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ON EINSTEIN'S PROGRAM AND QUANTUM THEORY

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Abstract

The Einstein's program forms a consistent system for universe description, beside the standard model of particles. It is founded upon a scalar field propagating at speed of light *c*, which constitutes a common relativist framework for classical and quantum properties of matter and interactions. Matter corresponds to standing waves. Classical domain corresponds to geometrical optics approximation, when frequencies are infinitely high, and then hidden. Quantum domain corresponds to wave optics approximation. Adiabatic variations of frequencies lead to electromagnetic interaction constituted by progressive waves. It leads to theoretical economy for Quantum Theory, with unification of first and second quantifications for interactions and matter, to the wave-particle duality by reduction of the introduced amplitude space-like function $u(r, t)$, which completes the usual time-like function $\psi(r, t)$, with hidden variables.

1. Introduction

For the physicists, the whole universe is nowadays described by the Standard Model of particles, which forms a consistent theoretical system. In addition to special relativity, it is based upon quantum mechanics, in a probabilistic framework. It is constituted by matter interacting through three different kinds of forces. They are all

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composed of fundamental particles which derive from relativist quantum fields, and behaving either as waves or as particles. The Standard Model has been validated in 2012 by the B.E.H., or Higgs, boson detection, which represents its crowning. Since it does not include gravitation, it describes only a partial aspect of the universe.

Until now, gravitation has resisted to its theoretical quantification. It is well described by general relativity, based upon a continuous field in a classical framework [1-5]. It has been widely confirmed by numerous experiments and by its theoretical consequences and practical applications. The graviton, as quantum particle mediating gravitation interaction, has not yet been experimentally detected and validated [6, 7]. On another hand, quantum field theories of gravity generally break down theoretically before reaching the Planck scale, which determines the limit between the wave and particle behavior of quantum particles [8]. We may conclude that the discrepancy between quantum mechanics and general relativity leans on the wave particle duality, together with the classical deterministic or quantum probabilistic approaches.

In extension of general relativity and of his different discoveries, including in quantum physics, such as the stimulated emission, Einstein had proposed a consistent approach for physics, symmetrical to the standard model. He privileged a classical continuous field. "*We have two realities: matter and field. … We cannot build physics on the basis of the matter concept alone. But the division into matter and field is, after the recognition of the equivalence of mass and energy, something artificial and not clearly defined. Could we not reject the concept of matter and build a pure field physics? … We could regard matter as the regions in space where the field is extremely strong. In this way a new philosophical background could be created. … Only field-energy would be left, and the particle would be merely an area of special density of field-energy. In that case one could hope to deduce the concept of the mass-point together with the equations of the motion of the particles from the field equations- the disturbing dualism would have been removed. … One would be compelled to demand that the particles themselves would everywhere be describable as singularity free solutions of the completed field-equations. … One could believe that it would be possible to find a new and secure foundation for all physics upon the path which had been so successfully begun by Faraday and Maxwell.*" [1]. The Einstein's Program has been supported, and validated, by the International Legal Metrology Organization. The speed of light in vacuum is admitted as a "pure", or primary, fundamental constant in experimental physics, with its numerical value strictly fixed, and the standard for measures of time is based on the period an electromagnetic wave frequency.

In previous articles [8-12], we showed how the Einstein's program forms a consistent system for universe description, beside the standard model. It allows us to complete the universe grasp, like both eyes give us access to tri-dimensional vision, or both ears to stereophonic audition. It founds upon a scalar field propagating at light velocity. Matter corresponds to standing waves, and electromagnetism, as a quantum interaction, to their adiabatic variations. In the geometrical optics approximation, when frequencies are infinitely high, the oscillations are hidden.

In this article, we propose to show how the Einstein's program permits to retrieve the main basic equations of quantum mechanics, like Schrödinger's equation, Dirac's distribution, Heisenberg's relations, resulting from adiabatic variations or almost standing waves.

