Classical physics also contains indirect proofs that the gravitational interaction depends not only on mass, but also on the density of bodies. So is the buoyant force, which is an effect of gravitational interaction (in fact, does not operate at a long distance from masses, as in space). It does not depend on mass, but on the density of the body immersed in a fluid. The buoyancy is simply the pressure exerted by the particles of quantum vacuum on each part of a liquid mass. For the Pascal's law this pressure on fluid acts as an *a tergo* force that pushes a body immersed towards the surface, and tends to keep it afloat. If the density of the immersed body is less than that of the water, the particles of the quantum vacuum exert on it a thrust towards the bottom smaller than that engaged on the water. Therefore the body floats.

Returning to the above mentioned formula, the deviation from the Newtonian law is minimal. It is, however, easy to verify that if the bodies rotate each on its own axis and are not perfectly spherical (but for example in the shape of an ellipsoid with an irregular density due to the distribution of the internal mass), there will be a slight fluctuation of the interaction in correspondence of the rotation period. This could explain the precession of the Mercury's perihelion in an easy and alternative way with respect to the theory of general relativity.

6. *Influence of the quantum vacuum on the electromagnetic interaction. Beyond the concept of photon propagation.*

Electromagnetic interaction is commonly explained as the effect of a massless particle travelling through space at a constant universal speed *c*. We suggest, instead, another point of view.

First of all, it is impossible to detect a photon when is moving through space; nor we can imagine any experiment, even if only conceptual, to do so. We only can say that when an atom vibrates, going from a higher energy level to a lower one, it emits energy, and this energy can be detected on another atom after a certain time depending on the distance. Hence, the concern of maintaining constant the principle of energy conservation also in time make us think a “storage” of this energy in a particle.

A quantum vision of phenomena may indicate a possible alternative.

An electron can be found only at certain energy levels corresponding to certain distances from the nucleus. It would be a nonsense to ask how it can jump from one level to another. In fact, everything we can detect is its presence in one of these levels, and never in an intermediate position. On the other hand, the electron can be seen as a particle or as a wave, that is, as mass or energy. Here we note that also in a non-atomic scale energy can only be detected on the atoms and never “free” in space. It is conceivable, therefore, that it can flow through space by a mechanism of nonlinear “shots”, as if it “jumped” from the atom radiating to the irradiated one. It follows that the constant *c* is only a term to calculate the delay in the transfer of energy from one to another atom, but no more.

However, the idea that *c* is constant is soon questioned.

Its value should express, in fact, the speed of propagation of the electromagnetic field in the vacuum. However, quantum physics shows that the absolute vacuum does not exist, and the Casimir effect shows that the mass-energy of quantum vacuum is different, for example, in a Casimir space (like between the slabs of the experiment) compared to an open space. Therefore the idea of the universal constant is in crisis. Indeed we can assume that as the apparent speed of propagation of an electromagnetic field decreases with the density of the medium “crossed”, so it decreases with the variation of the density of mass-energy of the vacuum, which is not constant as the experiment devised by Casimir shows[10].

The “historical” Michelson-Morley experiment does not prove that light moves in space-time at a constant speed, it only proves that it is not possible to measure the “speed” of the light with respect to the ether, and therefore shows that there is no ether.

Here we question not only if light moves in space-time at a constant speed, we also question whether it actually travels through space-time. The interferometry experiments of Fizeau, Hoek and Zeeman, carried out from 1851 to 1927, do not prove that light moves through a fluid, or that it is partly transported when it moves. Many possible experimental systematic and random errors (due to the difficulty of measuring minimal differences in light "speed"), might invalidate them if repeated with modern techniques. As a matter of fact, these ancient experiments simply demonstrate that the electromagnetic interaction in a moving fluid is faster in the flow direction than in the opposite direction. However, this can also be explained without assuming that the speed of the fluid is partially summed to the speed of light (either according to the formula of Fresnel, either according to the relativistic law of motion composition).

It is conceivable, for example, that the delay of the electromagnetic interaction, shorter in the flow direction than in the opposite direction may be explained simply by the loss of hydraulic load in the test circuit. In fact, the load of a circuit in which the fluid flows is lower in the direction of flow. It follows that the pressure and, therefore, the density of a fluid shall be lower in the point of detection than in the point of signal entry. Therefore the light speed seems to increase, as if it was partially summed with the speed of the flow.

