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CONSERVATION LAWS BASED ON PROPERTIES OF LIGHT

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From Special Relativity it is inferred that: "*to detect the relativistic changes occurring to the objects, the reference standard must not have the same kind of changes as the objects*". Only in this way, it is possible to detect and to describe, *completely*, all kinds of phenomena occurring in the system. This can be done regardless of the fact that such changes cannot be detected by "super local" observers moving altogether with the objects.

The same holds for the gravitational changes occurring to the objects *when they change of gravity (G) potentials*. Observers having identical field potential changes as the objects cannot detect these changes, the same as those due to velocity changes.

Thus, in general, to be able to describe all kinds of phenomena occurring away from the observer, it is essential to use a *reference standard has not changed in the same way as the objects*. Thence such standard must not change both of velocities and of G potentials, at least[1]. This also makes sure[2] that *the unit system used in each equation is the same for all of its quantities.* This is called here *the physical homogeneity condition*[3].

According to this, it is useful to define three cases:

a) *Super-local (SL) cases*. In these cases, the object and the observer are moving close together. Thus they have identical "velocity and potentials".

b) *Local (L) cases*. In these cases, the object and the observer are in identical "potentials". However, the object may be moving with respect to the observers.

c) *Nonlocal (NL) cases*. In such more general cases the object may be moving in field potentials different with respect to some observer at rest in some fixed potential.

According to this, it is also useful to define three different kinds of observers.

1. *A super local (SL) observer* moving together with the object. His standard and the object are bounded to have *identical velocity and G potential.*

2. *A local (L) observer.* He can describe, after theoretical methods, the changes occurring to the bodies moving in a region of *constant G potential*, with respect to his reference standard (that has not had the same velocity changes). This is the case of *special relativity*.

3. *A Nonlocal (NL) observer.* He can describe, theoretically, the changes that other NL bodies moving in different G potentials must have with respect to his standard in a fixed potential. The last one has not had the same changes of velocity and G potentials as the bodies. (The observer reference standard is in some fixed state of velocity and G potential.)

2.1 Local Relativity

2.2.1 The Michelson-Morely Experiments

In ordinary life, we are used to observe that the velocity of an object relative to us normally changes when we change our velocity relative to the object. However, in the Michelson-Morley experiments, when a similar fact was expected to occur with "light", it was found that *the superlocal speed of light (c) does not change after the changes of velocity of the measuring system* (the earth).

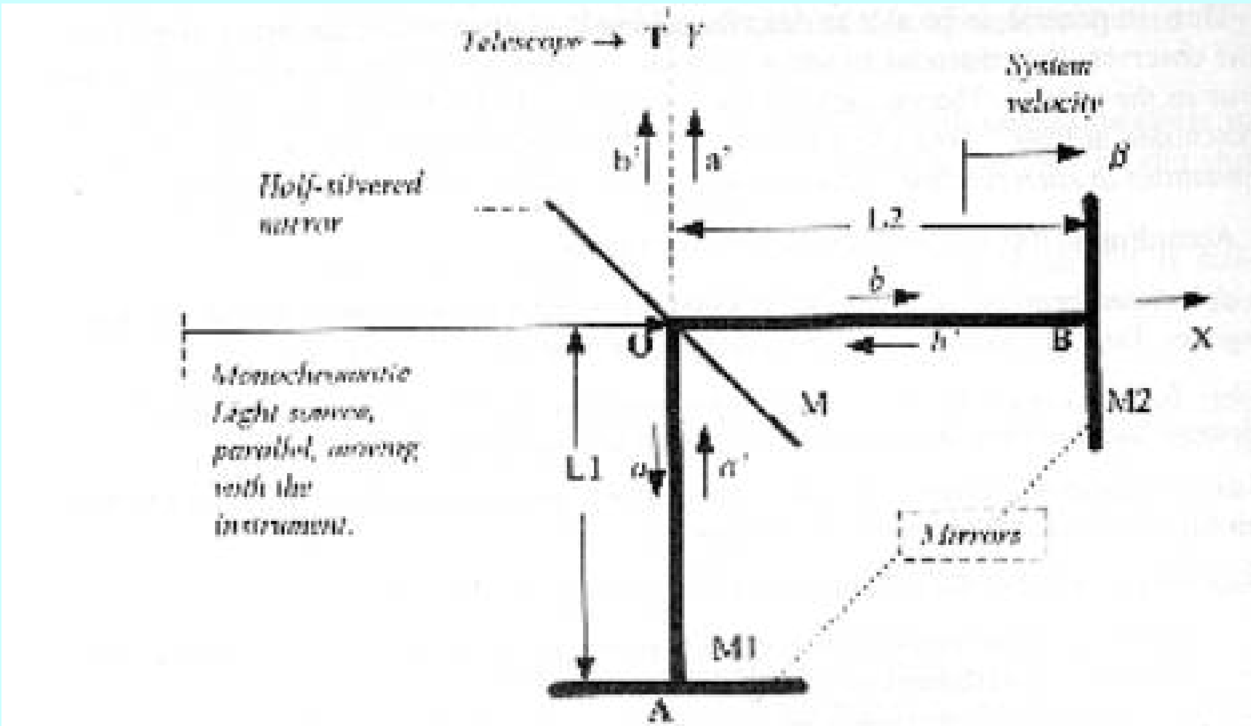


Fig. 2.1 *Diagram of the Michelson-Morley experiment after ignoring unimportant details[4].*

The negative results of the MM experiments were in clear disagreement with the classical concepts that existed in physics by the end of the last century.