2. The Einstein's Program

We restrict to summarize some equations deduced from Einstein's program [8-12], in order to show how they are related to main equations of quantum mechanics, otherwise widely documented.

2.1. Standing field kinematics

Starting from a scalar field ε propagating at light velocity c, we are assured that whole following consequences are relativistic. The general harmonic solutions of the d'Alembertian's equation

$$\varepsilon = \Delta\varepsilon - (1/c^2)(\partial^2\varepsilon/\partial t^2) = 0, \qquad \partial^{\mu}\partial_{\mu}\varepsilon = 0 \tag{1}$$

may be reduced to two kinds of elementary ones, according to their kinematic, or their geometric, properties. We find progressive waves, with constant frequency $\omega = kc$, propagating at speed of light in opposite direction, like $\cos(\omega t \pm kx)$, and standing waves of the form $\varepsilon_0(x_0, t_0) = u_0(k_0 x_0)\psi_0(\omega_0 t_0) = \cos(\omega_0 t_0)$ $\cos(k_0 x_0)$. The separation of variables for space and time expresses that they oscillate locally, defining then a system of coordinates at rest (x_0, t_0). The functions

$u_0(k_0x_0)$ and $\psi_0(\omega_0t_0)$ being independent, the frequency ω_0 is necessarily constant in $(1/u_0)\Delta_0u_0 = (1/\psi_0)(\partial^2\psi_0/c^2\partial t_0{}^2) = -k_0{}^2 = -\omega_0{}^2/c^2$. Progressive and standing waves can be considered either as basic, or as composed from others since

$$\cos(\omega_0t_0 + k_0x_0) + \cos(\omega_0t_0 - k_0x_0) = 2\cos(\omega_0t_0)\cos(k_0x_0), \tag{2}$$

$$\cos(\omega_0t_0)\cos(k_0x_0) + \sin(\omega_0t_0)\sin(k_0x_0) = \cos(\omega_0t_0 - k_0x_0). \tag{3}$$

When the frequencies of opposite progressive waves are different in a system of reference (x, t),

$$\cos(\omega_1t - k_1x) + \cos(\omega_2t + k_2x) = 2\cos(\omega t - \beta kx)\cos(kx - \beta\omega t), \tag{4}$$

by identification with (2), they form a standing wave with main frequency $\omega_0 = \sqrt{\omega_1\omega_2}$ at rest, becoming $\omega = (\omega_1 + \omega_2)/2 = kc$, in motion with a speed $v = \beta c = (\omega_1 - \omega_2/\omega_1 + \omega_2)c$, leading to the Lorentz transformation between the systems of reference (x_0, t_0) and (x, t), and to its whole consequences.

The geometric properties of standing waves are described by the function of space $u(k_0x_0)$, which obeys the Helmholtz's equation $\Delta_0u_0 + k_0{}^2u_0 = 0$. Its solutions verify Bessel spherical functions, and particularly its simplest elementary solution, with spherical symmetry, finite at origin of the reference system, and representing a lumped function,

$$u_0(k_0r_0) = (\sin k_0r_0)/(k_0r_0). \tag{5}$$

In geometrical optics approximation, when the frequency is very high and tends towards infinity $\omega_0 = k_0 \to \propto$, the space function u_0 tends towards Dirac's distribution $u_0(k_0r_0) \to \delta(r_0)$. The standing wave of the field behaves as a free classical material particle isolated in space.

From a kinematical point of view, the central extremum of an extended standing wave, either at rest or in motion, is appropriate to localize its position x_0, exactly like the centre of mass for a material system. It verifies, for instance from (5),

$$\nabla_0u_0(x_0) = 0. \tag{6}$$

The four-dimensional Minkowski's formalism traduces invariance properties of standing waves at rest, when they move uniformly. Confirmation is found into invariant quantities obtained from four-quantities, such as coordinates $x_\mu x^\mu = x_0{}^2$ or $x_\mu x^\mu = c^2 t_0{}^2$, and functions $u_\mu u^\mu = u^2(x_0)$ or $\psi_\mu \psi^\mu = \psi^2(t_0)$. Their space-like or time-like characters are absolute, depending of their referring quantities defined in the rest system, in which the variables of space and time are separate.

