ESSAI SUR LES CONDITIONS INITIALES QUANTIQUES ET LES ONDES DE GRAVITATION

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Résumé

On montre que les conditions quantiques initiales de Bohm pour un objet solitaire quantique peuvent être infiniment nombreuses en contradiction avec le modèle de Bohr pour l'atome d'hydrogène.

Le premier (et le dernier) modèle de Bohr pour l'atome d'hydrogène est très proche du modèle physique classique. En se basant sur les faits expérimentaux (observations spectroscopiques d'un ensemble) Bohr n'a deviné qu'un seul paire de conditions initiales pour l'atome d'hydrogène isolé. Cette approche ne permet pas d'être trouvées les propriétés possibles d'une multitude d'atomes d'hydrogène (ensemble statistique). Ce modèle est incomplet et au lieu de le compléter, Bohr introduit dans la science des incertitudes et des probabilités, que j'appelle "Illusions de Copenhague ".

Dans cet essai les champs de gravitation de toutes les particules (y compris le photon) sont décomposés en ondes monochromatiques planes. La longueur d'onde de gravitation obtenue coïncide avec la longueur d'onde de L. de Broglie. Malgré son amplitude de gravitation très petite cette onde peut "guider" les particules à cause de la loi de conservation de l'énergie. C`est très semblable au "potentiel quantique" de Bohm. Bohm imagine son potentiel quantique comme un porteur d'information, dont l'amplitude ne change pas avec la distance et qui se propage probablement avec une vitesse beaucoup plus grande que la vitesse de la lumière.

Notre potentiel de gravitation explique l`influence du milieu sur le mouvement des particules (diffraction, interférence), mais en se déplassant avec la vitesse des particules, le paquet de gravitation ne permet pas l'existance des nonlocalités et l`envoi des signaux plus rapides que la vitesse de la lumière.

Il est montré encore que l`onde de gravitation permet le calcul de nombreuses proprités toutes nouvelles des systèmes quantiques. Pour la première fois ici sont calculés le temps de vie moyen d 'un ensemle statistique d`états exités et des nouvelles proprietés des photons "entremêlés" (corrélés). *Des calculs pareils ne sont pas possibles pour la physique quantique contemporaine.*

Ces résultats (comme l'écrit Bohm) sont en déhors de la physique quantique contemporaine. Il est montré que nos nouveaux résultats coïncident avec tous les faits expérimentaux connus

Mots-clés: atome solitaire, temps de vie propre, conditions initiales, modèle classique, largeur de la raie du photon.

ESSAY FOR QUANTUM MECHANICAL INITIAL CONDITIONS AND GRAVITY WAVE

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Summary

It is shown that in Bohm's interpretation of quantum mechanics the number of initial conditions of a single solitary quantum object must be infinitely large (contrary to Bohr's model of the hydrogen atom). Bohr's first (and last) model of hydrogen is consistent with the models of classical physics. Based on experimental facts (spectroscopic observation of an ensemble) Bohr guessed that only one pair of initial conditions corresponds to an individual hydrogen atom. This does not allow finding the possible properties of many hydrogen atoms (a statistical ensemble). Such model is not complete and instead of making it complete, Bohr introduces in science inherent uncertainties and probabilities, which I call "Copenhagen's illusions".

In this *"essay"* the gravity fields of all particles (including photon) are expanded in terms of plane monochromatic waves. The obtained gravity wave-length coincides with the length of de Broglie's wave. Despite of its very small amplitude, the gravity wave can guide the particle because of the energy conservation laws. This resembles the "quantum potential" of Bohm. He thinks the quantum potential as a guide of information, with amplitude that does not change with distance, and probably propagates with velocity many times faster than the light velocity. My gravity potential explains the influence of environment on the particle's motion (diffraction, interference); and by moving together with the particle, the gravity packet does not allow existence of non-locality and possibility for sending signals faster than the speed of light.

It is also shown that the gravity wave allows us to calculate many *new properties* of quantum systems. The **mean lifetime** of an ensemble of excited hydrogen levels (k), when transitions occur to any lower state (n). The new properties of entangled (correlated) photons are calculated here for the first time. All s*uch calculations are not possible for contemporary Quantum Physics.* These results (as written by Bohm) are "beyond" the contemporary quantum mechanics. It is shown that these ***new results*** **coincide exactly with all known experimental results.**

Key words: solitary atom; "soliton-photon"; "own lifetime"; entangled photons; initial conditions; classical model; photon linewidth, soliton gravity potential.

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In memory of Professor Dr. Emil Vapirev.

FOREWORD

"This work should not exist, because it contradicts the uncertainty principle and probabilities inherent in science". M. Mateev, professor at Sofia University.

WHAT IF THE WAVES OF LUIS DE BROGLIE ARE REAL WAVES INSTEAD OF SOME OBSCURE "STATISTICAL WAVES"?

Since the late 1920s, the theory formulated by Niels Bohr and his colleagues at Copenhagen has been the dominant interpretation of quantum mechanics. Yet an alternative interpretation, based on the work of Luis de Broglie and reformulated and extended by David Bohm [1,2] and his colleagues, explains the experimental data equally well. Through a detailed historical and sociological study of debates within and between opposing camps, and the reception given to each theory, Cushing [3] shows that despite the preeminence of the Copenhagen view, Bohm's interpretation cannot be ignored. Copenhagen interpretation became widely accepted not because it is a better explanation ("how") of the atomic phenomena than Bohm's, but because it happened to appear first.

Since these two interpretations of quantum mechanics have the same set of equations available for calculation, it might seem as though they should be observationally completely equivalent. If the calculation of any observable quantity is well posed in both theories, then both theories will calculate, or produce, the same answer when the formalism is applied. This appears to have been Bohm's own view because, when asked directly in 1986 whether there were any new predictions from his model, Bohm responded: "*Not the way it's done. There are no new predictions because it is a new interpretation given to the same theory*".

But later Bohm and Hiley in their book [2] (p.345) wrote: *"In this section we shall discuss some suggestions of our own in which we show how our proposals can also be extended beyond the current quantum theory"*. Bohm was convinced that new results beyond the Copenhagen's quantum physics could be obtained. He insisted that the science must be opened for any possible interpretations and only experiments or observations can choose the interpretation which corresponds to reality.

The main difference between Copenhagen and Bohm's points of view consists in the Copenhagen's illusion that the wave function is a complete description of the quantum objects. I show in this paper that the quantum and even the classical physics are not complete (in sense that all known elements in nature are connected properly). This can be proved, if we remember that each particle in nature (including photon) possesses energy ***(J)*** and equivalent mass (***$m=J/c^2$***). Correspondingly, the particle's gravity field **(G),** and gravity potential φ_g, are real. When **particles and electromagnetic fields interact, the gravity potential (φ_g) is not taken into account neither in classical nor in quantum physics**. According to the Copenhagen interpretation, "*uncertainties*", "*dualities*", "*probabilities*", etc., are natural properties of the Universe. These properties are universal not because the human beings cannot examine nature in more details, but because deeper knowledge does not exist. These are the limits placed upon the Nature (and knowledge). It must be accepted that the Nature does not go its own ways (laws) but chooses the next steps **by playing dice.** This is what I call "Copenhagen's illusions".

Bohm's point of view allows us to think that these qualities (probabilities, uncertainties, duality) are not inherent properties of nature, but are a result of our inability to determine (or know) exactly some set of "initial conditions" for resolving a concrete task. But if one can **determine or guess** some set of different initial conditions, it may be possible to obtain new results.

In this work I hope to show that Bohm-de Broglie's interpretation leads to additional, more reach, unexpected results. I will use Bohm's point of view and will show that in some cases the "**initial conditions**" can be known, can be measured or **can be guessed**. Then Bohm's (and de Broglie's) interpretation is more productive, with new, experimentally measured (or measurable) predictions ("beyond the contemporary quantum physics"). Bohm's point of view is closer to the classical physics. This is a necessary condition for two theories, following each other. Despite introducing gravity waves, my point of view also is very close to classical physics. Here it is shown that "beyond the Copenhagen's

Quantum Physics" ***even radioactive decay is not probabilistic (chance events) but follows exact deterministic laws.***

This "essay" consists of three sections: In section I, the *photon-soliton initial conditions (metric properties)* and gravity wave are briefly explained and introduced for all particles (including photon). In section II the soliton's properties are used for the description of an individual atom's properties. The exact energy of the emitted photon is obtained for quantum transition ($k>n$) following an electron's acceleration. In this section, the "own life-time" of a single hydrogen atom in an excited state, the width of the excited levels, the mean-lifetime of the ensemble of hydrogen atoms and the spectral width of the emitted photons are also described. In the last section III, the possible shape of the soliton, the possible shape of gravity field, the gravity wave function, the "common" wave function of photon and correlated photons, the spin of the photons are shown and discussed. Some known experiments with correlated photons are explained. The new proposals for experiments with correlated photons are described. It is also shown that some of these experiments are interpreted wrongly using non-locality.

I. PHOTON AND SOLITON INITIAL CONDITIONS

A COPENHAGEN'S ILLUSION*: THE EXPRESSIONS FOR THE ENERGY OF THE PHOTON AND THE ENERGY OF CLASSICAL ELECTROMAGNETIC WAVES ARE COMPLETELY DIFFERENT AND CANNOT BE DERIVED FROM ONE ANOTHER*.