In conclusion, we can assume that the electromagnetic interaction occurs with less delay when the density of the fluid, between the radiating body and the one irradiated, decreases, rather than in case it increases, as in the Fizeau's experiment, in which the test fluid is made flow respectively in the direction of light propagation or in the opposite direction.

We now question not only whether the light speed is constant in vacuum (which in quantum physics does not exist), but also the idea of movement of light through a medium.

In these new perspectives, even the concept of *field,* upon which so much of modern physics is based, comes into question.

In fact, a field is a portion of space where, if a body is set, a force operates; but the idea of a field as a physical reality, regardless of the presence of the body, is a pure postulate. Here we note that no experiment, even conceptual, lets us measure field itself; and we doubt that the concept of field, albeit useful to explain many phenomena, is not very different from that of planet orbits, which allows to calculate the displacement, but it certainly does not indicate any physical reality.

7. *Space and time as perception of quantum vacuum states*.

Does vacuum exist?

To this “Cartesian” question modern physics gave an answer at first with the theory of relativity, for which there is no field empty space. However, as we have just seen, the concept of “field” does not seem conceptually correct.

Subsequently, quantum physics came to the same conclusion by noting that vacuum cannot exist, both because in a region empty of mass/energy Heisenberg’s uncertainty relation will not work and because, in order to perceive this hypothetical region, a machine or an observer should be present, and these, necessarily dispersing energy during the measurement, would fill the void of mass/energy, and would ultimately measure their own radiation.

In truth, simple logic leads to this result. Indeed, how can there exist what by definition does not cause any effect, even indirectly, and therefore cannot be perceived in any way? Even if there were, how would we notice it? If the “emptiness” is what does not exist, it means that vacuum ... does not exist.

The cosmological conception sometimes attributed to Newton - a finite universe expanding in an infinite void space - meets not only the difficulties that have been proposed by modern cosmology (the density should fade out at the outer limit, but for the principle of equipartition of energy, and therefore of mass, this would imply that the density is zero also at the center and in any other part of the system), but maybe even those coming from pure logic. In fact, how could we perceive the absence of matter in the regions close to the outer limit? Only that which exists can be measured, and therefore you would get smaller and smaller measurements, but never null[11].

Therefore we cannot reasonably doubt the correctness of the theory of quantum vacuum, and of zero-point energy.

This theory can tell us something new about the concept of space and time and about electromagnetic interaction.

Here we visualize any space: countless quantum vacuum particles will vibrate therein. However, for the law deduced from the Casimir effect, these particles will all be integer multiples of a minimum entity, which will represent the minimum measurable space of that system. In the same system, a minimum measurable time will also exist, given by the perception of something that crosses the minimum space[12]. This entity crossing the minimum space cannot, of course, be a body with mass/energy: the minimum space “contains” only the minimum quantum level of mass/energy of the system, and it means that no other material body can stay therein.

Here we pose an important query: if an electromagnetic interaction can traverse the minimum quantum space of our system. We postulate that this is not possible at all, because an electromagnetic interaction would need a certain integer multiples of the minimum space. Ultimately, the space is composed by particles of quantum vacuum, and there is also below the minimum size measurable by detection systems based on the electromagnetic interaction; nevertheless it becomes measurable only at the same magnitude or greater than those that can be “crossed” by a photon with the shortest possible wavelength.

Another issue is central: can the electromagnetic interaction "cross" a minimum measurable space in a minimum measurable time? The answer to this question must be positive: in fact, the minimum measurable time is given by the perception of something that appears first at one edge and then the other one of such an area, and we can therefore say that to measure the minimum space, a time measurement must be given. However, this temporal entity must be viewable through a minimum spatial shift; otherwise it would not be no more a measurement of the minimum measurable time.

In conclusion we can assume that the light "speed” is nothing but the ratio of the minimum space and the minimum measurable time. The apparent constancy of this factor *c*, and the not applicability to this “motion” of the “law of addiction of motions”, is due to the fact that if a body is in a relative motion to each other, the minimum measurable integer submultiple of the largest wave/particle which vibrates in the space of separation, progressively increases or reduces in accord with the variation of space[13]. Hence, also the minimum time measured shall vary, and therefore the ratio shall always remain constant, at least for an observer inside the system.

C is the maximum measurable speed, but it can’t tell us nothing about what it really happens during the electromagnetic interaction between the radiating body and the one irradiated[14].