In order to point out their constant frequency, we express them as

$$\varepsilon(\omega t,\, kx) = u(kx,\, \beta\omega t)\exp i(\omega t - \beta kx), \quad \varphi = \omega t - \beta kx. \tag{7}$$

In special and general relativity, the equations are based on mass-points, as singularities, moving on trajectories. They lean then directly upon geometrical optics approximation. The periodic equations, generic of standing fields, are hidden. The space coordinates x_α, involved in the metric, are point-like dynamical variables, and not field variables *r* which would describe an extended repartition in space. Then, the kinematic properties for standing waves of a scalar field propagating at light velocity *c*, with constant frequency ω and velocity *v*, are formally identical with mechanic properties of isolated matter. The Lorentz transformation is specific of standing waves with respect to progressive waves [10].

2.2. Standing field dynamics

All above equations are unlimited with respect to space and time, since *x* or *t* may become infinite. Usually, one imposes boundary conditions, in which matter acts either as a source fixing the frequency ω, or as a detector annealing it, as well as a geometrical space boundary fixing the wavelength λ through $k = 2\pi/\lambda$. This is not felicitous from relativistic consistency, since space and time operate separately. In addition, matter is heterogeneous with respect to field. In order to remain in homogeneous frame, we rather consider boundaries provided by wave packets. Two progressive waves with different frequencies ω_1, ω_2 propagating in the same direction at light velocity, give rise to a wave packet propagating in the same direction at light velocity, with a main wave with frequency $\omega = (\omega_1 + \omega_2)/2$, modulated by a wave with frequency $\beta\omega = (\omega_1 - \omega_2)/2 = \Delta\omega/2 = \Delta kc/2$ and wavelength $\Lambda = 2\pi/\beta k$ and period $T = \Lambda/c$. Since $\beta < 1$, the modulation wave acts as an envelope with space and time extensions $\Delta x = \Lambda/2$, $\Delta t = T/2$, leading to well known Fourier relations $\Delta x.\Delta k = 2\pi$ and $\Delta t.\Delta\omega = 2\pi$.

Then, Fourier relations represent homogeneous boundary conditions for the scalar field ε. From a physical point of view, they must be associated with the d'Alembertian's equation (1) in order to complete them, emphasizing that the field cannot extend to infinity with respect to space and time.

When the frequencies difference $\beta\omega = (\omega_1 - \omega_2)/2 = \Delta\omega/2 << \omega$ is very small, it can be considered as a perturbation with respect to the main frequency, $\beta\omega = \delta\omega$. Then a wave packet can be assimilated to a progressive monochromatic wave with frequency $\Omega = \omega \pm \delta\omega$, inside the limits fixed by the component frequencies $\omega_1 = \omega + \delta\omega$ and $\omega_2 = \omega - \delta\omega$. By difference with standing waves frequencies, which must be constant and monochromatic, progressive fields solutions of (1), may be more complex, with frequencies varying with space and time. An almost monochromatic wave is characterized by a frequency $\Omega(x, t)$, varying very slowly around a constant ω

$$\Omega(x, t) = K(x, t)c = \omega \pm \delta\Omega(x, t), \quad \delta\Omega(x, t) << \omega, \quad \omega = \text{constant}. \tag{8}$$

From a physical point of view, we recognize the definition of an adiabatic variation for the frequency [13]. We can then expect that all following properties of almost fields occur inside such a process. Instead of admitting a constant frequency ω of elementary waves propagating all over space-time as given data, we rather consider that it represents the mean value, all over the field, of different varying frequencies $\Omega(x, t)$. In other words, the modulation waves with perturbation frequencies $\delta\Omega(x, t)$, propagating at light velocity, behave as interactions between main waves, leading that their mean frequency ω remains practically constant all over the space-time [10].