To understand the physics involved in this important experiment it is necessary to realize that the instrument has two kinds of essential parts: a) uncharged matter and b) electromagnetic (EM) radiation traveling in a quasi-stationary state between mirrors.

The material parts are two arms, perpendicular to each other, with mirrors at their ends. The radiation quanta come from *a monochromatic light source that is moving altogether with the instrument*. Such radiation is divided by a half-silvered mirror into two beams, (a) and (b), that travel along the two arms. They form continuous wave trains of monochromatic radiation traveling back and forth between the corresponding mirrors. After that, the two beams (a' and b') come together and entered a telescope so as to be able to observe the result of the sum (interference) of the waves.

Any eventual change of the interference pattern could only come from an eventual difference of the number of wavelengths of light traveling back and forth along the two rods. A difference of half a wavelength would have produced a change from luminosity to darkness or vice versa. However the result of these experiments was *negative"*.

Notice that in this kind of experiment,

a) Atoms moving altogether with the instrument emit the photons. Thus, these atoms and their photons have identical changes of velocity and field potentials as the rods.

b) The radiation is in conditions identical to those of any standing wave between the mirrors.

Essentially, in a MM experiment what is measured is the difference between *the number of standing waves* in one arm (n_1), and the one in the other arm (n_2). In order that such difference can be constant for any wavelength, each number must be constant. The same conclusion comes out from the negative results coming from interferometers with arms of different lengths, carried out by Kennedy. This means that "*the number of standing waves in each of the arms do not change after the velocity changes of the system*[5]

Since these numbers independent on unit systems of any observers, "*then same numbers must be true for local and SL observers*". However, the current interpretations done by them may different.

The Super-Local viewpoint (*Classical observer*)**.**

*a) The SL lengths **L** of the rods and are normally found to be constant and independent the system velocity*[6] *and on the changes of G potentials, just because the relative values between all of the SL lengths remain unchanged. The same holds for the wavelengths of any well-defined standing wave.*

b) The constant value of the wavelengths and of the number of them, in any standing wave, makes believe in that the their frequencies have not changed. Then the local speed of light, which is equal to the product of the frequency and of the wavelength, is constant.

The Local viewpoint (*Inertial observer*)**.**

In this case, "*the observer's standard has not had the same changes of velocity that the object has had*". Then this observer can get a more general and self-consistent explanation for the relativistic changes occurring to the bodies after changes of velocity with respect to the observer the SL observer:

All of them, the lengths of the rods, and wavelengths of the radiation's, along a common orientation, do change, after the common change of velocity. They do it in the same way and in the same proportion, respectively, with respect to the fixed observer. Then every ratio between them remains constant. *This is because all of the well-defined parts of the measuring system have had identical changes of velocity and because they all obey identical physical laws.*

Something similar holds for the frequencies of the radiation.

Then the SL ratios remain constants after the common changes of velocity. This is due to the strict linearity of the changes occurring to the bodies and to the radiation in stationary states after the common velocity changes.

The Non Local viewpoint (*Super-inertial observers***)**

In this case, "*the observer has not had the same changes of* <u>*velocity and G potential*</u>" that the object has had. For him:

All of them, the lengths of the rods, and wavelengths of the radiation's, along a common orientation, do *change, after the common changes of velocity and G potentials, in the same way and in the same proportion, respectively. Then every ratio between them remains constant. This is because all of the well-defined parts of the measuring system have had identical changes of velocity and G potentials and because they all obey identical physical laws. Something similar holds for the frequencies of the radiation in stationary states.*

Then the SL ratios are constant, after changes of velocity, due to the strict linearity the changes occurring to the bodies and radiation during the common changes of velocity and G potentials.

Then the main reason for the negative results of the MM experiments is the strict linearity of all of the changes occurring, both in matter and in the radiation's, after changes of velocity and G potentials.

- Only in this way, all of the variables within his measuring system can change, in identical way and in identical proportions, respectively.
- Only in this way, every ratio between the respective values can remain unchanged.

Thus, the lack of any change found by SL observers can make *them believe* that nothing has changed after the changes of velocity and G field potentials of their measurements systems[7]. However, the truth is that "everything" is changing with respect to their previous states, reason for which such changes are not detected locally. Since SL observers moving together with their measuring systems don't know of this, they normally assign the same constant numerical values to their SL standards.

Historically, Einstein, based on the MM experiments, *postulated that* the *(superlocal) speed of light is the same in all reference frames in uniform motion*. Thus the basic relations for the relative changes that should be occurring to the objects, after changes of velocity, with respect to the fixed (inertial) observer, were found by plain mathematical methods. These relations, derived by first time by Lorentz, are called *Lorentz Transformations*.

The theory of *special relativity* has been fairly verified with experimental facts, within a wide range of velocities. Consequently, it should be accepted, definitively, that the current parameters of bodies moving with respect to some fixed observer are functions of the velocity of the bodies with respect to such observer[8]. For the above reasons, something similar, but not identical, should hold for bodies when they are moved to a G potential different from that of the observer.