Because the following results are very essential for studying the initial conditions for photons and atoms, I make here a brief (but sufficiently full) résumé of our papers [4,5] (with permission of my co-author and friend – B. Slavov).

Many authors assume that each quantum system emits a photon for a very short period of time, in any way shorter than the mean lifetime $\tau=T_{1/2}/ln(2)$ ($T_{1/2}$ is the time during which one half of quantum systems are still in the excited state. The photon is emitted in a random, not predefined direction [6]; the photon momentum $\hbar\omega/c$ is in the direction of its propagation, and an equal momentum, but in opposite direction, is transferred to the quantum system emitting the photon. When the photon is absorbed, the momentum received by the absorbing quantum system is in the direction of propagation of the absorbed photon. In the same papers [6] Einstein wrote that the above properties of photons were the most important results of his work, although in the same work he formulated the hypothesis about stimulated emission and derived the formula of Planck. In this work he found the relations between the coefficients of emission and absorption. We all know very well these papers and we all were so fascinated by his derivation of the Planck's formula that we missed to see the important properties of photons, which could have a great consequence for the subsequent development of science. This consequence is simple and clear: **each quantum system emits electromagnetic pulses like a radar** (the radar was unknown to Einstein in 1916).

A SMALL ILLUSION. In 1966 the much respected by me professor H.H. told me that the photons are spherical electromagnetic waves. I asked him: "And what about the momentum and the recoil of the emitting quantum system? (He knew about the effect of Moessbauer). His answer was that when the spherical wave is absorbed (emitted) by a quantum system, the emitting (and absorbing) quantum system receives a recoil (Copenhagen's collapse of wave: At the same time two particles, **in spite of the distance between them, simultaneously receive momentum**). In addition he explained that when a photon, emitted by a star one million years ago is absorbed here on Earth, the act of emission and absorption also lasts one million years. The photon momentum is $p = F.t$ where F is force and t is the duration of action of this force. If the interaction time is longer, then F is smaller in order to conserve the momentum (greater distance, smaller F). The only important thing is the "conservation of momentum and energy". I know many prominent and respected scientists who even in our days think in the same way. It was then when I was for the first time confronted with a mystical, illusory explanation of reality. Properly, such things are some of the **Copenhagen's illusions, which allows sending signals faster than the light** velocity (independent of the distance between them, two quantum systems simultaneously receive momenta).

In analogy with the radar, a large number of quantum systems resemble a large number of radars rotating chaotically in all directions and sporadically emitting electromagnetic energy. The average emission is spherically symmetric, but each radar pulse has its own direction, energy and the momentum received by the emitting antenna in direction opposite to the electromagnetic pulse. The time for momentum transfer is equal to the time for emission (or absorption) of electromagnetic energy - neither more, nor less than this time. The experiments show that each photon does not change its shape (and volume) in space and time because it transfers its energy and impulse to another atom (at unrestricted distance).

I.1. The soliton

J. P. Vigier showed [7] that the photon could be represented as a solitary electromagnetic wave - a soliton. In our works [4,5] we proposed a soliton-like model of the photon. As a consequence, attributes such as effective volume, amplitude, gravity field, and frequency (measured by interference phenomena and which coincides with the frequency of de Broglie's wave) can be used to describe the soliton. We show that the electromagnetic amplitude, volume, classical cross-section and photo-effect cross-section of the photon-soliton can be estimated in an empirical as well as in an analytical way [4,5,8,9]. The pioneer work of Russell [10], where he describes the hydro-dynamical solitary wave, has undergone impressive development in the last 35 years [11-13]. It has been applied in different areas, including the description of cosmic objects and elementary particles.

We begin with the statement that when in a quantum system a quantum transition (between two levels, $k > n$) takes place, the energy always has a fixed value and if the photon is an electromagnetic soliton, it must posses a **fixed amplitude of its electromagnetic field**. As a consequence there should be a relation **between the amplitude of this electromagnetic field and it frequency** (or de Broglie's **wavelength**).

I.2. Empirical soliton-like model for the photon

In the electrodynamics, the relation between the energy density of the electromagnetic field (E_a) and the frequency ω of the photon is given by:

$$E_a^2 = \frac{\hbar\omega N_a}{V}, \qquad \text{(I.1)}$$

where N_a is the average number of photons with frequency ω which occupy the volume V. To be more specific, let us consider an idealised radar pulse as shown in Fig.I.1 (the dashed area at a distance from the antenna). It must be remembered that this packet has a mass equal to $m = J/c^2 = \hbar\omega N_a/c^2$, and a corresponding gravitational field. Something more, **even if this packet contains one photon only, a gravitational field still exists.** Let us assume that in the constant volume V_r the energy density E_r^2 is also a constant. In this case for the energy J_r of the radar pulse we have:

$$J_r = E_r^2 V_r \qquad \text{(I.3)}$$

If we take a larger volume $V_g > V_r$, which includes the radar pulse volume, the density of the radiation in volume V_g appears to be smaller, $E_g^2 < E_r^2$, since the energy J_r of the radar pulse remains the same but this energy occupies a larger volume V_g:

$$\frac{E_r^2}{E_g^2} = \frac{V_g}{V_r} \tag{I.4}$$

The energy of the radar pulse J_r can be estimated from the new volume V_g and the new energy density E_g^2:

$$J_r = E_g^2 V_g \tag{I.5}$$

The ratio between (I.3) and (I.5) is:

$$\frac{E_r^2 V_r}{E_g^2 V_g} = 1 \tag{I.6}$$

This relation is valid always when $V_g > V_r$ because the actual electromagnetic energy in the radar volume is constant. This is not the case when one takes a volume $V_s < V_r$, V_s being a part of V_r. Then the energy density in the smaller volume V_s is preserved (E_r^2) and it is not possible to obtain (I.6), but we have instead:

$$\frac{E_r^2 V_r}{E_r^2 V_s} > 1 \tag{I.7}$$

If the photon is a soliton [7], the volumes of the solitons may be very small (comparable to the dimensions of the atoms) and one can write for the energy of the soliton:

$$J = \hbar\omega = E_0^2 V \tag{I.8}$$

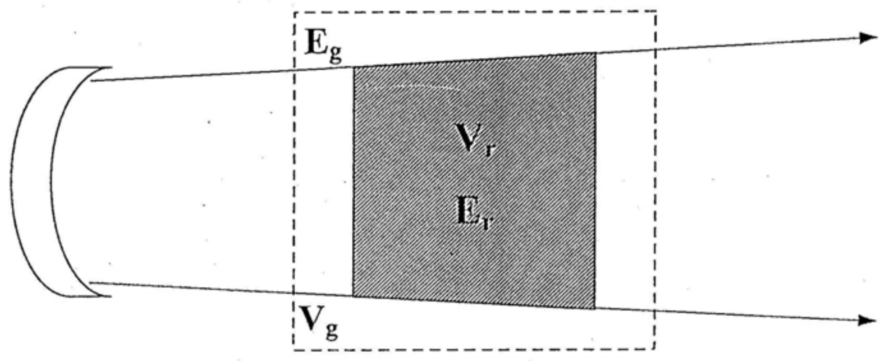


Fig. I.1. Schematic representation of an idealised radar pulse having a constant electric field amplitude E_r, and occupying a constant volume V_r.

This inevitably leads to a constant relation between the amplitude E_0, frequency ω and volume V, of the soliton. Moreover, when a quantum transition takes place, the energy

always has a fixed value and if the photon is an electromagnetic soliton, **it must posses fixed amplitude of its field.**

It is shown [4,5] that for all atoms there is a fixed relation between the Coulomb electric field *E* acting on an electron in the lowest-lying atomic state, and the frequency of the photons (ω_0), which energy is exactly equal to the ionization energy of such atomic state. *E* is calculated from the distance (***r***) between nuclear charge and electrons. The results show that within the bounds of the accuracy of the experiments, there is a constant ratio (*K*) for all elements:

$$\frac{E^2}{\omega_0^3} \cong K \qquad \text{(I.9)}$$

This shows that the Coulomb field (*E*) binding the electrons in all atoms is related to the frequency ω_0 of the photons with energy equal to the energy of ionisation. We can estimate *K* from the energy of ionisation of hydrogen, $\hbar\omega_0 = 13.6 \text{ eV}$, and (I.9) (also for hydrogen):

$$K = \frac{e^2}{r^4\omega_0^3} \cong 3.3\times 10^{-35} gscm^{-1} \qquad \text{(I.10)}$$

Most authors assume that a quantum system does not emit when occupying one of the states with $k > n$. While following a stationary trajectory (guided by the real de Broglie's wave), the atom does not emit electromagnetic radiation. It emits only during a transition when the radial co-ordinates change for a very short time interval (**after Copenhagen's view this is a quantum jump**). According to Pauli [14] and Einstein [15], the quantum transition ($r_k \rightarrow r_n$) takes place for a very short time, shorter than the mean life-time (τ) (of the excited state, *k*). Pauli estimates the time of transition to be on the order of $2\pi/\omega$ It is enough to accept here that the time for emission (absorption) of the photon depends on the frequency as stated by Pauli:

$$t_e = \frac{b_0}{\omega} \qquad \text{(I.11)}$$

It is shown [4] that (for electron) b_0=1/2. Since we assume that the single photon contains a solitary electromagnetic wave - soliton, we conclude that the energy of the soliton must be equal to the energy of the photon (I.8). To calculate the volume V_e of the soliton, we must know its effective length l_e and effective classical cross-section S_e.