From a mathematical point of view, almost field properties derive from monochromatic ones, through the variation of constants method (Duhamel principle). Accordingly, following (8), an almost standing wave obeys,

$$\varepsilon(x, t) = U(x, t)\exp i\Phi(x, t), \quad \Phi(x, t) = \Omega(x, t)t - \mathbf{K}(x, t).\mathbf{x} + 2n\pi, \tag{9}$$

where products of second order $\delta\Omega dt \approx 0$ and $\delta\mathbf{K}.d\mathbf{x} \approx 0$, defined modulo 2π, are neglected at first order of approximation. This is equivalent to incorporate, in almost monochromatic solutions, the boundary conditions defined by Fourier relations.

$$d\Phi(x,t) = \Omega(x,\, t)dt - \mathbf{K}(x,\, t).d\mathbf{x} \approx \omega dt - \mathbf{k}.d\mathbf{x}, \quad U(x,t) = u(x,\, t) \pm \delta U(x,\, t). \tag{10}$$

According to (1), $\varepsilon(x,\, t)$ in (9) verifies,

$$\partial^{\mu}\partial_{\mu}U - U\partial^{\mu}\Phi\partial_{\mu}\Phi = 0 \quad \text{or}$$

$$\partial^2 U / c^2\partial t^2 - \nabla^2 U - U[(\partial\Phi / c\partial t)^2 - (\nabla\Phi)^2] = 0, \tag{11}$$

$$\partial^{\mu}(U^2\partial_{\mu}\Phi) = 0 \quad \text{or} \quad \partial(U^2\Omega)/c^2\partial t + \nabla.(U^2\beta\mathbf{K}) = 0. \tag{12}$$

These relations apply to progressive waves for $\beta = \pm 1,$ to standing waves at rest for $\beta = 0$ and in motion for $\beta < 1,$ to monochromatic waves for ω and $\mathbf{k}$ constant, to almost monochromatic waves for varying $\Omega(x,t)$ et $\mathbf{K}(x,t).$ They lead to dynamical properties for energy-momentum conservation, and to least action principles, for standing fields and almost standing fields [8-12].

For a standing wave with constant frequency $\delta\Omega(x,t) = 0,$ either at rest or in motion, (12) reduces to

$$\partial u_0{}^2 / \partial t_0 = 0, \quad \partial u^2 / \partial t + \nabla.u^2\mathbf{v} = 0 \quad \text{or} \quad \partial_{\mu}w^{\mu} = 0, \tag{13}$$

where $w^{\mu} = (u^2,\, u^2\, \mathbf{v}/c\,) = u_0(x_0)^2(1,\, \mathbf{v}/c\,)/\sqrt{(1-\beta^2)}$ is a four-dimensional vector. This continuity equation for u^2 is formally identical with Newton's equation continuity for matter-momentum density

$$\partial\mu / \partial t + \nabla.\mu\mathbf{v} = 0, \quad \text{with} \quad u^2 = \mu c^2. \tag{14}$$

We are led to admit, by transposition, that u^2 represents the energy density of the standing field.

Following relations (5) and (6), in the spherical symmetry case, for its kinematical behavior, the space function u_0 can be reduced to its point-like centre of energy density whose position x_0 is such that

$$\nabla_0 u_0{}^2 = 0, \quad \nabla u^2 + (\partial u^2\, \mathbf{v}/ c^2\partial t) = 0, \quad \nabla\times\mathbf{v} = 0, \quad \text{or}$$

$$\pi^{\mu\nu} = \partial^{\mu} w^{\nu} - \partial^{\nu} w^{\mu} = 0. \tag{15}$$

Since u^2 is a standing wave energy density spread in space, and then a potential energy density, $\mathbf{F} = -\nabla u^2 = -\nabla w_P$ is a density force, and $\partial u^2 \mathbf{v} / c^2 \partial t$ a density momentum, while $\pi^{\mu\nu}$ is a four-dimensional force density.