2.2.2 A simplified version of the MM Experiment

From the negative result of the experiments of Michelson-Morley and Kennedy it is concluded that the same negative result should be obtained by replacing the radiation between the mirrors with radiation in stationary state. Then the same should hold for a "simplified version" of such experiment, which is made up of any stationary electromagnetic wave confined in a wave cavity formed by two perfect mirrors and a supporting rod between them.

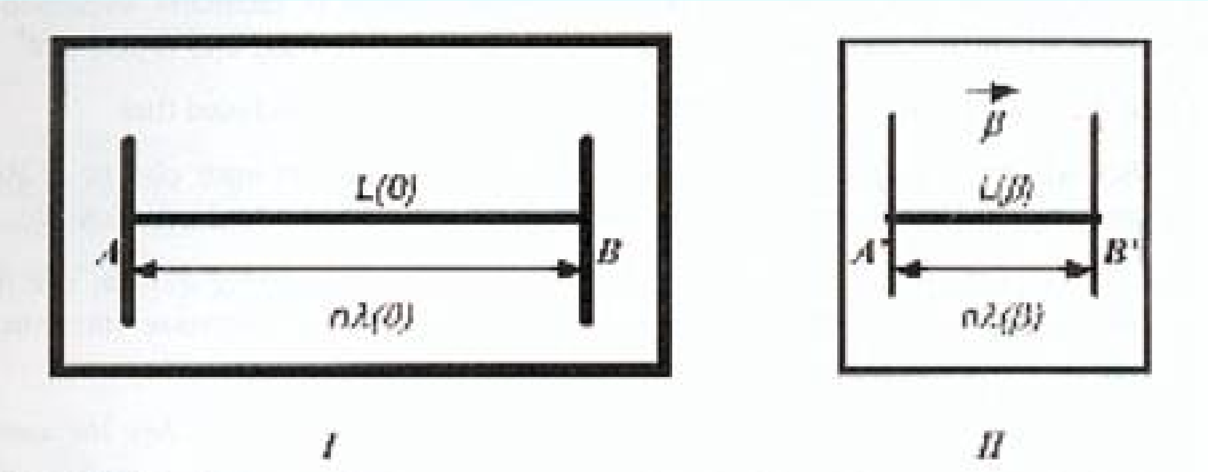


Fig. 2.2. Simplified version of the M-M experiments: a single rod with two end mirrors and light in stationary state between them. The left instrument is moving with respect to the right one with the velocity b. According to special relativity, it is contracted along the movement direction. In the two instruments, the net number of wavelengths is the same.

Indeed these experiments prove that:

The length of the rod and the wavelength of the stationary radiation, along the movement direction, must change in the same proportion, with respect to the fixed observer, after the same changes of velocity. Only in this way, the number of wavelengths (n) between them can remain invariable.

Similar property should hold for the natural frequencies of all of the particles and stationary radiation in the system, respectively. Only in this way, it is possible that the SL observer moving with the system cannot detect any single change of the number of wavelengths in any stationary radiation in his system.

2.3 The More Explicit Equivalence Principle (EEP)

The initial idea for this work was to start all over from the unquestionable and essential facts that can be learned from the negative results of idealized Michelson-Morley (MM) experiments[9].

From the results of the simplified MM experiment, it may be concluded that:

. *The rods and the stationary radiation between the mirrors must change in the same way and in the same proportion, along the same orientations, respectively.*

b. *It is not possible to detect any SL change, within a measuring system, due to changes of velocity and field potentials of such system, because every ratio between superlocal quantities remains unchanged, respectively.*

c. *Uncharged matter and stationary forms of the radiation must obey the same general physical laws. Only in this way, any local ratio within a system can remain invariable regardless of the changes that the bodies may have with respect to bodies that have not changed of velocity and potentials.*

d. *For general purposes, it is safe to assume that Matter is made up of stationary forms of radiation[10].*

e. *The Equivalence Principle turns out to be a consequence of the common nature of matter and stationary radiation.*

These points are different forms of *a more explicit equivalence principle compared with the Einstein's one.* Let us call it *Explicit Equivalence Principle (EEP)* According to it:

1. *Stationary radiation must have the same general properties of uncharged particles and vice versa.*

2. *The general physical properties of uncharged bodies are fixed by properties of radiation in stationary states*

3. *General physical principles and laws can be derived from the simplest kind of particle model made up of stationary radiation*[11].

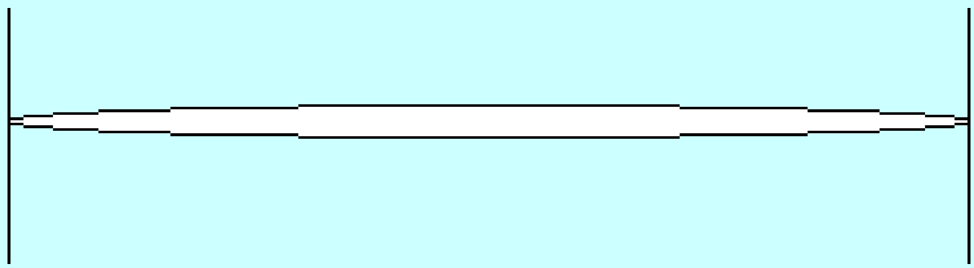
4. *The real changes occurring to the objects can only be observed, in its real magnitude, by observers that have not changed in same proportion as the objects*[12].