In our case the electromagnetic field and the effective time (***t_e***) are related as shown in Fig. I.2. The exact behaviour of the function *E*(*t*) is still unknown, but it is not necessary for our analysis. It is sufficient to know that:

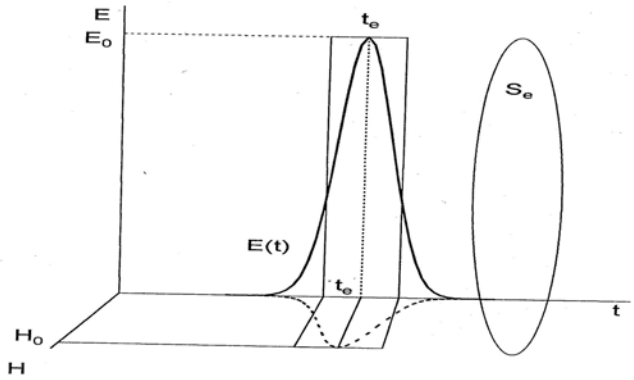


Fig. I.2. Schematic representation of the electromagnetic field of the soliton, the effective time t_e, the amplitudes E_0, H_0 and the effective cross-section S_e.

$$E_0 t_e = \int_0^\infty E(t)dt \tag{I.12}$$

If the effective time of emission is (t_e), the length l_e is given by:

$$l_e = c/2\omega = \lambda/4\pi \tag{I.13}$$

where c is the speed of light. An expression for the macroscopic cross-section S_e of the soliton will be given later in the text.

I.3. The photon-soliton and its interactions

In the Photo-effect in a hydrogen atom, the soliton electric field (E_0) acts on the two electric charges (electron and proton) in opposite directions. The momentum of the electric force is given by:

$$eE_0 t_e = \sqrt{2m_0 J} + 2m_0 v \tag{I.14}$$

Here e is the charge of the electron, $t_e = b_0/\omega$ is the effective time of interaction, m_0 is the mass of the electron, J is the binding energy of the electron, $\sqrt{2m_0 J}$ is the momentum necessary for the ionisation, and v is the velocity of the ejected electron. In the case when the photon energy is exactly sufficient for ionisation ($v = 0$), we obtain:

$$eE_0 \frac{b_0}{\omega} = \sqrt{2m_0 \hbar\omega} \tag{I.15}$$

Here $\hbar\omega$ is the energy of the photon equal to the ionisation energy J. J includes the **gravity** energy in the same way as the interaction of an electric field E_0 with charged particles includes also the energy of the magnetic field. After some transformations we obtain:

$$\frac{E_0^2}{\omega^3} = \frac{8m_0\hbar}{e^2} \quad (b_0=1/2) \tag{I.16}$$

The soliton energy:

The energy of the soliton is:

$$J = E_0^2\left(\frac{b_0^2 e^2}{2m_0\omega^2}\right) = E_0^2 V_e = \hbar\omega \tag{I.17}$$

Analytical expression for the effective volume, V_e is (b_0=1/2):

$$\boldsymbol{V_e} = \left(\frac{e^2}{8m_0\omega^2}\right) \tag{I.18}$$

The dimension of this quantity is volume, and we treat it as an effective volume of the soliton ($\boldsymbol{V_e = S_e l_e}$).

In conclusion, we have obtained expressions for the effective volume of the soliton and its effective length ($\boldsymbol{l_e = c/2\omega}$). The macroscopic cross-section ($\boldsymbol{S_e}$) of the soliton is:

$$\boldsymbol{S_e = V_e / l_e} \tag{I.19}$$

I.4. The photon-soliton and the muonic atom

It is well known that photons with equal energies are identical. Assuming that solitons with equal energies are also identical, it is evident that a fundamental relation like (I.16) should not depend on the type of the quantum system that absorbs (or emits) them. To analyze this point one can repeat the calculations for the photo-effect considering the interaction of a soliton with a muonic atom in which the electron is replaced by a muon. Since the masses of the electron and the muon are different, one could expect relation (I.16) to be different for the muon. More precisely, in the muonic case in place of expression (I.16) we have:

$$\frac{E_0^2}{\omega^3} = \frac{2M\hbar}{b^2 e^2} \tag{I.20}$$

M is the mass of the heavier particle (muon). If the fundamental relation (I.16) should not depend on the type of the quantum system that absorbs the photons, the constant *b* must be different from the constant b_0. We have:

$$\frac{E_0^2}{\omega^3} = \frac{2M\hbar}{b^2 e^2} = \frac{2m_0\hbar}{b_0^2 e^2}; \frac{b_0^2}{b^2} = \frac{m_0}{M} \tag{I.21}$$

The difference between the constants b_0 and *b* shows that the effective transition time for the process of the soliton absorption in those systems is different because of the different masses of the particles participating in the photo-effect. It was shown [4] that the constant K_0 does not depend on the mass of absorbing or emitting particles.

$$\frac{E_0^2}{\omega^3} = \frac{2M\hbar}{b^2 e^2} = \frac{2m_0\hbar}{b_0^2 e^2} = K_0 \approx 3.3\text{x}10^{-35}\text{gs/cm} \qquad \text{(I.22)}$$

This result indicates that for a soliton, the relation between the electromagnetic amplitude and frequency is a universal one. Another important result is that, although the soliton's interaction time with particles of different masses is different ($b \neq b_0$), solitons with equal energies cannot be distinguished from each other - neither energetically, nor spectroscopically. This is because in the case of solitons with equal energies, the principal relation between the electromagnetic energy density and frequency, as well as soliton's volume, remain the same.

I.5. The macroscopic cross-section of the soliton and the photo-effect cross-section

From the expression of the effective volume (I.18) and the effective length, the macroscopic cross-section is determined from (I.19):

$$S_e = \boldsymbol{e^2/4cm_0\omega} \qquad \text{(I.23)}$$

For $b_0 = 1/2$ the cross-section S_e can be calculated for any energy of the solitons (see Table I.1). If we accept that the soliton possesses a classical effective cross-section, this cross-section should be related to the probability of interaction, e.g. in the case of the photo-effect. In Table I.1 we summarise the experimental cross-sections for the photo-effect (σ_τ) for different elements when the energy of the photon is exactly equal to the ionisation potential for the K-shell. As it can be seen from the corresponding column in Table I.1, the calculated ratio σ_τ/S_e is practically a constant. An exciting result is that for a change in the value of the ionisation potential and the cross-section of more than three orders of magnitude, the ratio σ_τ/s_e changes by less than ±15 % (for $b_0 = 1/2$).

These results are easy to explain from a classical point of view. Let us consider the interaction cross-section σ_τ as a sum of the classical cross-section S_e of the soliton, and the classical cross-section (S_K) of the shielded area of the K-electron shell of the atoms (Fig.I.3):

$$S_K = \pi r_k^2 / 4 \qquad \text{(I.24)}$$

where r_k is the radial co-ordinate of the K-shell for each element. The value of the area within the K-electron shell is:

$$S_K = \pi r_K^2 / 4 = \frac{\pi\hbar}{8m_0\omega} \qquad \text{(I.25)}$$

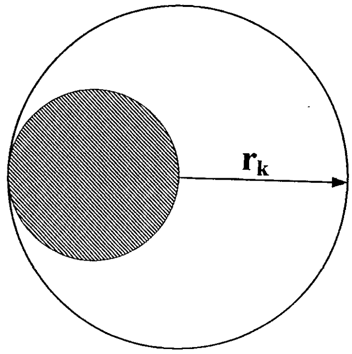


Fig. I.3. The shaded region (soliton) in the K-shell plane (open circle) with which the soliton interacts. In the case of photo-effect, it has a radius of $r_k/2$ and an area of $\pi(r_k)^2/4$.

As a result, for all elements, the interaction cross-section (I.24) for a photo-effect is:

$$\sigma_\tau = \left(\frac{e^2}{4m_0 c\omega} + \frac{\pi\hbar}{8m_0\omega} \right) \qquad \text{(I.26)}$$

For the value of the ratio σ_τ/S_e it is obtained:

$$\sigma_\tau/S_e = \left(1 + \frac{\pi\hbar c}{2e^2} \right) = (1+\pi/2\alpha) \approx 2.16\text{x}10^2 \qquad \text{(I.27)}$$

Here, $\hbar c/e^2 = 1/\alpha \approx 137$, where α is the ***fine-structure constant.*** *This constant will appear further when soliton and atom properties are related to one another.* The coincidence of the above value (I.27) with the values in the corresponding column of Table I.1 is surprising. It is known that the calculation errors for σ_τ (for the case when the energy of the photon is equal to the ionisation potential) are quite large. In the column for σ_τ/S_e the difference between the minimum and the maximum values is approximately 30 % (for all elements). The accuracy is better than ±15 % for all elements. The results given in Table I.1 show that the assumption $K_0 = K$ is justified (for $b_0 = 1/2$) and that relation (I.26) can be used for the calculation of the cross-section σ_τ at the exact energy of ionisation. **This is an experimental proof that the described solitons exist in reality** (with effective volume, V_e, length, l_e, and cross-section, S_e).