Equation (15), in which energy density w^{μ} is a four-gradient $\partial^{\mu} a$, is mathematically equivalent to the least action relation

$$\delta \int da = 0, \quad \delta \int \partial^{\mu} a dx_{\mu} = 0 \quad \text{with} \quad w^{\mu} = \partial^{\mu} a. \tag{16}$$

When we transpose the mass density $\mu = u^2 / c^2$, taking into account identities $\nabla P^2 = 2(\mathbf{P}.\nabla)\mathbf{P} + 2\mathbf{P} \times (\nabla \times \mathbf{P})$ and $d\mathbf{P} / dt = \partial \mathbf{P} / \partial t + (\mathbf{v}.\nabla)\mathbf{P}$ for c and v constant, after integration with respect to space, we get the equation for matter

$$d\mathbf{p} / dt = -\nabla mc^2 + \{\nabla (mv)^2\} / 2m, \quad d\mathbf{p} / dt = \nabla L_m = -\nabla m_0 c^2 \sqrt{(1 - \beta^2)}. \tag{17}$$

We retrieve the relativistic Lagrangian of mechanics for free matter $L_m = -m_0 c^2 \sqrt{(1 - \beta^2)}$.

2.3. Electromagnetic interaction

For of an almost standing wave, the continuity equation concerns the total energy density, $W = U^2 \Omega = w + \delta W$, sum of the mean standing wave w and of the interactions δW. Relation (15) is

$$\prod^{\mu\nu} = \partial^{\mu} W^{\nu} - \partial^{\nu} W^{\mu} = 0 \quad \text{or} \quad \prod^{\mu\nu} = \pi^{\mu\nu} + \delta \prod^{\mu\nu} = 0. \tag{18}$$

By difference with the null four-dimensional density force $\pi^{\mu\nu}$ for a standing wave, only the total density force $\prod^{\mu\nu}$ for an almost standing wave vanishes. In the first case, this asserts the space stability of an isolated standing wave, while in the second case, the space stability concerns the whole almost standing wave. It behaves as a system composed of two sub-systems, the mean standing field with high frequency $\Omega(x, t) \approx \omega$, and the interaction field with lower frequency $\delta\Omega(x, t)$, each one exerting an equal and opposite density force $\pi^{\mu\nu} = -\delta\prod^{\mu\nu}$ against the other.

In (15), the vanishing four-dimensional force density tensor $\pi^{\mu\nu}$ of a standing wave, asserts that the energy-momentum density four-vector w^{μ} is four-parallel, or directed along the motion velocity **v**. By comparison, for an almost standing wave, the total energy-momentum density tensor $\prod^{\mu\nu}$ which still vanishes, asserts also that the total energy-momentum density four-vector W^{μ} is four-parallel, or directed along the motion velocity **v**. However, the mean energy-momentum density tensor $\pi^{\mu\nu}$, no longer vanishes in (18) as previously in (15): the mean energy-momentum density four-vector w^{μ} is then no longer parallel. This comes from the opposite density force $\delta\prod^{\mu\nu}$ exerted by the interaction.

It appears that an almost standing field behaves as a whole system in motion which can be split in two sub-systems, the mean standing field and the interaction field. Both are moving with velocity v, while exerting each other opposite forces in different directions, including perpendicularly to the velocity v. The perturbation field, arising from local frequency variations $\delta\Omega(x, t)$, introduces orthogonal components in interaction density force and momentum.