5. *To describe all kinds of physical phenomena, in its real and complete perspective, the reference frames must not change in the same way as the objects*.

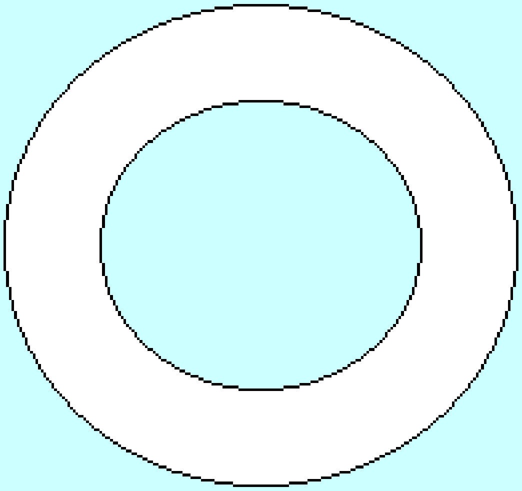
2.3.1 The Particle Model

According to the EEP, the general physical laws for uncharged bodies and for their G fields can be derived by using particle models made up of radiation in stationary state.

The idealized particle model used here is consistent with the simplified MM experiment in Fig. 2.2. This model is made up of *a single quantum of radiation in a stationary state between perfect mirrors.* They may be at the minimum standard distance of one half of the model radiation wavelength. See Fig. 2.3



(a)



(b)

Fig. 2.3 *(a). The simplest "light-box" particle model is made up of a single quantum of radiation in stationary state. Its length is a half of a wavelength. (b) A more realistic model, to the left, has a torus shape whose perimeter is just one or more wavelengths. Its NL rest masses-energy is hn(0,r). This one is like a closed optical fiber glass. Its angular momentum, derived from the corresponding law derived below, is nh/2p. This one is consistent with that of boson particles.*

For the moment it is not necessary to take into account the mirrors and eventual rods or cavities because, according to the Equivalence Principle, they must change in the same proportion as the radiation. In spite of this, the way in which radiation can be trapped into self-consistent stationary states is discussed below.

This means that *a rather new kind of physics can be based on just elemental properties of light*. In this way, these new laws are should be more exact and reliable than the conventional ones depending on hypotheses based on trial and error methods.

On the other hand, this particle model opens a new way for *unifying concepts and laws for different branches of physics*. Thus, one of the main purposes of this work is to verify that that this is so[13].

2.4 Nonlocal Relativity in Gravitational Fields

According to the Explicit Equivalence Principle, when a measuring system has changed of velocity and G potential, a SL observer moving with it cannot detect such changes. This is because all of the instrument parts, including the round trips of radiation, used for the measurements, change in the same way and the same proportion. Therefore, every SL ratio remains invariable, regardless of the changes that every part of it has had, with respect to observers that have not changed of velocity and potentials.

According to this:

Only the Nonlocal (NL) observers that have not changed in the same way as the objects can in principle detect any relativistic change

In special relativity, for example, the changes occurring to the bodies, when they change of velocity, can only be observed by (inertial) observers that have not had the same velocity changes.

In gravity, on the other hand, the changes that have occurred to bodies that have changed of G potentials can only be observed, in its real perspective, by NL *observers that have not changed of G Potentials*.

Effectively, the experiments on *gravitational time dilation*, for example, put into relief that the frequencies of atomic clocks located in different G potentials are different relative to each other, respectively. From them, it may be concluded that

Observers located in different G potentials have different unit systems. *Their standards atoms are not physically the same with respect to each othe*r

The current relations between quantities measured in different G potentials are not homogeneous, i. e., they are meaningless, without a true physical meaning[14].

*To relate quantities measured in different G potentials, according to strictly homogeneous relations, they must be previously transformed to some single unit system that have not changed of G potentia*l. Such system must be based on some single standard in some well-defined state of velocity and G potential. For this reason, here, the theoretical observers have standards at rest in some fixed G potential[15].

Conventions

Here, for objects located in G potentials different to the observer's one, the transformed quantities are called *Nonlocal (NL) quantities*[16]. Either they have been derived, theoretically, from conservative properties of light, or after using some *gravity transformations* that have been derived from experiment. The same results have been obtained from experimental tests.

Since the frequency of the observer's clock is fixed by his local G potential, then such potential, or his position, must be clearly stated. Here this has been done by adding a subscript indicating the observer's position (r*). In the case of a *central static field,* the object potentials turn out to depend only on NL positions (*r*). Thus here, for simplicity, a subscript indicates just its NL position, stated normally by *r**. This is done just for symbol simplicity.

Most of the times the NL quantities turned out to be *functions of the velocity and of the NL positions (r) of the object with respect to the observer*[17]. These variables have normally been stated, explicitly, in a parenthesis[18], just like in ordinary functions.

Here, for simplicity, only small NL time intervals are normally used. Some strictly invariable clock at rest at the observer's potential fixes them.