Table I.1. ***For all elements the energy ($\hbar\omega$) and experimental cross-section (σ_τ) change more than 10^3 times, but ratio (σ_τ/S_e) remains a constant***, (I.27).

Element	$\hbar\omega$, eV	S_e, cm^2	σ_τ, cm^2	σ_τ / S_e
Be	$0{,}113.10^3$	$123{,}0.10^{-22}$	$259{,}5.10^{-20}$	$2{,}113.10^2$
N	$0{,}387.10^3$	$35{,}70.10^{-22}$	$71{,}60.10^{-20}$	$2{,}004.10^2$
F	$0{,}682.10^3$	$20{,}30.10^{-22}$	$46{,}20.10^{-20}$	$2{,}270.10^2$
P	$2{,}144.10^3$	$6{,}490.10^{-22}$	$13{,}70.10^{-20}$	$2{,}112.10^2$
V	$5{,}465.10^3$	$2{,}540.10^{-22}$	$5{,}090.10^{-20}$	$1{,}998.10^2$
Br	$13{,}47.10^3$	$1{,}030.10^{-22}$	$1{,}860.10^{-20}$	$1{,}890.10^2$
Ag	$25{,}51.10^3$	$0{,}545.10^{-22}$	$0{,}986.10^{-20}$	$1{,}807.10^2$
Pr	$41{,}99.10^3$	$0{,}431.10^{-22}$	$0{,}572.10^{-20}$	$1{,}726.10^2$
U	$115{,}6.10^3$	$0{,}119.10^{-22}$	$0{,}181.10^{-20}$	$1{,}520.10^2$

I.6. Comparison with Planck's density of radiation

As it is known, Planck's energy density of radiation is

$$\rho(\omega) = E^2 = \frac{\hbar\omega^3}{\pi^2 c^3} \frac{d\omega}{\left[\exp(\hbar\omega / kT) - 1\right]} \qquad \text{(I.28)}$$

The unit frequency interval is $d\omega = 1$ s^{-1}. The part which depends on temperature (T) is usually interpreted as the average number of photons ($\overline{N}$) in unit volume. So, (I.28) can be represented as

$$\rho(\omega) = E^2 = \frac{\hbar\omega^3}{\pi^2 c^3} \overline{N} \qquad \text{(I.29)}$$

When $\overline{N} = 1$, equation (I.29) can be compared with the equation for the soliton energy density ($(E_0)^2 = \rho_s$):

$$\rho_s = E_0^2 = K_0 \omega^3 \qquad \text{(I.30)}$$

Or

$$\frac{E^2}{E_0^2} = \frac{e^2}{8\pi^2 m_0 c^3} \approx 1.2\text{x}10^{-25} \qquad \text{(I.31)}$$

$$E = \sqrt{\frac{e^2}{8\pi^2 m_0 c^3}} E_0 \approx 3.4\text{x}10^{-13} E_0$$

This confirms our assumption that in volumes larger in comparison with the actual volume of the electromagnetic field, the energy density (because of the larger volume) appears to be smaller. **The soliton energy density is consistent with Planck's energy density.**

These results explain the first unsuccessful attempt to describe the photoelectric effect within the framework of the electromagnetic wave theory. The soliton (particle) and its energy are concentrated in a very small volume.

Table I.2. ***Some important parameters of solitons with different energies. V_e is the volume, P - the pulse power, S_e - the macroscopic cross-section and Φ - the energy flux of the soliton (the accuracy is ~20 %). Energy density of photon energy 4.2x10^6 corresponds to energy density of electron ($J=m_0c^2$).***

ħω, eV	**ω, s^{-1}**	**E_o^2, J/cm^3**	**V_e, cm^3**	**P, J/s**	**S_e, cm^2**	**Φ, J/cm^{2}s**
$4,1.10^{-5}$	$6,28.10^{10}$	$8,2.10^{-10}$	$8,0.10^{-15}$	$8,3.10^{-13}$	$3,3.10^{-14}$	$2,48.10^{1}$
1.10^{0}	$1,51.10^{15}$	$1,16.10^{4}$	$1,37.10^{-23}$	$4,8.10^{-4}$	$1,4.10^{-18}$	$3,4.10^{14}$
2.10^{0}	$3,02.10^{15}$	$9,00.10^{4}$	$3,43.10^{-24}$	$1,9.10^{-3}$	$6,9.10^{-19}$	$2,8.10^{15}$
1.10^{1}	$1,51.10^{16}$	$1,16.10^{7}$	$1,37.10^{-25}$	$4,8.10^{-2}$	$1,4.10^{-19}$	$3,4.10^{17}$
1.10^{2}	$1,51.10^{17}$	$1,16.10^{10}$	$1,37.10^{-27}$	$4,8.10^{0}$	$1,4.10^{-20}$	$3,4.10^{20}$
1.10^{3}	$1,51.10^{18}$	$1,16.10^{13}$	$1,37.10^{-29}$	$4,8.10^{2}$	$1,4.10^{-21}$	$3,4.10^{23}$
1.10^{4}	$1,51.10^{19}$	$1,16.10^{16}$	$1,37.10^{-31}$	$4,8.10^{4}$	$1,4.10^{-22}$	$3,4.10^{26}$
1.10^{5}	$1,51.10^{20}$	$1,16.10^{19}$	$1,37.10^{-33}$	$4,8.10^{6}$	$1,4.10^{-23}$	$3,4.10^{29}$
$4,2.10^{6}$	$6,34.10^{21}$	$8,52.10^{23}$	$7,79.10^{-37}$	$8,5.10^{8}$	$3,3.10^{-25}$	$2,6.10^{33}$

According to our opinion, the most important argument against the electromagnetic soliton in vacuum is that the classical electromagnetic wave (consisting of many photons) "has to decay" (diffraction divergence). It is known that soliton solutions are obtained for pulse propagation in a non-linear media. At first sight there could be no non-linearity in vacuum that would lead to soliton solutions. But it may only seem so. If we accept the discussed ideas (and data in the Table.I.2), we can conclude that from the moment of it emission the soliton carries energy with enormous density. The equivalent **energy mass *J/c^2* (and gravity field, G)** may change the properties of space and lead to the required non-linear solutions. The observation of macroscopic diffraction divergence must be due to the divergence of many photons (or other particles).

1.7. Gravity Potential of Particles and Photons.

In many books and text books one can find the following problem (for **home-works of students):** *Expand the field of electric charge* (***e***)*, moving with constant velocity* (**v**)**,** *in terms of plane monochromatic wave* (Landau and Lifshitz, ***Teoria Polia,*** (in Russian) [16]).

The answer of the problem: In the nonrelativistic case the potential (φ_e) is:

$$\varphi_e = (e/2\pi^2(k^2 - (kv/c)^2))(\exp(-i(kv)t)) \qquad \textbf{(I.32)}$$

Here $k = 1/\lambda = m_0 v/\hbar$. From this follows **that the frequency of the wave is**

$$\omega = kv; \qquad \textbf{(I.33)}$$

In relativistic case**,** $k = 1/\lambda = m_0 v/(\hbar(1-v^2/c^2)^{1/2})$, ($v \le c$) and the potential φ_e becomes:

$$\varphi_e = (e\hbar^2/2\pi^2(m_0 v)^2)\exp(-i(\omega)t)) = A_e \exp(-i(\omega)t) \qquad \textbf{(I.34)}$$

Gravity field of the particles has the same structure as the electric field, $gm_0/r^2 \rightarrow e/r^2$ **(g** is the **constant of gravitation). I assume** that the gravity potential of a moving particle (φ_g) **must be proportional in every moment (t) to the electric potential** φ_e. Consequently expanded gravity potential of the particle (φ_g) must be

$$\varphi_g = (g\hbar^2/2\pi^2 m_0 v^2)\exp(-i(\omega)t)) = A_g \exp(-i(\omega)t)) \qquad \textbf{(I.35)}$$

It can be seen that the gravity amplitudes $A_g = g\hbar^2/2\pi^2 m_0 v^2$ depend on the masses and velocities of particles. Only for very small masses and velocities the gravity amplitude (A_g) is sufficiently large (Fig.I.4).

As was shown, a solitary photon consists of a very small electromagnetic particle (soliton) with a mass ($m_0 = J_{mn}/c^2 = \hbar\omega/c^2$), plus its surrounding gravity potential, (φ_g). This particle (soliton) moves with velocity **v = c.** The frequency of the gravity wave can be represented also as $\omega = J_{mn}/\hbar$. For gravity wave length it is obtained:

$$\lambda = \hbar c/J_{mn} = \hbar/p \qquad \textbf{(I.36)}$$

Gravity wave length (λ) coincides with the length of de Broglie's (matter) wave.