Relations (17), generalized by constants variation method for mass $M(x, t) = m \pm \delta M(x, t)$, become

$$\nabla Mc^2 + \partial P / \partial t = 0, \quad \nabla \times P = 0, \quad dP/dt = -\nabla Mc^2 + (\nabla P^2)/2M . \quad (19)$$

The density force $\delta\prod^{\mu\nu} \neq 0$ exerted by the interaction is formally identical with the electromagnetic tensor $F^{\mu\nu} = \partial^{\mu} A^{\nu} - \partial^{\nu} A^{\mu} \neq 0$. We can set them in correspondence $\delta\prod^{\mu\nu} = eF^{\mu\nu}$, through a constant charge e, in which $\delta M(x, t) = eV(x, t)/c^2$ and $\delta P(x, t) = eA(x, t)/c$. The double sign for mass variation corresponds to the two signs for electric charges, or to emission and absorption of electromagnetic energy by matter. We retrieve the minimum coupling of classical electrodynamics, $P^{\mu}(x, t) = p^{\mu} + eA^{\mu}(x, t)/c$, with $M(x, t)c^2 =$

$mc^2 + eV(x, t)$, and $P(x, t) = p + eA(x, t)/c$, where electromagnetic energy exchanged with a particle is very small with respect to its own energy $eA^{\mu}(x, t)/c = \delta P^{\mu}(x, t) << p^{\mu}$. Electromagnetic interaction is then directly linked to frequencies variations of the field ε.

From (19) derives the relativistic Newton's equation for charged matter with the Lorentz force

$$dP/dt = -\nabla m_0 c^2 \sqrt{(1-\beta^2)} + e(E + v \times H/c). \qquad (20)$$

2.4. Adiabatic invariance

For an almost standing wave, we get from (11), to first order approximation,

$$[\partial U^2/\partial t + \nabla . U^2 \mathbf{v}]/U^2 + \delta[\partial \Omega/\partial t + \nabla . \Omega \mathbf{v}]/\Omega = 0 \qquad \text{or}$$

$$(\partial_{\nu} W^{\nu})/W + \delta(\partial_{\nu} \Omega^{\nu}/\Omega = 0 \qquad (21)$$

with energy density $W = w \pm \delta W = \mu c^2 = \mu c^2 \pm \delta \mu c^2$, four-dimensional energy density $W^{\nu} = w^{\nu} \pm \delta W = (\mu c^2, \mu \mathbf{v} c)$, frequency $\Omega = \omega \pm \delta \Omega$, and four-dimensional frequency $\Omega^{\nu} = (\Omega, \Omega \mathbf{v}/c)$, leading to

$$W = I\Omega \quad \text{and} \quad W^{\nu} = I\Omega^{\nu} \qquad (22),$$

when we take into account the double sign in frequency variation $\delta\Omega$. The constant I is an adiabatic invariant density. In first approximation, they reduce to energy-momentum densities, and to their variations, relations

$$w^{\nu} = I\omega^{\nu} \quad \text{or} \quad \mu c^2 = I\omega \quad \text{and} \quad \mu \mathbf{v} = I\beta\mathbf{k}, \qquad (23)$$

$$\delta W^{\nu} = I\delta\Omega^{\nu} \quad \text{or} \quad \delta\mu c^2 = I\delta\Omega \quad \text{and} \quad \delta\mu\mathbf{v} = I\delta\beta\mathbf{K}. \qquad (24)$$

Integrations with respect to space of μ and I densities, lead to relations between four-energy and four-frequency through the adiabatic invariant H, formally identical with the Planck's constant h.

$$E^{\nu} = (mc^2, \mathbf{p}c) = m_0 c^2 u^{\nu} = H\omega^{\nu} = H(\omega, \mathbf{k}c) = H\omega_0 u^{\nu},$$

$$u^{\nu} = (1, \mathbf{v}/c), \quad m_0 c^2 = H\omega_0. \qquad (25)$$

Adiabatic variations frequency Ω of the standing wave corresponding to matter, lead to electromagnetic interaction constituted by progressive waves. Electromagnetic interaction energy derives from mass variation $dE = c^2 dm,$ leaning directly upon the wave property of matter: its energy $dE = hd\nu = c^2 dm$ derives from variations of matter energy $E = h\nu = mc^2.$

3. Relations with Quantum Theory

3.1. Theoretical economy

The Einstein's program tends towards a unitary theoretical economy by showing how, independently of any interpretations, different fundamental principles of Quantum Theory derive mathematically from a scalar field propagating at speed of light c.