The NL space intervals, $Ds_{r*}(r)$ and the NL time intervals, $Dt_{r*}(r)$, are related to each other by the NL speed of light, with respect to some observer at some positions *r**, called $c_{r*}(r)$:

The velocity of a body is normally stated as a ratio between the body velocity and the speed of light with respect to the same observer, = $V_{r*}(r)/c_{r*}(r)$. Since such ratio is non-dimensional, this one is independent on the kind of unit systems. Thus *b* does not depend on the observer's potential.

In the local case, according to the Explicit Equivalence Principle, the "*local*" *speed of light* is constant, in any position *r*

$$c_r(r) = \frac{ds_r(r)}{dt_r} = \nu_r(r)\,\lambda_r(r) = \nu\lambda = c \quad (constant)$$

E2.1a

Below it is proved that the NL speed of light and the NL refraction index of the space, in a potential different with respect to the observer are not universal constants[19].

$$c_{r*}(r) = \frac{ds_{r*}(r)}{dt_{r*}} = \nu_{r*}(r)\,\lambda_{r*}(r) \neq c$$

E2.1b

2.4.1 Atomic clocks and basic local standards

Using atomic clocks whose frequencies are fixed by some well-defined atomic oscillation normally makes the most exact time measurements. In principle, the same can be done after using the natural frequency of any spectrum line of the same atom. Thus, "one second" is a well-defined multiple of the period of one standard photon.

According to the particle model, *the eigen-frequencies of the atoms are similar to the well-defined harmonics of wave cavities or strings*. Thus the frequencies of the radiation's emitted by these bodies are related to each other by universal constants. This is obviously consistent with the atomic spectrums.

Thus the fraction of mass-energy lost by an atom after the emission of a standard photon is a non dimensional (universal) constant. *Such constant is the same for local and nonlocal observers*, regardless of the differences between their unit systems. This means that:

$$\frac{\Delta m A_{r*}(0,r^*)}{m A_{r*}(0,r^*)} = \frac{h\nu_{r*}(0,r^*)}{m A_{r*}(0,r^*)} = \frac{h\nu_{r*}(0,r)}{m A_{r*}(0,r)} = \frac{\Delta m_{r*}(0,r)}{m A_{r*}(0,r)} = f = constant$$

E2.2

Thus, *the NL frequency of a single photon is just a small and well-defined (universal) fraction of the NL mass-energy of the atom that emitted it*.

This is most important because any change of the NL rest mass of an atom, due to changes of G field potentials, must be associated to a change of the NL frequency of the radiation's emitted by such atom. This one must occur in just the same proportion, and vice versa.

2.5 Conservation Laws from Wave Continuity

2.5.1 Wave continuity.

The main conservation laws can be found in a rather trivial way from wave continuity of monochromatic radiation. Assume in Fig. 2.4 that an observer has a local *antenna AB made up of a small wire* located in some fixed position *r**.

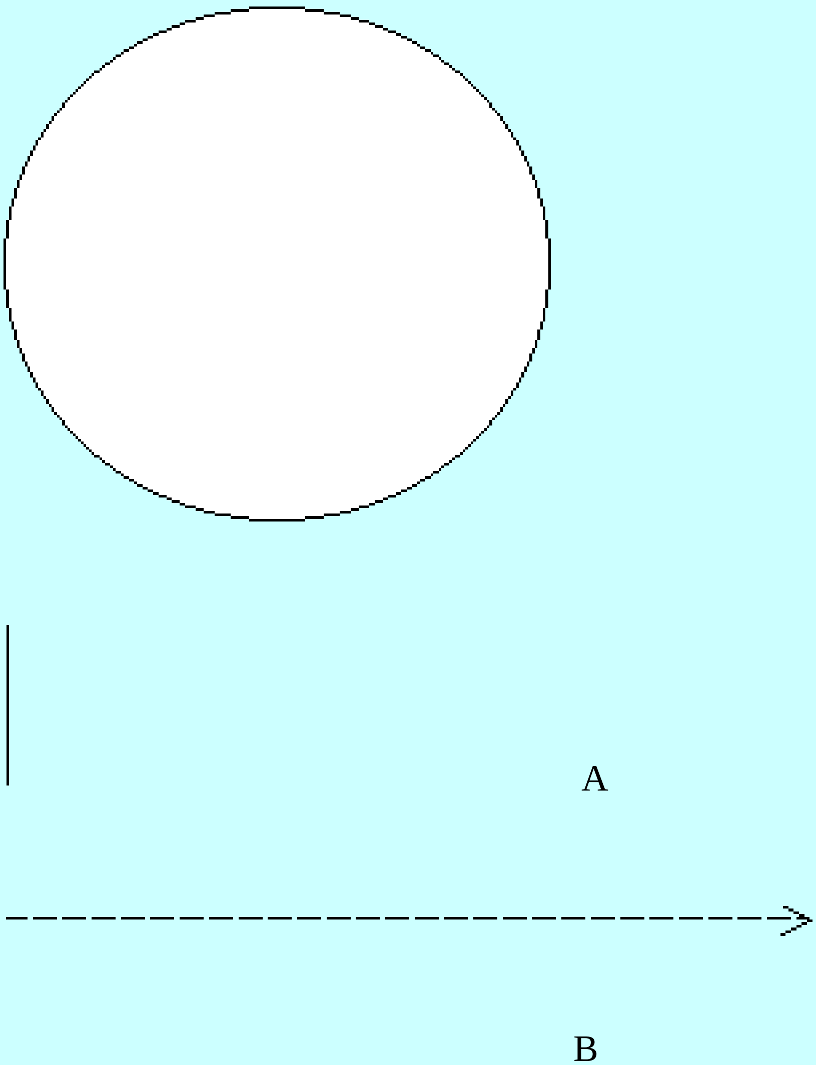


***Fig. 2.4 Conservation** of the number of waves of a wavetrain emitted by an antenna AB. The number of waves or cycles (n) crossing static spheres of arbitrary radius is constant (n).*

Assume that the antenna electrons are forced to oscillate, periodically and continuously, a certain number (*n*) of cycles *in just one second*$_{r*}$.