Everything we can say is that when electromagnetic energy passes from one body to another, *c* represents the benchmark, remaining constant regardless of the distance between the radiating body and irradiated one, and also regardless their relative motion which leads us to calculate the point of space and time where the energy appears on another body. We don’t know absolutely anything about the transfer mechanism, and all we can suppose is that, after a certain time, the energy "jumps" instantaneously from one body to another one, as well as an electron "jumps" instantaneously from a quantum level to a higher one[15].

If the above hypothesis is correct, we can point out that:

a) the quantum vacuum energy is not electromagnetic, but it is gravitational.

b) the quantum vacuum energy causes the gravitational interaction.

c) there is no interaction between gravitational and the electromagnetic effects (or, to use a classical terminology, between their quantum particles).

d) matter interacts with both these forms of energy. However, while the electromagnetic interaction occurs outside space/time, instead matter is also immersed in the quantum vacuum energy and is also affected by the gravitational effects.

What we really perceive is not motion of the electromagnetic energy through space and time, but evolution of matter into space/time, which leads it to meet predetermined electromagnetic phenomena[16]. We can say that we can only move the bodies inside space/time, making them meet various electromagnetic phenomena, but we are not allowed to change the order of electromagnetic phenomena which will occur at each point of space/time.

The experimental data suggest, therefore, that electromagnetic interactions take place simultaneously, or in other words outside of space/time[17].

However, the radiating body and the irradiated one are immersed in the quantum vacuum, which coincides with the space/time. Hence, gravitational energy of the quantum vacuum delays the time of the jump, and also the moment when occurs the interaction and the transfer of energy between the two bodies themselves.

The greater the total energy that the particles of the quantum vacuum exert on the radiating body and the irradiated one, the greater is the delay. This energy increases in proportion to distance[18], or even when one of the two bodies is in proximity of a great mass, which, according to our hypothesis, should be surrounded by particles of quantum vacuum at higher frequency. In both such cases, the quantum vacuum particles create between the two bodies more energy than that normally caused by the particles vibrating thereinto undisturbed, and therefore the energy transfer takes more time.

In other words, even if it is not completely correct, we can consider the universe as an Euclidean structure, without any need for curving its own structure. The "speed" of light *c* is not a constant (it actually is not even a speed), and the intensity of gravitational field "slows down" this apparent "speed."

8. Conclusions.

In the relativistic physics, the continuous modification of space and time, according to complex equations which describe the curvature, is the "price" that is necessary to pay to maintain unvaried the laws of physics in all non-inertial systems[19].

This paper illustrates the idea that many gravitational and electromagnetic phenomena usually explained through relativity could also be well visualized in an Euclid-Newton scenario, as simple consequences of the presence of the quantum vacuum.

The Casimir experiment shows that in quantum terms, vacuum does not exist. So, can we longer accept a theory that requires as a necessary postulate the constancy of light speed *in a vacuum*? What's the meaning of the relativistic constant *c* if the vacuum does not exist?

The existence of the quantum vacuum rather suggests that the electromagnetic interaction does not hinge on something that really crosses the space-time. Hence *c* just indicates a delay, not a speed, in the transfer of electromagnetic energy from one body to another one. The delay, within the same system, it is not subject to the law of addition of the motions, because it is not precisely a speed, but instead a sort of jump "below and outside" of space-time.

The main experimental verification of the ideas developed in this study consists in the application of equation (1) as described in paragraph 4, to calculate the planetary orbits, and particularly the precession of the perihelion of Mercury. In laboratory, the above mentioned equation may be verified with a "torsion balance", repeating the famous Cavendish experiment with weights in the shape of parallelepipeds instead of spheres, and then comparing the measures after a rotation of 90° on the centers of gravity axis.

Moreover, the ideas expounded in this article may be experimentally verified at least in three other different ways.

First of all, by passing a ray of light through the «space of Casimir», i. e. a system (like between two plates of the Casimir experiment) where the energy of the particles of quantum vacuum is lower than outside, given the lower number of integer submultiples of frequencies contained therein. At the passage of the light ray within the space of Casimir, a negative refractive index should appear. Since the vacuum does not exist, the Maxwell equations, which instead presuppose it, should be therefore modified. When the equations were applied to a space of Casimir, they would need indexes of electric permittivity (ε_0) and magnetic permeability (μ_0) of vacuum less than zero. Therefore they lead to a negative refractive index, due to the effect of a "speed" of the wave of light in the space of Casimir greater than in the external vacuum space.