Such an evolution appeared already in the past in Quantum Mechanics, when, beyond its agreement with experiment, the non relativist Schrödinger's equation was derived from the relativist Klein-Gordon's equation as an approximation. Nevertheless it continued to serve as fundamental basis for the elaboration of the Copenhagen consistent interpretation, (description of a single quantum particle in motion, wave-particle duality behavior obeying uncertainty principle, Dirac's relativist equation, superposition principle, the statute of the observer associated with the admitted collapse of the wave function…). At the present time, the more general relativist Quantum Field Theory has introduced some distance with Quantum Mechanics description. For instance, a quantum particle is no longer considered as single; its presence is not experimentally permanent, since it can be created or annihilated; its experimental point-like character behavior is not of prime importance since it derives as a kind of resonance from a continuous field expressed by partial differential equations; its mass is not a constant independent of time but varies according to the Feynman process; its interactions verify gauge theories, in which the lagrangian is invariant under continuous local transformations.

All these features are consistent with the above equations deriving from the Einstein's program. Since it leans on a generating basic c-scalar field, which provides a physical general framework, it draws our attention to some main problems of Quantum Theory such as the Planck's constant statute, the hidden variables, the wave-particle duality, and the relation between matter and interactions, which should ask to be deepened further.

3.2. The Planck's constant statute

3.1.1. First and second quantifications

The relations (21-25) show that h corresponds formally to a phenomenological constant value of an adiabatic invariant, which structure derives from the c-scalar field. A unique equation (21) gathers its application to standing fields, behaving like matter $E = h\nu = mc^2$, and to the perturbation field as electromagnetic interaction $dE = hd\nu = c^2 dm.$ By comparison, two decades separates historically, the discovery of first quantification $E = h\nu$, for electromagnetic energy, from the second quantification, for matter. In addition, the particles of matter, such as electrons, and of interactions, such as photons, are entirely independent, physically and geometrically. Physically, they derive in Quantum Theory, from fundamental fields, each one with specific nature and properties [15]. Nevertheless, they all have in common energy as profound nature, which authorizes their interactions and transformations, following some well defined processes. Geometrically, the independency of matter and interactions particles appears in the emission-absorption of the second by the first ones, merged with the creation-annihilation process. For instance in the Compton effect, their solutions show that, instead of being absorbed, the light verifies the relativist laws of light reflection from a moving mirror, performed by electron [8].

In these conditions, "since the photon is generally observable only when it disappears, a new type of atomic detector, able to record the trace of a single photon, without absorbing energy," [18] has been realized by S. Haroche and his collaborators.

3.1.2. Secondary fundamental constant

The Planck's constant h plays a fundamental role at the foundation of Quantum Theory, together with the speed of light in vacuum c. However, Einstein's program consequences (21-25) show that h statute must not be considered on the same footing as c: theory and experiment show how, until now, it may be put into the background.

From a theoretical point of view, quantum theories are fundamentally relativistic, leaning then also upon the speed of light constant c. By opposition, general relativity, which has still resisted to its quantification [9], has not been superseded to describe gravitation, in a classical and determinist framework, ignoring h [1-5]. From an experimental point of view, the graviton, as quantum particle mediating interaction, has not yet been experimentally detected and validated [6, 7]. What is more significant, the speed of light in vacuum c is admitted as a "pure", or primary, fundamental constant in experimental physics, with its numerical value strictly fixed, for the International Legal Metrology Organization. In other words, it is admitted that no error affects its knowledge and its effective utilization.

By comparison, the Planck's constant, which value $h = 6.62606957(29) \times 10^{-34}$ Js is known with an uncertainty of 10^{-7} is only a secondary, or "composed" fundamental constant. At present time, it does not serve, in experimental physics, to determine the standard of mass-energy through the relation $E = h\nu = mc^2$, even though an electromagnetic frequency can be measured with the best accuracy in physics nowadays, with an uncertainty less than 10^{-18} following the standard of time [16-17].