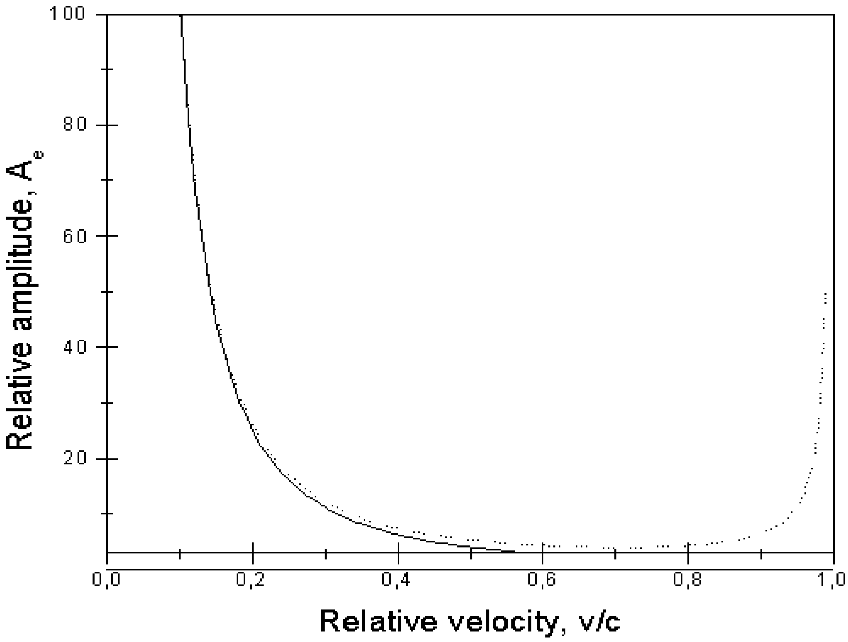


Fig.I.4 Relative amplitude: doted line is non-relativistic case. The solid line - relativistic case.

The photon's gravity potential is:

$$\varphi_p = (g\hbar/2\pi^2\omega)\exp(-i(\omega)t)) \qquad (m_0c^2=\hbar\omega) \qquad \textbf{(I.37)}$$

The gravity amplitude ($\mathbf{A_p}$) of the photon is:

$$A_p = (g\hbar/2\pi^2\omega), \text{ or } A_p = g\hbar^{1/2}(K_0V_e)^{1/2}/2\pi^2 \qquad \textbf{(I.38)}$$

In the second equation ω is replaced with the effective volume V_e and constant K_0 of the soliton. The amplitude of the photon's gravity potential ($\mathbf{A_p}$) is proportional to $(V_e)^{1/2}$.

The full potential of particles is $\varphi_{eg}= \varphi_e+\varphi_g$. At each moment of time **t,** the potential $\varphi_g \ll \varphi_e$ and for example **if the particle is electron**, then ratio φ_g/φ_e can be estimated easily:

$$\varphi_g/\varphi_e = gm_0/e \approx 1.28x10^{-25} \qquad \textbf{(I.39)}$$

The full potential can be approximated:

$$\varphi_{eg}= \varphi_e+\varphi_g = (\varphi_e+1.28x10^{-25}\varphi_e) \approx \varphi_e \qquad \textbf{(I.40)}$$

Probably, gravity potential is appropriate (large enough) for micro-particles observations only (Fig.I.4). **(Like a potential of particles on a liquid surface wave** [17],

where, because of the energy conservation, the particle cannot exists in a place with φ_g = 0). As can be seen, all sorts of particle fields can be presented with **common wave function**:

$$\varphi = A exp(-i\omega t) \qquad \textbf{(I.41)}$$

(The constant ***A*** depends on particle's properties).

I don't know if, as Tauber writes [18], "purely electromagnetic elementary particles" with a nonzero mass at rest ($\mathbf{m_0}$) are possible, **but when energy conservation law is concerned, the "negligible" gravity potential cannot be neglected.**

II. SOLITON'S INITIAL CONDITIONS AND THE HYDROGEN ATOM.

Bohr's atomic model of Hydrogen is the simplest object for understanding my new proposal, giving an explanation how different initial conditions of an individual atom change the results for an ensemble of hydrogen atoms. In Section I, some **metric properties** of described photon-soliton and hydrogen atom resemble "**classical initial conditions" and conjecture that photon's and atom's properties may be better understood** with the help of Bohm's "initial conditions". The main tool for determination of the new atomic initial conditions is the photon-soliton (Section I.) [4, 5, 19]. New results that follow the use of such new initial conditions are confirmed experimentally.

In the quantum mechanics, there is nothing more realistic than Bohr's model of a **solitary** hydrogen atom. Realistic, but not complete. Bohr *guessed* only one pair of possible initial conditions. His theory cannot explain many properties of hydrogen: The time of transition, the moment of disintegration of excited states (this is forbidden in Copenhagen's interpretation), intensities of hydrogen lines, width of the excited levels, the properties of heavier atoms and so on. Because of these failures, Bohr himself refutes his genial model and inserts in nature and science his **inherent** uncertainty, duality, probability. How can this uncertainty, inherent in nature, be understood? How can an electron (or light) be observed sometimes as a wave, sometimes as a particle, and never simultaneously as a wave and a particle? Only when such an object *is **not observed*** **can it be a simultaneous superposition of a wave and a particle**. In connection with these, Schrodinger writes in a private letter: "this stupendous and completely not philosophical stupidity of Copenhagen", and after this cuts short: "I know that this is not a fault of N.B., he doesn't find the time for a study of philosophy. But I have a deep pity, that with his authority, the brains of one, two **or three generations** are entangled and forbidden to think over the problems, which "He" claims are resolved." (Jean-Marc Levy-Leblond, *Mots et Maux de la physique* *quantique*, Rev. Int. Phil., No 212, 2000). Three generations have passed. **Now we can state that gravity waves and particles (in reality) exist simultaneously.**

On the basis of photon-soliton properties, derived from experimental interaction of a photon with a hydrogen atom [4, 5], I succeeded in selecting a set of, "some sort" initial conditions for the excited states of hydrogen. These additional initial conditions, together with additional hypotheses allow for a description of a series of unexpected and experimentally proven results. Such are the period of transitions between different hydrogen states (time necessary for "quantum jumps"). The "own lifetime" of the excited states of a solitary atom or nucleus is the period between the excitation and decay of the excited level. (This is the time after excitation of a solitary atom when Schrödinger's cat in the black box will be killed from the atom's decay – also beyond the Copenhagen interpretation). For the first time, this theory allows us to calculate the exact "mean lifetime" of the excited states (for a statistical ensemble of hydrogen atoms) – **which is "beyond" the capabilities of Copenhagen's quantum theory.** The solitons allow for an explanation of two-slit interference experiments with entangled (correlated) photons. The soliton properties allow to predict the outcome of new experiments, which show that a particle-soliton must pass only one of the two opened slits, but the real wave of de Broglie (gravity wave) passes two slits resulting in a nice interference pattern (consistent with [17]).

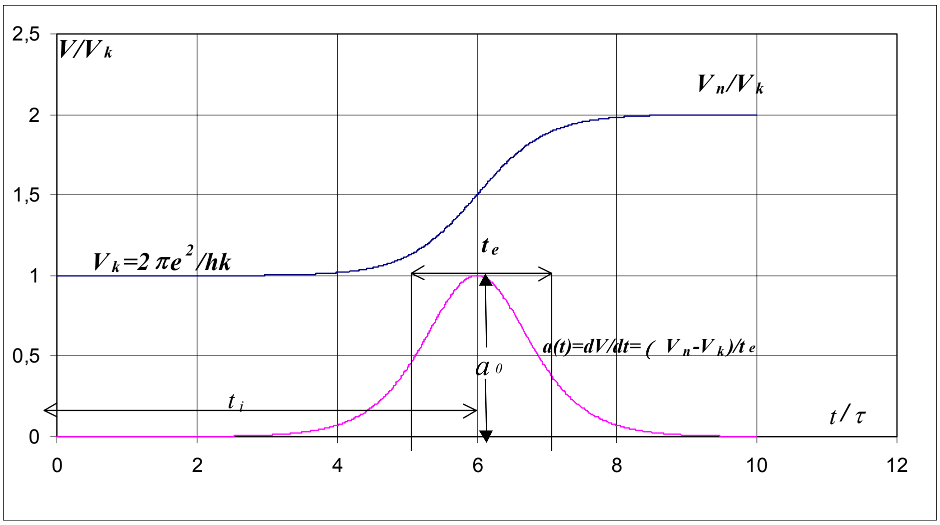


Fig.II.1. A diagram of velocities (V_k, V_n) and acceleration (a), (k=2, n=1). The shape of acceleration curve is not exactly known, but the effective time for velocity change is $t_e = \lambda/4\pi c = 1/2\omega$, with a maximum value a_0. The own lifetime is t_i.