The second experiment is measuring the time on the surface of a considerable mass (for example, a mountain or a pyramid) and then inside a narrow cavity within this mass (for example, a small internal cavity near the center of mass). The two measures should be different from each other, with an apparent acceleration of the time measured inside the cavity.

General relativity can't explain this difference, in fact the mass curving the space/time is always the same. The difference, instead, will depend on the lower energy of the particles/waves of quantum vacuum inside the cavity. Not taking in account the waves coming from outside, they will be only submultiples of the frequency equal to the maximum dimension of the cavity. This will determine, within the cavity, a minor delay in the transmission of electromagnetic energy, and therefore an apparent acceleration of time compared to a clock situated on the outer surface of the mass.

Finally, we can imagine an astronomical experiment. The curvature of the light rays near a large mass ("gravitational lens" effect or "Einstein effect") may be explained as a phenomenon of refraction. It may hinge on the higher density of particles of the quantum vacuum close to the surface, so that the rays of light cross a crown of particles of quantum vacuum with greater density then in the space crossed before. Therefore, the refractive index from the outer strata to those closer to the surface will progressively increase (see footnote 10).

Since the refraction phenomena are always associated with reflection those, if we know the degree of displacement of the image of a star during a solar eclipse, compared to the usual position, we may also calculable the position where a second, a much weaker reflected image, should appear.

The second imagine that here we hypothesize, cannot be explained by general relativity, and if really verified, it could constitute the best evidence that general relativity is not a definitive theory.

According to a common opinion the more a theory is expressed simply, the more beautiful it is. Probably what seems beautiful to us, is in harmony with the universe's structure, it's like the "eco of the truth"[20].

The conjectures proposed in this essay certainly are not so much ambitious. However, they differ radically from the more complex theories explaining in very different terms the gravitational interaction as an effect of the quantum vacuum[21], and aim to visualize in a simple and alternative way:

a) gravitation in quantum terms.
b) inertia and rectilinear motion.
c) the fictitious forces that appear in non-inertial systems.
d) the increment of the speed of the universe expansion.
e) the gravitational lens effect.

These ideas also lead to predict the existence of a second reflected image of the stars observable near a large mass, in addition to the deflected commonly explained by the gravitational lens effect.

Finally, the purpose of this essay is to open new perspectives. Through the conception of the quantum vacuum that informs the Casimir experiment, the quantum theory, in the original shape not based on extreme theories and on difficult mathematical formalisms of its latest developments, may open the way of overrun general relativity, by a greater and simpler generalization.

Einstein himself criticized some hypothetical extensions of the theory of relativity based on the multiplication of dimensions, that wants to incorporate also the electromagnetism into the field equations, claiming to not understand why, if the dimensions are more than four, we actually feel only four[22]. Analogously we could ask why, if the space-time and the universe itself are not Euclidean, we see them as well.

The modern quantum physics offers us a way to place the phenomena, and the world itself in which we live, in a simple Euclid-Newton reference system.

◦ ◦ ◦ ◦ ◦

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[1] The conception of the particles of the quantum vacuum as integer submultiples of the widest possible wavelength within the sphere-universe delimits the maximum number, preventing them from being infinite and resulting in an infinite energy in the system. In this logic we can overcome the difficulty pointed out by Hawking: «the problem is that the virtual particles have energy, and because there are an infinite number of virtual pairs, they would have an infinite amount of energy. According to general relativity, this means that they would curve the universe to an infinitely small size, which obviously does not happen» [4]; and: «the uncertainty principle means that even empty space is filled with pairs of virtual particles and antiparticles. These pairs would have an infinite amount of energy. This means that their gravitational attraction would curve up the universe to an infinitely small size») [3].

[2] We should also assume that in the case of an isolated body in the "sphere-universe" the tendency of particles of the quantum vacuum to pass through the body in relation to the frequency does not affect the motion impressed towards the surface, as described in par. 1. In fact, the particles that will vibrate in the opposite direction on the axis of movement shall also have the same characteristic, and then the two effects shall compensate. This is because the force applied to the body will be the resultant of the vectors of opposite direction generated by the effect of the sole particles the frequency of which allows the interaction with the body of reference.

[3] Feynman, [2]: «If something is moving, with nothing touching it and completely undisturbed, it will go on forever, coasting at a uniform speed in a straight line (Why does it keep on coasting? We do not know, but that is the way it is) ».

[4] This neglecting, because of its smallness, the inverse repulsive effect produced by the particles of quantum vacuum that arise within the space of separation between the plates.