3.3. Wave-particle duality

However, owing to the numerical values of the fundamental constants (h, c, G) only, involved in the relations $E = mc^2 = h\nu = hc / \lambda_c = Gm^2 / \lambda_c$ for a material particle, the Planck's constant h, together with the speed of light c and the gravitation constant G, allows to determine the physical boundary limits (E, ν, λ_c) to the wave-particle duality behaviour, for a particle with mass m, behaving as a standing wave of the c-scalar field with frequency ν [8] .

Instead to differentiate fundamental material and interactions particles of the standard model, as bosons or fermions, by their quantum statistical and spin properties, the Einstein program incites us to discriminate them by their relativist properties of motion, depending they have a rest mass or not. The distinction is exclusive since particles without mass, like photons and gluons for interactions, move always with light speed: it can never be different. On the contrary, particles with mass, like fermions for matter, have a motion velocity v strictly inferior to light speed c, following the generic relation $v = \beta c = (\omega_1 - \omega_2 / \omega_{1+}\omega_2)c$, in which the frequencies ω_1, ω_2 are hidden in the particle-geometrical optics approximation.

As a consequence of the Einstein's program (5), the Compton's wavelength $\lambda_0 = h/m_0c = hk_0/2\pi$ characterizes a material quantum particle, through a space-like bunched function $u_0(k_0r_0)$. It tends towards a Dirac's distribution $u_0(k_0r_0) \to \delta(r_0)$, without the Planck's constant, when the frequency is very high and tends towards infinity $\omega_0 = k_0 \to \propto$, in geometrical optics approximation: the standing wave of the field behaves then as a free classical material particle isolated in space. Such a limit approximation appears as more physical than the difficult and controversial collapse of the wave function ψ, which time-like character is not suitable to describe a distribution in space.

In quantum domain, in absence of a space-like function describing the extension of a quantum particle, its point-like character for the photon is implicitly admitted because of the Planck's constant in the Einstein's relation $E = h\nu$, and for matter in the de Broglie's relation $E = h\nu = mc^2$. In quantum mechanics equations, it remains through the constancy of the photon frequency and the mass for a free particle. In quantum field equations, the interactions arise from variations of the mass-energy of matter through the lagrangian.

From a physical point of view, it is obvious that a particle cannot be strictly point-like, since its energy density would be infinite. In quantum mechanics, where experiment is privileged, like in Young double-slit, the extended character of energy repartition is approximated by splitting it in two parts: all energy is concentrated in a point, interaction remains only as information all around space-time, following the (5) and (6) approximations.

3.4. Hidden variables

According to Einstein, the probabilistic experimental behaviour of quantum particles, like electrons, proves that the quantum mechanics description is incomplete. "*The statistical character of the present theory would then have to be a necessary consequence of the incompleteness of the description of the systems in quantum mechanics*."

Such an incompleteness does not concern the equations of quantum mechanics themselves. From a mathematical point of view, they do not need to be modified or supplemented. They are mathematically complete, when we stay in the consistent quantum framework. For instance, in Bohm's hidden variable theory [14], the nonlocal quantum potential $Q = -(h^2\nabla^2 a)/8\pi^2 a,$ which constitutes an implicate hidden order in the guidance of a particle, derives from the usual Schrödinger equation $ih\partial\psi / 2\pi\partial t = -(h^2\nabla^2\psi)/8\pi^2 m,$ through the solution $\psi = a.\exp i2\pi S/h.$

However, the equations resulting from Einstein's program specify particularly how, and why, quantum mechanics, and more generally quantum theory formalisms, are physically incomplete. They do not take account of the space-like amplitude function $u(r_0),$ which describes a particle in its rest system. It represents an extraneous complement to the quantum framework, which is based upon time-like equations: of Klein-Gordon for bosons, (from which derives the non-relativist Schrödinger equation), of Dirac for fermions, or of introduced lagrangian densities for massive particles [15]. The discrepancy between time-like and space-like characters is absolute.

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