Fig.I.2 represents a soliton electromagnetic field, ***E(t)***. The shape of the field is not known exactly. The effective time is t_e, the effective classical cross-section S_e, the effective volume $V_e = S_e l_e$, and the shape resembles the contour of a bell with a maximum E_0. As it is known from the electrodynamics, a charged particle emits radiation only when it is accelerated. The soliton's electric field at a distance ***x*** from the accelerated electric charge at every moment (***t***) must be proportional to the acceleration (***a***), in a latter moment **(*t = x/c*).** The curve of electron's acceleration (***a(t)***), (***Fig.II.1***), must correspond to the shape of the electric field (***E(t)***), on ***Fig.I.2***. Such acceleration is possible when the electron changes it velocity from a constant velocity (V_k) to a **higher constant velocity** (V_n), as shown on ***Fig.II.1.***

II.1.The soliton and the hydrogen atom

In Bohr's hydrogen atom, the velocity of the electron at the upper level (***k***) is smaller in comparison with its velocity at the lower level (***n***), (Fig.II.1). The electron in a stationary state does not emit photons. The Coulomb and gravitational forces are in equilibrium with the centrifugal forces between the electron and proton moving around their centre of mass. Because the gravity forces are negligible (about 10^{-42} times) in comparison with the electromagnetic forces, Bohr has neglected the gravity. Without this **rational approximation,** the energy of the emitted photon must be:

$$J_{nk} = \frac{(e^2 + gMm_0)^2 m_0}{2\hbar^2}\left[\left(\frac{1}{n^2} - \frac{1}{k^2}\right)\right]$$

where ***M*** is the mass of the proton (m_0 is the mass of electron). Bohr's approximation is so perfect that Rydberg's constant of hydrogen (R_0), the energy of the levels, the frequencies of the lines (in the maximum) are all in very good agreement with the experiments (when corrected with equivalent mass of proton and electron). Everyone must think that Bohr's approximation is completely satisfactory and cannot hide essential things from us. Some hypotheses show though that it may be not so. One can make a **logical assumption** that the gravity field energy is negligible, **but is a constant and necessary part** from the total energy of the particle. Gravity fields of proton and electron, expanded as plane monochromatic waves, have one and the same wave-length ($\lambda = \hbar/MV = \hbar/m_0 v = \hbar/p$). The two particles form an undivided hydrogen atom.

The assumptions I make here are:

a) The particle's trajectory coincides with the velocity's direction, and consequently, the gravity wavelength λ must be measured along the particle's trajectory. In a stationary state, the proton and electron are both positioned at the maximum of the gravity's amplitude, and cannot emit photons. The cause is that the photon must take its gravity energy from the hydrogen's gravity energy. When this happens, the proton and the electron must change their positions.

b) If the atomic center of mass moves with respect to surrounding objects with velocity V_a, the gravity wave length of hydrogen is $\lambda_h = \hbar/(M+m_0)V_a$.

c) The product of the full particle's momentum p, and the *gravity wave length* λ, ***is the Planck's constant*** $\hbar = p\lambda$. The same constant ($\hbar$) is the ratio between the full energy of a particle, J, and its gravity frequency, $\hbar = J/\omega$. This likes the speed of light, which can be expressed as $c = J/p$ and $c^2 = J/M$.

The experiments [20] with ultra-cold neutrons show that their motion in Earth's gravitational field (in special conditions) deviates strongly from the gravity law ($1/R^2$) and this deviation is explained very accurately using de Broglie's wave. When two or more particles interact, the gravity energy conservation law and the gravity momentum conservation law as well, should not be neglected. For example, when a particle soliton is emitted, its gravity energy must be a part of the full atomic gravity energy. An **electromagnetic particle - soliton plus it gravity wave is what I call photon**.

Gravity is an inherent property of nature, penetrates in all natural phenomena and gravity waves become observable for microscopic masses and comparatively small velocities. The gravity frequency does not depend on the *direction of velocity* ($\omega = J/\hbar$), and therefore the soliton plus a corresponding gravity energy (photon) can be emitted only when **the absolute value** of the charged particle's velocity changes. When an excited atom decays, two processes start: first, the electron accelerates, when spiralling from upper excited state (k) to the lower state (n) (its absolute velocity increases). Second, at the same time (simultaneously with acceleration), soliton's gravity volume starts to increase (from zero), the electromagnetic field amplitude (E_0) reaches its maximum value at the maximum of electron's acceleration. After this, the electromagnetic amplitude decreases to zero (zero acceleration) and the photon (soliton plus gravity wave) is emitted. Ggravity wave reaches a frequency (ω_{kn}), which corresponds to the energy of the photon. The process terminates when the electron reaches the lower level velocity (V_n), and its gravity frequency $\omega_n = \omega_{kn} + \omega_k$. So, the soliton gravity energy – (constant part of the total atomic gravity energy) is conserved ($\omega_{kn} = \omega_n - \omega_k$). **It must be remembered that when describing electron's motion about the centre of mass, an equivalent description holds for proton's motion.** The absolute proton's velocity and acceleration are very small in comparison with electron's one, but the gravity waves of the two particles have **wave-length λ and form a solitary quantum system able to emit a single photon** (during an effective time period $t_e=1/2\omega$)**. Copenhagen school accepts that it is *useless*** to think about this period. In some mysterious way the electron passes from the upper to the lower level ("quantum jumps").

It must be accepted that the effective action time of a soliton's electric field (emitted from a hydrogen atom), (Fig.I.2), **corresponds to the effective time of transition in the hydrogen atom,** (Fig.II.1). Then one can find the average value of the effective acceleration of the electron (when the transition occurs), and knowing this acceleration, it is possible to obtain the energy of the emitted photon.

II.2. Acceleration.

The effective time ($t_e=1/2\omega_{kn}$) of the soliton requires a corresponding acceleration time of the electron when the electron passes from upper (***k***) to lower level (***n***). On the Fig.II.1, the absolute velocities (V_k, V_n) are shown schematically together with the average acceleration ($a(t)$). The effective time of acceleration and the shape of the acceleration curve must correspond to the effective time of the soliton and to the shape of soliton electric field. Knowing the absolute velocities (V_k and V_n – perpendicular to trajectory radius), one can obtain the effective acceleration ($a(t)$) of the electron when passing from upper level (***k***) to lower level (***n***). The corresponding velocities (according to Bohr's approximation) are:

$$V_k = e^2/\hbar k; \quad V_n = e^2/\hbar n \qquad \text{(II.1)}$$

If gravitational force is taken into account, then the velocities are:

$$V_k = (e^2+G_cMm_0)/\hbar k; \quad V_n = (e^2+ G_cMm_0)/\hbar n \qquad \text{(II.1a)}$$

Now this correction is not necessary and for simplicity (II.1) will be used.

The effective acceleration is:

$$a = dV/dt = (V_n - V_k)/t_e = (e^2/\hbar)(1/n - 1/k)/t_e \qquad \text{(II.2a)}$$

Substituting (t_e) we obtain:

$$a = 2\omega_{nk}(V_n - V_k) = (2e^2\omega_{nk}/\hbar)(1/n - 1/k) \qquad \text{(II.2b)}$$

The effective path (H_{nk} is the travelled effective distance) of the electron while changing it state is:

$$H_{nk} = (a/2)t_e^2 + V_k t_e \qquad \text{(II.3)}$$

Substituting here (t_e), and V_k from (II.1), one can find the effective path:

$$H_{nk} = (e^2\omega_{nk}/\hbar)(1/n - 1/k)(1/4\omega_{nk}^2) + e^2/\hbar k(1/2\omega_{nk})$$

$\boldsymbol{H_{nk} = e^2/\hbar(1/2\omega_{nk})((1/2)(1/n - 1/k) + 1/k)}$ (II.4)

II.3. Energy of the photon-soliton.

According to the classical electrodynamics, when a charged particle emits energy, the force of electromagnetic reaction must be included. The average force, taking into account the reaction, due to the force of emission, is $\mathbf{F} = \boldsymbol{am_0}$. This force is a result of the Coulomb and gravitation fields of hydrogen atom, and the reaction to the photon emission (soliton plus gravity wave). So, the energy (J_{nk}) lost by the atomic system can be expressed, substituting the necessary quantities, by the equation:

$$J_{nk} = \mathbf{FH_{nk}} = am_0H_{nk} \qquad \text{(II.5)}$$

Substituting (II.2) and (II.4) into (II.5), and using II.1a, we obtain:

$$J_{nk} = \frac{(e^2 + G_c M m_0)^2 m_0}{2\hbar^2}\left[\left(\frac{1}{n^2} - \frac{1}{k^2}\right)\right] \qquad \text{(II.6)}$$

This is the energy, which the electromagnetic particle – photon (soliton plus its gravity energy), carries. The gravity frequency (de Broglie's ω_{nk}), is:

$$\omega_{nk} = J_{nk}/\hbar = \frac{(e^2 + G_c M m_0)^2 m_0}{2\hbar^3}\left[\left(\frac{1}{n^2} - \frac{1}{k^2}\right)\right] \qquad \text{(II.7)}$$

As it can be seen, in this way, the energy obtained through the absolute effective acceleration of the electron, coincides exactly with the results of Bohr.