[5] In this case, in fact, with respect to the waves/particles of quantum vacuum from the outside, the two plates will appear no longer separated by any space, and then will behave as a single rigid body.

[6] Seen as a differential effect of the pressure of the quantum vacuum particles that interact between two bodies along the straight line joining their centers, and, on the opposite side, along the line that separates each of them from the nearest large mass, or the limit of "universe sphere", the gravitational interaction appears as a force that decreases with the square of the distance, according to the well-known law of universal gravitation.

This is a remarkable similarity with the quadratic formula which expresses the illumination of an irradiated body $E = I \cdot \cos\alpha / r^2$. The fact is not surprising: the same way the energy transmitted by the electromagnetic force is the effect of particles vibrating between the radiating body and the irradiated, so the gravitational interaction, according to the theory presented here, is the effect of particles of quantum vacuum that vibrate between the two bodies, and between each of them and the nearest great mass (or the limit of the "universe sphere"). Therefore, considering only the distance between the two bodies, gravitational interaction appears as an attractive energy that a body exerts on the other inversely proportional to the square of their distance. Apparently, gravitational interaction is therefore a relationship between attracting body and attracted body similar to that between radiating body and irradiated body.

Another striking similarity can be noted. The distance between the bodies subject to gravitational interaction can be seen as the maximum space in which the effect of the interaction between a particle of quantum vacuum and one of the two bodies can occur. In quantum terms, the space of separation between the two bodies is the amplitude of probability that the interaction between quantum vacuum and each body will manifest (Ψ), and its square expresses the density of probability (Ψ^2) that this will happen. Since gravitational interaction is actually repulsive, it increases as the probability that a single electron of one of the bodies in question will be influenced by particle of quantum vacuum that vibrates outside the separation space, along the line that connects the body with the limit of the "universe sphere" or the closer great mass. However, considering only the relationship between the two bodies which interact, it seems attractive, and therefore appears to decrease as the probability of interaction between each of the two bodies and the particles of quantum vacuum within the space of separation increases, in other words it seems to decrease with the square of the distance between the two bodies.

[7] We now suppose further (see text) that a variation of gravitational interaction, similar to the one just described, occurs on Mercury because of its hypothetical elliptical shape at the equator, resulting in a pulse of gravitational interaction with the Sun at the rotation period of the planet. We suggest that this could explain the precession of the perihelion of the planet in an alternative way with respect to the theory of general relativity (as well known, the explanation of the precession of the perihelion of Mercury is considered one of the experimental tests of the theory).

[8] Line representing the path of any quantum vacuum particle interacting with the spherical body.

[9] In the case of the interaction between two spherical bodies of equal radius (so we simplify the demonstration not taking into account the average thickness, which will be equal for both), the correction of the Newtonian formula with the reference to the matter density can be illustrated as follows.

Since the gravitational interaction is calculated from the respective centers of gravity, i.e. from the center of each sphere, each change of density of a body for a given mass results in a reduction of the radius of the sphere (in fact $d = m/v$, and to increase the density of a spherical body without changing the mass and the spherical shape we should evidently reduce the volume, and therefore the radius of the sphere). If we reduce the radius of one of the two spheres between which the gravitational interaction is acting, we correspondingly and equally will increase the spaces of separation between the bodies and between the body the density of which is increased and the nearest external large mass (or the edge of the "universe sphere").

Because of the quantization of vacuum energy, in this greater space a given number of quantum vacuum particles may vibrate, which can be represented by a series of integers. The greater the *total* extension of the space, the greater the possibility that one of these integers is due to the additional space, so created between the bodies, and between each body and the outer wall of the system. The frequencies of the quantum vacuum particles that, because of the increase in density of a body, will vibrate in the space of separation between the bodies will therefore be greater in the separation space between the body with increased density and the closest great mass, or the outer edge of the "universe sphere", rather than in the (smaller) area of separation between the two interacting bodies. Hence, with an increase in the density of one of the two bodies, while the masses remain unchanged, the energy exerted by quantum vacuum grows more from the outside inwards, rather than from the inside outwards, along the axis that joins the gravity centers. This should produce a slight increase in the apparent attractive force between bodies.