It is a well-known fact that electrons emit a continuous wavetrain of electromagnetic (EM) radiation and that the net number of waves in such wavetrain *(n)* is just equal to the number of electron oscillations. Each wave corresponds to a *round trip* of the antenna electrons, which in turn produce a (closed) *cycle* of field changes around it. These field changes propagate themselves, continuously, with the NL speed of light.

2.5.2 Wave's number conservation

"According to "wave continuity" the *net number of waves of such wave train is conserved during its trip throughout conservative fields*. In principle, the waves can change in amplitude *but they cannot suddenly disappear*.

Each wave crossing a static plane corresponds to a well-defined "*cycle*" of the radiation. According to "wave continuity", the net number (*n*) of the charge oscillations per second, along the wire, must be just equal to the net number of waves (or cycles) per second that are crossing any static sphere around the antenna. This holds regardless of the G potentials existing in such sphere and regardless of the wave amplitude at such position. *This number is non-dimensional* and, therefore, it does not depend either on measurement units or on the observer's position.

According to this, the observer in the antenna position (*r**) can predict, without measuring, that soon or later *the same number of waves (or cycles)* will cross any arbitrary static sphere of NL radius *r* around him.

$$n_{r*}(r^*) = n_{r*}(r) = n = constant \qquad E2.3$$

This rather obvious fact may be called wave's (or cycles) number conservation[20].

According to this, the gradients of static conservative fields cannot change the number of wavelengths of such wave train, in spite of the eventual changes of amplitude or wavelengths that they may have during refraction phenomena. Each wave or cycle is like a well-defined *light signal*[21]. It is like the wagon of a train. *It cannot just disappear or appear in the empty space*.

This conservation law does not depend on the changes of direction (refraction) that photons may have during their trip throughout gradients of "static" conservative fields. In a similar way, reflections in static mirrors also conserve the photon frequencies.

2.5.3 Nonlocal frequency conservation

Assume now that the antenna emits a continuous wave of constant frequency. For the observer in the antenna position (r*), the local frequency of the electric charges is equal to the local frequency of the radiation emitted by it.

$$\nu_{r*}(r^*) = \frac{n}{\Delta t_{r*}} = n\left[\frac{cycle}{second_{r*}}\right] \qquad \Delta t_{r*} = 1\ second_{r*}$$

E2.4

The second member stands out the facts: a) that the numerator is the non-dimensional constant number of antenna cycles, and b) that the denominator depends only on the observer's clock rate. The last one, in turn, depends only on the NL position *r** of the observer. For this reason, the *frequency and the time intervals have a subscript r*.*

According to *wave's number conservation*, the net number of waves crossing any plane static with respect to the antenna, in the same time interval of the clock at r* is also the same. This is because not a single wave can just disappear, or just appear. Thus, in particular, *the number cycles that would cross any static sphere, of any NL position r, in each second of the clock of the observer at r** is, from E2.3 and E2.4,

$$\nu_{r*}(r) = \frac{n}{\Delta t_{r*}} = \frac{n}{1_{r*}} = \nu_{r*}(r^*) = Constant$$

E2.5

The fourth member is the particular case of the *local* frequency of the free radiation at *r**, with respect to the local clock[22]. This means that

The NL frequency of the radiation with respect to a strictly invariable clock (observer) remains constant during its trip through ordinary conservative fields[23]. (*NL frequency conservation law for radiation*).

2.6 General Properties of a Single Quantum

2.6.1 The quantum energy

For very weak intensities of a light beam, its energy is not continuously distributed in the space-time. It is divided in rather well defined parts propagating themselves with the speed of light. Such parts are normally called *quanta* or *photons.* When the number of them is not too large, one can count them by using instruments like photon counters and photo multipliers. Thus, the energy *E of each photon* can be obtained, for example, either by dividing the beam energy by the number of counts or by using proportional counters and pulse-height analyzers. The interesting point here is that *the ratio between the energy E and the frequency is the same for any kind of quantum, regardless of its frequency or polarization.* This is a universal constant called *the Planck constant*.

$$h = \frac{E}{\nu} = 6.625x10^{-34}$$ E2.6

Here, since we are starting all over from radiation's properties, *the local photon energy is, by definition, the multiple h of its frequency.*

Notice that the properties of a single quantum are better defined (quantized) compared with those of a light beam containing a non well-defined number of them. For this reason, it is more precise to talk about the *quantum energy or quantum frequency* instead of just energy or frequency. For the same reason, the most elemental unit of for frequency could be *one quantum cycle (QC) per second of the local clock* that may be called one *Quantum Hertz* (*QHz*). Thus, from E2.6, one[*QHz*] corresponds to energy equal to $6.6x10^{-34}$ *joule*.