From the classical electrodynamics we know that a free electromagnetic field is proportional and perpendicular to the acceleration vector of the charged particle emitting it, and to its direction of propagation. The energy of the emitted field is redistributed in the whole space and diminishes with the distance (***r***) as $1/r^2$. The field has a maximum at a direction perpendicular to the acceleration vector. Up to now it was not possible to calculate the effective value of the electron's acceleration in the hydrogen atom because the time for electron's velocity change was not accessible for investigation. Even the questions "how long is this time" and "when does the transition occur" are forbidden from Copenhagen. Now, the properties of the soliton determine this time as well as the effective acceleration. According to the classical electrodynamics, the electric field of soliton must be perpendicular (in every moment t_e) to both the acceleration vector ***a(t)***, and the direction of propagation, which coincides with the ***x***-axis (Fig.I.2). Because the acceleration vector ***a(t)*** is strictly in the orbit's plane, the maximum of electric field must be parallel to the orbit's plane (but perpendicular to ***a(t)***). The effective time of emission restricts the length ($\boldsymbol{l_e}$ along ***x*** direction), and the effective cross-section $\boldsymbol{S_e}$ is a surface in the orbit's plane within which the charges are accelerated. So, the soliton's volume is $\boldsymbol{V_e=S_e l_e}$ **,** and $\hbar\omega_{nk}$ corresponds to energy lost by the hydrogen atom. Something more, all energy losses of the atom can be transferred (in vacuum) at a very large, unrestricted distance. This means that the total photon energy (in volume $\boldsymbol{V_e}$) moves in direction perpendicular to the orbit's plane.

These properties of the photon and the hydrogen atom are not trivial and they must be examined in more details. If the solitons with these properties exist in nature, then the **transitions in a hydrogen atom must take a time $t_e = 1/2\omega_{nk}=\lambda/4\pi c$,** and an atom in an excited state must be comparatively stable.

II.4. The Shape of Acceleration and the Shape of Electromagnetic Field of the Soliton.

Fig.II.1 shows only an example of velocities and acceleration curves. These curves are not known exactly, because the shape of electromagnetic field of the soliton is also not known exactly. We know from the electrodynamics that the shape of the two curves must essentially coincide (in different units). The two curves can be *symmetrical or not symmetrical*, but independently of their exact shape, we can calculate the integral values of all necessary parameters. As it can be seen from (II.4), for $n = 1$ and $k = 2$ the effective path is equal to the Bohr's radius r_0:

$$H_{nk} = \frac{\hbar^2}{e^2 m_0} = r_0 \approx 5.3\text{x}10^{-11}\text{m}$$

It is three times smaller than the distance between the two orbits ($3r_0$). The real way of electron (L) probably is a spiral curve between orbits ***k*** and ***n***, with a length L > $3r_0$. So, one can make the assumption, that the gravity wave packet of photon is many times longer than the effective length of the electromagnetic particle-soliton. The energy of the soliton $\boldsymbol{J_{nk}}$, as it must be, does not depend on the effective time t_e, but this time is essential for the shapes of the curves.

II.5. The possible shapes of soliton curves.

Most often the shape of soliton curve (with a form like a contour of a bell) [11] is described by the equation:

$$E = (2\boldsymbol{E_0}/\tau)\text{sech}[(\text{t} - x/v)/ \tau] \quad \text{(II.8)}$$

Where τ is connected with the effective width (1/2ω) of the soliton's electric field. It is not clear that the electromagnetic field of the soliton corresponds exactly to (II.8), but according to the definition, the electric field in the maximum of the curve ($\boldsymbol{E_0}$) and effective time ($\boldsymbol{t_e}$) are related:

$$\boldsymbol{E_0 t_e} = \int_{-\infty}^{\infty} E(t)dt \qquad \text{(II.9)}$$

The simplest electric field *(E(t))* of the soliton in vacuum can be written:

$$E(t) = E_0 \frac{2}{(\exp((t_i - t)/t_e) \ + \exp(-(t_i - t)/t_e)} \qquad \text{(II.10)}$$

Also, *E(x)* must be:

$$E(x) = E_0 \frac{2}{(\exp((x_i - x)/l_e) + \exp(-(x_i - x)/l_e))} \qquad \text{(II.10a)}$$

If the soliton's electric field corresponds to (II.10), then the electron's ($\boldsymbol{a(t)}$) must have the same shape:

$$\boldsymbol{a(t)} = \boldsymbol{a_0} \frac{2}{(\exp((t_i - t)/t_e) + \exp(-(t_i - t)/t_e)} \qquad \text{(II.11)}$$

Here $\boldsymbol{a_0}$ is the acceleration at the maximum ($\boldsymbol{a_0} \sim \boldsymbol{E_0}$) and

$$\boldsymbol{a_0 t_e} = \int_{-\infty}^{\infty} a(t)dt \qquad \text{(II.12)}$$

The time $\boldsymbol{t_i}$ (**"own life time"**) is the time from the moment of excitation of a solitary atom in state ***k*** up to the moment of disintegration (transition to a lower state, or decay).. The time ($\boldsymbol{t_i}$), and the distance ($\boldsymbol{x_i}$), can eventually contain many, but not necessary entire number of orbit's lengths. The shapes of the two curves (II.10) and (II.11) should not be accepted as exact, but they must correspond to each other, since the equations (II.9) and (II.12) are exact by definition. On Fig.II.1, the velocity curve is described by $\boldsymbol{V \sim th((t_I - t)/t_e)}$, *and the acceleration* by $\boldsymbol{a(t) \sim sech((t_I - t)/t_e)}$.

II.6. Average Velocity of the Electron in Transitions (Quantum Jumps).

Knowing the effective length of a soliton in vacuum ($\boldsymbol{l_e}$), and the effective path of the electron ($\boldsymbol{H_{nk}}$), one can estimate the average velocity of an electron ($\boldsymbol{v_{nk}}$) when it travels the effective distance $\boldsymbol{H_{nk}}$:

$$\boldsymbol{H_{nk} = v_{nk} t_e} \qquad \text{(II.13)}$$

and

$$\boldsymbol{l_e = c t_e} \qquad \text{(II.14)}$$

So, the ratio of the two velocities is

$$\boldsymbol{v_{nk}/c = H_{nk}/l_e} \qquad \text{(II.15)}$$

When a transition occurs between ***k*** = 2 and ***n*** = 1, this ratio is:

$v_{nk}/c \approx 5.4x10^{-3}$

The average effective velocity of the electron is about 3 orders of magnitude smaller than the speed of light.

II.7. "When the Transitions Occur ("own life time", t_i= ?)"

Bohr's model concerns a solitary hydrogen atom with the most important initial conditions, $m_0 V_n r_n = n\hbar$. These initial conditions coincide with Bohr's stationary states, which never decay. For a statistical ensemble of quantum systems, **every individual hydrogen atom probably has a few different initial conditions from these of Bohr's (different energy of excitation)**. Then the atoms are not in a stationary state and can decay. (To be more specific, I remember ***the law of radioactive decay,*** $N=N_0\exp(-t/\tau)$, which concern a statistical ensemble **only**. The majority of scientists transform this law in probability (W) that a **solitary object** does not decay during a time (***t***): $W= \exp(-t/\tau)=N/N_0$).

A return to the real unitary field-particle of de Broglie and to Bohr's model of hydrogen atom. Gravity waves in hydrogen atoms are such that in the stationary state the mass of the electron (m_0), its velocity V_n and orbit radius r_n are related with the principal quantum number (n) according to:

$$m_0 V_n r_n = n\frac{h}{2\pi} = n\hbar \qquad \text{(II.16)}$$

The field-particle (electron) is in the potential well of a gravity wave, which keeps the electron in orbit n, and the electron cannot be accelerated (does not emit a soliton together with its corresponding gravity field). The length of gravity wave exactly satisfies the condition:

$$2\pi r_n = \frac{nh}{m_0 V_n} = n\lambda_n \qquad \text{(II.17)}$$

The equilibrium between Coulomb force, gravitation force, centrifugal force and positive interference of gravity wave cannot be destroyed, and **without an external perturbation, a soliton cannot be emitted. External perturbation is not necessary for decay of atom.** Suppose that energetically excited the electron can randomly occur at any distance (r_{ni}) *close* to the exact radius of the stationary orbit ($2\pi r_{ni} \neq n\lambda_n = 2\pi r_n$). Such **"Initial conditions"** are different for different atoms. The difference between the trajectory of the electron ($2\pi r_{ni}$) and $n\lambda_n$ can be very small, yet – the destructive interference leads (after some time, t_i) to a transition to a lower state. Imagine the gravity wave of the electron and the proton interfere as long as the minima of one wave coincides with the maxima of the other wave so that the amplitude ($G(t)$) of the interfering gravity waves becomes $|G(t)|^2 = 0$. This state is not allowed [17], **acceleration occurs** and the photon energy is emitted as explained previously. The larger the difference $|r_{ni} - r_n|$, the smaller the time necessary for destructive interference. If $|r_{ni} - r_n| \to 0$, the energy corresponds almost to the energy in a stationary state) the time for destructive interference would be very long. When the radial co-ordinates coincide (***r**$_{ni}$* = ***r**$_n$*) (**Bohr's initial condition**), a true stationary state would be established and without an external perturbation, this state could not decay. So, it is evident that the electron can be excited so, as to occur at all possible distances (***r**$_{ni}$*) from the proton.

II.8. Own Lifetime of a Single Hydrogen Atom.