Let $r = r_1$ the radius of the two spheres; if to increase the density of the first sphere we set $r = r_1 - n$, where n is any integer, and call x the space of separation between the two centers of gravity and y the space of separation between the center of gravity of the sphere in question and the limit of the universe-system, both of these spaces will be increased by a factor of n, in which a further number of quantum vacuum particles, an integer submultiple of $x + n$ and $y + n$, can vibrate. Since $y + n > x + n$, the integer submultiples of the two numbers that express each sum, which can be placed in n, will be greater in the first term than in the second. This indicates a greater number of possible frequencies of the quantum vacuum particles in the first space compared to the second, and therefore a greater pressure in the quantum vacuum energy from the outside towards the inside of the respective centers of gravity, with an apparent increase in the attractive force.

Leaving the density of the interacting bodies unchanged and modifying only the disposition of matter around the respective centers of gravity - as if two parallelepipeds disposed in axis along the centers of gravity, with the minor bases facing each other, were each rotated by 90° - would change the amount of the vacuum particles interacting with the bodies. In fact, if is changed the disposition of the bodies so as to increase the thickness of the matter interacting with the quantum vacuum particles vibrating on the outside towards the limit of the "universe sphere" (or, in practice, to the closest great mass), each body would absorb a greater proportion of interacting particles. The particles, not having interacted with the first body but crossing it and interacting with the facing body, resulting in a distancing effect, therewith decrease. This should therefore result in a higher apparent force of attraction between the two bodies.

[10] It means also that the gravitational lens effect, and the apparent deflection of light rays in the vicinity of large masses, is simply due to a form of refraction.

In fact, as the particles of quantum vacuum tend to cross the matter the more the lower the frequency is, at the edge of a mass a crown should form (the deeper the greater the mass is) of particles at high frequency which can't cross it. In proximity of a large spherical body there will be a greater percentage of particles at high frequency, than those at a lower frequency. In fact, the particles which pass through the body, will be replaced on the surface by others vibrating at any frequency. Hence, "balance" is a greater presence of particles at high frequency, i.e. a greater presence of mass. The progressive variation of "density" of quantum vacuum in the vicinity of a a body with a great mass, and the consequent increase of the refractive index towards the surface, may explain the effect of gravitational lens as a simple form of refraction.

In classical physics, when a ray of light penetrates into a more refractive material comes out parallel to the incident ray. It is, however, shifted laterally (in the direction of the first refraction), in function of incidence angle, thickness and refractive index of the interposed material. Similarly, the electromagnetic interaction between two bodies is deflected with respect to the straight line joining them, when the particles of quantum vacuum increase their density due to the presence of a large mass, around which they have higher frequency and thus greater mass/energy. The greater the mass, the more dense will be the belt of quantum vacuum particles at higher frequency surrounding it, and so correspondingly will be higher the refraction index and the apparent deflection of the ray of light. This scattering is equivalent to the gravitational lens effect usually explained by the general relativity.

[11] In other words, when the most sensitive instrument does not detect anything, it does not mean that there is nothing, but that we are measuring the minimum amount of time, space, mass or energy.

[12] Time can only be measured by detecting the motion of something, for example the hands of a clock, or viewing on a photographic plate the interval between two electromagnetic emissions of an atom. It is therefore clear that we cannot measure a shorter time of what can be viewed and measured in a minimum space. Newton [5] had already understood the point when he wrote that the relative time, i.e. the duration of events, is measured «per motum mensura, (seu accurata seu inaequabilis)».

[13] This minimum measurable integer submultiple of the wave/particle vibrating in the space of separation at the lowest frequency, small as it can be, cannot be equal to 1, because 1 is not a prime number. If instead 1 were really a prime number, we must conclude that the minimum measurable space does not vary with the variation of the area of separation, but is an entity equal for all systems, and such it would be also the minimum time. *C* would go back to be a universal constant, but it would remain unexplained why this "motion" is an exception to the law of addiction of motions.

[14] We now point out that it is impossible, even conceptually, to see the photon as it is moving into the space. Planck's quantum physics was born to explain the radiation from a black body by spotting a "shot" mechanism by which matter absorbs electromagnetic energy, but it does not necessarily means that the electromagnetic radiation propagates particles or waves through space.

[15] If this is correct, we can note a difficulty of the restricted relativity. Let us imagine two systems (for example, two spacecraft) that are undergoing an equal acceleration one in direction of the other. When the force ceases, the two systems, will behave like two inertial systems; we should therefore apply special relativity and also apply the Lorentz transformations. In particular, since there is no point of reference in relativity, nor the "absolute space", an observer within each of these two systems may consider himself at rest, and he can judge moving the other system approaching him. The same shall do the observer of the other system. For special relativity, the observer at rest sees the time slow in the system in relative motion if compared to him. Therefore both observers should see the time in the other system slow down. When the two systems will meet how can they be both measured late each other? However, if we consider that both the observers are measuring time and space as the effect of the particles of the quantum vacuum vibrating in the space of separation between the two systems, the measures of time and space which they operate are both based on multiples of the same distance and the same minimum amount of time. Therefore they are equal.