Here, for reasons of correspondence with ordinary physics, the common unit used for mass and energy, "called *mass-energy unit*" is *one* [*joule*], which is equal to $1.5x10^{33}$ [*QHz*].

2.6.2 The wavelets associated to a single quantum

The most important properties of radiation's can be learned from *interference and diffraction experiments* done with a monochromatic beam of photons that are traveling as nearly parallel wave fronts. When they pass through two small slits, for example, the photons are deviated by the slits in different orientations thus forming, in the average, some patterns of dark and light zones that are characteristic of continuous wave phenomena. One important detail is that

When the light intensity is so low that only single photons can pass through the slits, they are also deviated, statistically, in similar orientations as in the experiments made up with a large number of photons. Thus if we sum up the results of a large number of experiments done with single photons, the composite interference or diffraction pattern is the same as that carried out with ordinary monochromatic light.

Then, from such experiments it may be concluded that:

1. The wave properties of light beams must be due to wave properties each of its photons.
2. *A single quantum of radiation must have a more elemental kind of wave structure.* Historically, these more elemental waves have been called **wavelets**.
3. The *wave continuity* of light must be due to *wavelet continuity*.
4. According to the Huygen's principle, each photon should be the result of the interference of a large number of wavelets of that are in phase with respect to each other just at the photon position.
5. For the same reason, a photon must also the apparent source of wavelets that are actually with random phases, with respect to each other, in the rest of the space. Coherent phases would occur just in the photon position.
6. According to the interference rules, *the wavelets are not destroyed during the interference with other wavelets*, i.e.; they must have the property of "wave continuity". Then they must travel rather indefinitely in the free space.

According to the EEP and the last point, the space must be crossed by a high density of "random-phase" wavelets coming from radiation that are either free or confined in the universe particles. The universe should be like a "wavelet sea", rather densely populated with random wavelets traveling in all directions, most of the times interfering destructively, in the so-called empty space, and constructively in radiation's and particles.

A photon or a particle must be just a temporal locus of constructive interference a relatively reduced number of wavelets compared with the large number of wavelets with random phased coming from the rest of the universe.

From long time ago, such wavelets have been successfully used in optics and, tacitly, in quantum electrodynamics. According to the Explicit Equivalence Principle, they should account, in a unified way, for the largest number of phenomena in physics just because they would be the most elemental realities in the universe[24]. This is something that is proven below, roughly, for quantum mechanics and gravity.

2.6.3 NL conservation laws for radiation's in conservative fields

From NL frequency conservation given by E2.4, and the point **1**, it is obvious that, in general:

a) The NL frequency of conservation of light is a consequence of NL frequency conservation of single photons, with respect to some fixed clock of constant frequency.

b) The NL frequency conservation law for photons is a consequence of the wave continuity of each of its wavelets.

c) The photon NL energy is constant during its trip in static conservative fields.

d) Photons do not exchange energy with strictly static conservative fields. This may be called the no energy exchange Law

These properties correspond with the facts observed even in static gravity fields, as proved below.

2.6.4 The Nonlocal dual vectors

A free quantum normally travels in some well-defined orientation. *It's NL frequency* is, by definition, the virtual rate at which the coherent quantum wavelets (or quantum cycles) are crossing some plane perpendicular to its propagation direction, with respect to the clock of some fixed observer at r*. This property is more completely described by a single NL *vector* oriented in the direction of quantum propagation. Its absolute value is the NL frequency with respect to the observer at *r**.

$$\nu_{r*}(r) = \frac{\Delta n}{\Delta t_{r*}}\left[\frac{quantum - cycle}{second_{r*}}\right] = n_{r*}\left[quantum - Hertz_{r*}\right] \qquad \text{E2.7}$$

This one is called here the *quantum's NL frequency vector (with respect to the observer at r*).*

Notice that "the local properties of a quantum with respect to the observer are fixed by *just* this vector" (neglecting, for simplicity reason, its polarization).

It is also useful to define a "*Nonlocal quantum vector*" equal to the multiple *h* of its NL frequency vector. Because in this way its value just proportional to its *NL momentum* and its modulus is just its *energy*:

$$\vec{q}_{r*}(r) = h\,\vec{\nu}_{r*}(r) = \vec{p}_{r*}(r)c_{r*}(r) \qquad E_{r*}(r) = \left|\vec{q}_{r*}(r)\right| \qquad \text{E2.8}$$

During a quantum cycle, the quantum propagates itself parallel to the quantum vector. Then it is useful to define *a NL quantum wavelength vector* whose absolute value is its NL displacement after a single quantum cycle. *Then the NL speed of light* is the scalar product of its frequency and wavelength vectors, called here *dual vectors*.

$$c_{r*}(r^*) = \vec{\nu}_{r*}(r^*)\bullet\vec{\lambda}_{r*}(r^*); \qquad c_{r*}(r) = \vec{\nu}_{r*}(r)\bullet\vec{\lambda}_{r*}(r) \qquad \text{E2.9}$$

From NL frequency conservation, the absolute value of this vector remains constant during its free propagation in static conservative fields. However, according to the Huygen's principle, its orientation may change due to refraction phenomena, after a gradient of NL speed of light, without changing its absolute value, i.e., according to NL frequency conservation.