On the contrary, a relativistic approach probably would solve this problem in the sense that the two systems, having experienced the same acceleration, can be considered both in motion, with the same speed, the one towards the other, so inside them the same time shall be measured. Which makes we think ... this is not so much relativistic: in fact it assumes a privileged reference external to the two systems, like the absolute space which is *a priori* of classical physics, and that the relativistic physics so much reproaches Newton.

[16] The same conclusion is implicit in the relativity theory, just try to imagine how the world would look from the point of view of a photon (it is curious that Einstein himself told that when he was a boy questioned himself how the world would appear to an observer riding a ray of light, as noted by Stachel [10]).

Instead of imagine the light moving through space-time (a fact that no experiment allows to check), if we invert the usual point of view, we can imagine the electromagnetic energy stationary and the space-time (i.e. quantum vacuum) moving at constant speed "*c*" through it. In such a scenario, the Lorentz transformations involve an infinite contraction of the space in the direction of motion and an expansion at infinity of time. This means that the distribution of energy in this two-dimensional space-time is an *objective data*, which precedes and is independent of space and time, and cannot be better described.

[17] This may be the possible way to overcome some of the paradoxes of modern quantum physics. Like, for example, the problem of the "quantum jump", so that a photon behaves as if it knew in advance will be measured as a wave or as a particle. Or also the entanglement, when two observers at any distance measure the amount of motion of two identical particles, and the measurement of one determines also the result that will be found later by the second observer, so causing an instantaneously collapse of the wave function just before the second observation.

The above hypothesis, given the distribution of energy in the universe is predetermined, means that the experiments can detect or not, according to the choices that the investigator will do, and then the modifications that he will introduce in space-time, an event, in example the position where the energy appears. However, this position is determined *ex ante,* and cannot be changed, it can only be measured, or not, according to the behavior that the experimenter gives to the matter in the space-time.

[18] Here we note that the famous experiment of Michelson and Morley which should mean that the electromagnetic interaction crosses space-time at a universal constant speed, was executed with an interferometer orthogonal arms. Given the equal length of the arms carrying the mirrors, the particles of the quantum vacuum vibrating between the two mirrors and the photographic plate detector had to be equal submultiples of the same frequency (equal to the distance between the plate and each mirror). Therefore the energy of the quantum vacuum in act in each system of the two equal arms of the interferometer was the same, i.e. equal, in both arms of the instrument, and also the same was the time delay in the transfer of electromagnetic energy.

[19] The theory of relativity describes how the same event is deformed in a system other than in which it is happening. To this extent, are used complex transformations of the coordinates of space/time, which becomes "in the Minkowski way," in special relativity, and "in Riemann way" in general relativity.

A new perspective is possible. In fact, accepting the idea that we can only measure the interaction between particles, the concept of "event" loses its own meaning. No longer makes sense, for example, to ask how the same event would be perceived by an observer in accelerated motion with respect to one in state of rest. In fact, two observers (i. e. two irradiated bodies), can never perceive the same interaction from the irradiating body.

Take the example, as simple as possible, of an atom whose electron, moving to a lower energy level, interacts with another atom, raising an electron to a higher energy level.

Seen as a specific physical phenomenon, this interaction does not produce any other effect in any other region of space/time. In fact, any other atom of any other detection device can measure a *later* vibration of the same atom, or a simultaneous vibration of *near* (but different) other atoms (which radiate as well), or a vibration *reflected* by the first atom irradiated. Really makes no sense to ask how the same event would be perceived by an observer moving with respect to the first one, or immersed in a gravitational field, because electromagnetic events measured by each of the observers, reduced to interactions between electrons, are very similar to each other, but they never are the same. Obviously, these small differences are normally imperceptible, because an event is given by electromagnetic vibrations, according to a certain sequence, of a high number of atoms of the radiating body. It is, however, easy to demonstrate that: *a*) the number of observers who can detect a phenomenon is not infinite, because when the bodies irradiated have absorbed all the energy emitted by the radiating body, no other observer will detect anything, *b*) sequences of vibration measured by different observers will never be the same: in fact, if all the energy radiated by the excited atoms of the radiating body (the whole sequence) interacts with the atoms of the body irradiated, no other instrument external to this body could detect any external phenomenon (but rather a phenomenon of reflected radiation from this body).