Locally, the quantum momentum is proportional to its quantum vector, because:

$$p = \frac{h}{\lambda} = \frac{h\nu}{c} = \frac{q}{c} \qquad \text{E2.10}$$

2.6.5 The unit system based on quantum properties

According both to the equivalence principle and to the model nature, the most elemental kind of unit system can be based on the properties of some *standard quantum* emitted by a local standard atom *at rest.*[25]

The local *mass-energy unit* can be a multiple of its frequency .... *m µ h n.*

The local *time unit* can be a multiple of its period...........................*T µ* n^{-1}.

The local *length unit* can be a multiple of its *wavelength*............*l µ* cn^{-1}.

Notice that "*the differences between the unit systems of observers at rest in different G potentials depend, ultimately and exclusively, on frequency differences. Such differences can be determined from just "G time dilation experiments*".

Here, to simplify and to find easy correspondences with the *mks unit system*, the joule is used as common unit of mass and energy (mass-energy). This is called *mjs system.* Its units are related to any standard photon frequency by universal constants.

$$1\,joule = N_1 \nu; \qquad 1\,meter_{r*} = \frac{N_2}{\nu}; \qquad 1\ sec_{r*} = \frac{N_3}{\nu}. \qquad \text{E2.11}$$

N1, *N2*, and *N3* are non-dimensional (universal) constants. Thus, they do not change after a change of the observer position in a G field. However, the NL frequency does change, according to GTD experiments.

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[1] For simplicity, the language here is a plain generalization of the language and reference frames used in SR

[2] This precaution comes from the well-known fact that matter is not strictly invariable under changes of velocity and under changes of G potentials.

[3] Otherwise, if the standards and the objects change in same way as the objects, any the ratio between their quantities would remain invariable thus preventing the possibility for describing or detecting the real changes occurring to the bodies

[4] For simplicity, let us ignore unimportant details of these experiments.

[5] It is important to notice that this number is non-dimensional and, therefore, it does not depend on unit systems. This is the same for all kinds of observers.

[6] He cannot realize of the changes occurring to his rule and his rods, relative to the NL observer, because those changes occur in identical proportion in all of the SL bodies. For this reason, and for practical purposes, all of the SL observers assign the same numerical values to their standards. Something similar occurs with the frequencies of the atomic emissions and with the clock frequencies.

[7] It is important to keep in mind that the invariability of the speed of light is a consequence of the fact that everything in the system *changes in same way and same proportions, after the same changes of velocity and field potentials, with respect their original values*. Only in this way, every respective ratio can remain unchanged.

[8] According to the Lorenz transformations, all of them, the length of the rod, the average wavelength and the average frequency of the radiation, and the mass of the atoms in the box II, moving with the velocity with respect to the observer at rest in the box I, are related each other and to the velocity by;

[9] *A more exact definition of G potential is done below*. For the moment, let us accept that the possibility that properties of the space are not the same anywhere and that they are a function of the position (*r*). Such function is called NL potential.

[10] Notice that this case is similar to the stationary waves within a *laser wave cavity*.

[11]This is a fact that can be verified below, mainly for special relativity, quantum mechanics and gravity

[12] Effectively, such changes have been detected by observers that have not had the same object changes of *velocities and G potentials.* They have not been observed in *electric fields.*

[13] This model is consistent with the phase locked cavities used by Jennison-Drinkwater[10]

[14]It is probable that earlier attempts to use this particle model may have failed if they have not used a strictly homogeneous language, as the one used here. Only in this way, it is possible to describe, all kinds of changes that the stationary radiation may have after changes of velocity and G field changes.

[15] In experiments, such constant potential can be approximately true for an observer far away from the regions of maximum field changes.

[16] These quantities correspond with the *unrenormalized quantities* used by W. Thirring[11]. and P. Rastall[12].

[17] Here, for simplicity, polarization has been not taken into account.

[18] The subscript of the variables in the parenthesis of a function has been omitted because it is evident that these quantities are referred to the same unit system of the function.

[19] This is due to the fact that the unit systems of the observers at *R and R** are different *relative to each other*.

[20] Since these cycles are well defined *happenings* for all of the NL observers *at rest relative to each other, this fact* may also be called "*the happening number conservation*". This one is consistent with the fact that "*the happenings in the universe occur regardless on whether or not we can observe them*

[21] Notice that the old method of sending light signals is still the most reliable base for exchanging information between observers located in different G potentials.

[22] This constant has a subscript *r** just to make clear that this constants have only "local validity." observers in different potentials would observe different constants because their clocks run at different rates relative to each other.

[23]It is important to keep in mind that this law holds for any strictly conservative field.

[24] For example, the paradoxes like the Einstein-Podowsky-Rosen (EPR) come from the fact that we normally *believe* in that photons and particles elemental objects rather isolated from the rest of the universe[24]. *They would be no paradoxes if we realize that the more elemental realities in the universe are not the particles nor the photons but the more elemental kinds of wavelets.*

[25] *Here writing down a zero for the velocity in the parenthesis states the rest condition.*