There is no need to change the structure of space/time. If we accept the idea that the measurable electromagnetic interactions between two bodies are never exactly reproduced on other bodies, it makes no sense to change the structure of space/time to preserve the uniqueness of the observed phenomenon, making it the same to any other observer.

Take the classic example in special relativity and put it in the simplest form. The atom *A* (part of a light source) radiates the atom *B* (which is part of a mirror) radiating along the ordinate axis of a Cartesian reference system. On the atom *C*, at rest with respect to them and a short distance from the source, we can measure two different interactions, the first from *A* and the second from *B*, separated by a time *x* ($\Delta t = x$). A fourth atom, *D*, in uniform rectilinear motion along the x-axis with respect to the system *A*, *B*, *C* measures instead a larger time interval between the two interactions ($\Delta t = x+n$), which should indicate that in the second system the time is slowing down .

Actually, *D* does not measure the same interactions detected by *C*, it is measuring instead two following interactions due to two following vibrations of the atoms *A* and *B*. Hence we have not a unique phenomenon, which in the second system must be located in a different space/time (in our case, through the Lorentz transformations): there are instead two different phenomena in a single space/time structure of Euclid-Newton.

[20] Here we can suggest a little digression. Sometimes the recent developments of quantum physics seem to lose sight of the simple and clear approach that Planck did; hence almost insoluble difficulties arise.

We can point out, for example, incoherencies in the common interpretation of the experiment with the Mach-Zehnder interferometer, that should demonstrate how a photon turn mysteriously itself in the form of particle or wave, according to the experiment we are making (see description in Penrose [6]).

According to this conceptual experiment, if a single photon is sent against a beam splitter (semi-silvered mirror or a thin sheet of transparent material), and the wave packet is therefore divided into two beams directed in perpendicular directions to many observers at the same distance, only one will detect it. If, however, both potential observers agree to reflect the received signal, redirecting it towards a second beam splitter at equal distance from each reflective apparatus, only one of the detectors placed in front of this beam splitter receive the photon, and it will always remain the same while repeating the experiment. This would make a paradox rise up: one of the observers could detect the photon as a particle, but now it behaves as a wave. In fact, if it came to the second beam splitter as a particle, it may be further divided so that both the sensors would measure, and instead, it being now a wave, creates two interferences, one destructive and one constructive, and thus only one detector can perceive it (the one on which the interference which occurs is constructive, of course).

Here we are not interested in attempting to explain the "mystery". We suggest, instead, applying original ideas at the base of quantum physics. They can lead us to a simpler view.

Quantum theory was born to explain the experimental results of the radiation from a black body through the idea that the electromagnetic energy can be emitted, or absorbed, only according to discrete quantities, which are multiples of a minimum amount, then called "photon". The photon, simply, cannot be divided into two different parts; thus the interpretation of the experiment with the Mach-Zehnder interferometer contains a contradiction with respect to the premises of the quantum, because it assumes wrongly that this is possible when you look at it as a wave train. In fact, this point of view assumes that a photon can be divided in two different wave trains. We note, on the contrary, that the photon is indivisible, and therefore can "cross" any beam splitter, but it remains one.

As a matter of fact, when performed in the laboratory, the experiment shows exactly this: there is a photon that can be detected by one of the observers placed in front of a beam splitter (the closer one, since the two optical paths are never perfectly equal, and anyway it is impossible that the particles of the quantum vacuum that vibrate in the two spaces of separation are the same in both paths, having to take account also of all the other surrounding masses).

If instead of the observers we pose the mirrors, the photon is reflected by a mirror towards the second beam splitter, obviously remains unique and it can be detected only by one of the instruments placed in front of the second separator (the closer instrument).

You might ask, if anything, this single photon how it can, if the paths are equal, to "choose" the observer or the detector, which then measures it. The answer is very simple: the idea that the paths can be the same - even if only in theory, and regardless of the insurmountable practical difficulties - it is a second mistake. When it encounters the beam splitter, the photon interacts with the first electron in its path, which determines, according to the position of impact, if it is reflected or refracted, and therefore the only direction that will take. In the same space and at the same time there cannot be two electrons, and therefore it is only one, the first that the photon encounters, what determines the direction.

[21] Sakharov [9]; Puthoff, [7]; Puthoff, [8].

[22] Einstein [1].