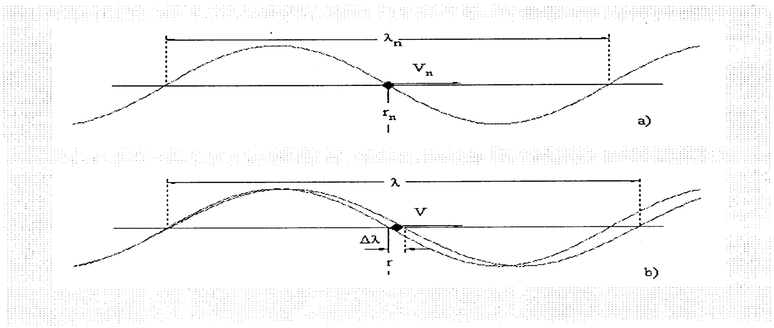


Fig.II.2. A scheme of a hydrogen excited states. Wave-particle of the electron and its interference; a) true stationary state; b) almost stationary state.

In Fig.II.2 a schematic wave-particle in some excited state of the hydrogen atom is shown. In Fig.II.2a) the velocity of the electron V_n is such that λ_n and r_n correspond exactly to Bohr's condition:

$$\lambda_n = \frac{h}{m_0 V_n} \qquad \text{(II.18)}$$

Such wave electron-proton returns (each time it makes a period) with the same phase and repeats its motion for an infinitely long time. If the velocity of the electron (*V*) is slightly different, the new λ will also be slightly different (compared with λ_n):

$$\lambda = \frac{h}{m_0 V} \qquad \text{(II.19)}$$

Such wave electron-proton would arrive (each time it makes a period) with a slightly different phase. With time, this phase difference increases. The moment when the sum of the amplitudes becomes zero (for the first time) can be calculated; electron-proton are no more in the potential well. The moment this occurs defines the *own lifetime* (***t$_i$***) of this excited atom. The sum of the amplitudes of electron-proton gravity wave can be written (like for classical particles, [17]):

$$G(t) = \sin\left(\frac{2\pi}{\lambda}(Vt - r)\right) + \sin\left(\frac{2\pi}{\lambda}(Vt)\right) \qquad \text{(II.20)}$$

Here r is the new radius, which is only slightly different from r_n. The relation between wave length (λ), frequency (ω), and velocity (V) is:

$$\lambda = \frac{2\pi V}{\omega} \qquad \text{(II.21)}$$

Substituting (II.21) in (II.20) gives:

$$G(t) = \sin\left(\omega t - \frac{\omega r}{V}\right) + \sin(\omega t) \qquad \text{(II.22)}$$

In Bohr's model, $r/V = 1/\omega$, therefore (II.22) becomes

$$G(t) = \sin(\omega t - 1) + \sin(\omega t) \qquad \text{(II.23)}$$

which is the sum of the gravity wave amplitude, (G(t), (de Broglie's amplitudes) expressed by the time and the frequency of a not-exactly-stationary state. From (II.18) and (II.19) the small differences $\Delta\lambda$ and $\Delta\omega$ are found $\Delta\omega = \omega_n - \omega$):

$$\frac{\Delta\lambda}{\lambda} = \frac{\lambda_n - \lambda}{\lambda} = \left(\frac{V}{V_n} - 1\right) = \frac{\omega}{\Delta\omega} \qquad \text{(II.24)}$$

Taking into account that in Bohr's model

$$\frac{V}{V_n} = \sqrt[3]{\frac{\omega}{\omega_n}} = \sqrt[3]{\frac{\omega_n + \Delta\omega}{\omega_n}} \qquad \text{(II.25)}$$

from (II.24), the gravity frequency ω (different from stationary gravity frequency ω_n) is found:

$$\omega = \left(\Delta\omega\left(\sqrt[3]{\frac{\omega_n + \Delta\omega}{\omega_n}} - 1\right)\right) \qquad \text{(II.26)}$$

The moment (***t$_i$***) when $|G|^2 = 0$ has to be found:

$$|G(t)|^2 = |\sin(\omega t_i - 1) + \sin(\omega t_i)|^2 = 0 \qquad \text{(II.27)}$$

Hence

$$\sin(\omega t_i - 1) = -\sin(\omega t_i) \qquad \text{(II.28)}$$

or

$$t_i = \frac{1}{2\omega} \qquad \text{(II.28a)}$$

So, substituting the "**non-stationary-frequency"** ($\omega \neq \omega_n$) from (II.26), gives the needed **"own lifetime"** (t_i):

$$t_i = \frac{1}{2\Delta\omega\left(\sqrt[3]{\frac{\omega}{\omega_n}} - 1\right)} = \frac{1}{2\Delta\omega\left(\sqrt[3]{\frac{\omega_n + \Delta\omega}{\omega_n}} - 1\right)} \qquad \text{(II.29)}$$

This is the time for which the electron-gravity wave stays at some orbit and electron cannot be accelerated. As it is seen, when $\omega = \omega_n$ ($\Delta\omega = 0$), the time is $t_i \to \infty$, as it should be for Bohr's stationary states. For $\Delta\omega << \omega_n$, the expression for the time (II.29) is symmetric (for positive and negative $\Delta\omega$). It is more convenient to transform (II.29) in terms of *the* energy (ΔJ):

$$t_i = \frac{\hbar}{2\Delta J\left(\sqrt[3]{\frac{\Delta J}{J_n} + 1} - 1\right)} \qquad \text{(II.30)}$$

where the energy can be measured in units eV and $\hbar$ [eV.s]. The energy of the different excited states can be expressed through the Rydberg's constant (R). Thus, the *own lifetime* of each single excited hydrogen atom depends on the small energy difference (ΔJ) and the principal quantum number (n):

$$t_i = \frac{\hbar}{2\Delta J\left(\sqrt[3]{1 + \frac{n^2 \Delta J}{R}} - 1\right)} \qquad \text{(II.31)}$$

In the case when $n^2 \Delta J << R$, the denominator can be expanded in series, and taking only two first terms of the expansion ($1 + n^2 (\Delta J)/3R$ ...) to give:

$$t_i = \frac{3\hbar R}{2(\Delta J)^2 n^2} \qquad \text{(II.32)}$$

Part of the results are shown in the Fig.II.3 (for $\hbar$=6.59x10^{-16} eV.s and R=13.595 eV). These curves are different for different ΔJ (about excited states, J_n). They could be compared with the normalised "**own lifetimes**" of the nuclei ([21,23] and Fig.II.5).

"**The *own lifetime***" (***t**$_i$*) of a solitary hydrogen atom (published 1999 [21]) and that of a nucleus (1971, [23]) depend on the possible initial ΔJ, which can be different for different solitary quantum systems. For a hydrogen atom, ΔJ depends on the initial co-ordinates and momenta of electron-proton system. Because the "**own lifetime**" of a nucleus [23] also depends on ΔJ, it can be assumed that the initial conditions for the nuclei are **also the initial co-ordinates and momenta of the particles as in the classical mechanics.**

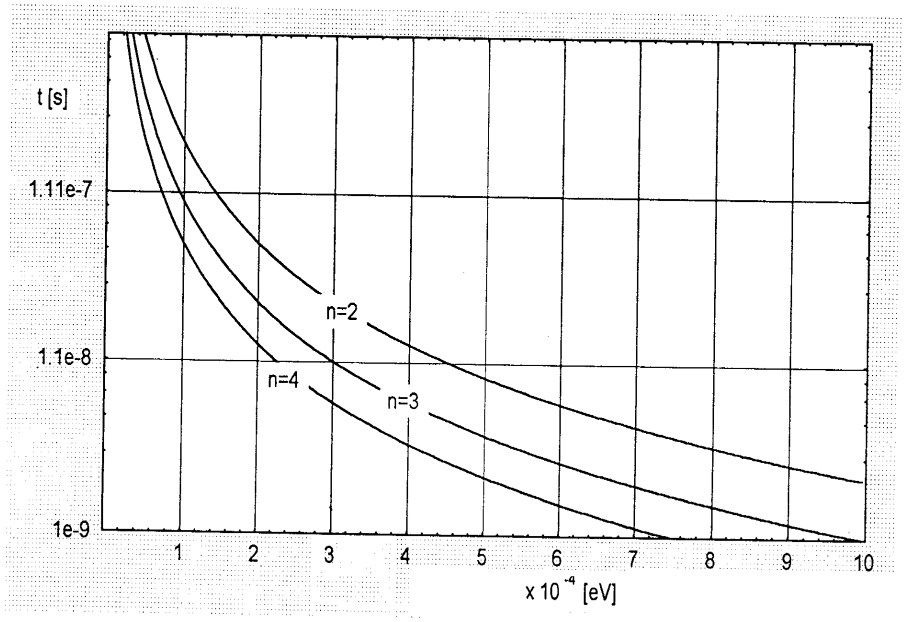


Fig.II.3. Time (t_i) versus energy ($\Delta J x 10^{-4}$[eV]) for n=2,3 and 4. These curves are symmetrical to the curves for energy differences (-ΔJ) to the left of zero (J_n) Its can be compared with Fig.II.5 [23].

These exact calculations contradict the uncertainty principle. The energy of a single hydrogen level is exactly calculated. **The readers are forced to choose between the inherent in science** (from Copenhagen school) **uncertainty** principle, and the **inherent in Nature gravity energy.** I choose the inherent in nature gravity energy conservation in any elementary interaction of particles (in spite of the negligibly small gravity energy).

The time (t_i) cannot be measured experimentally (except in the case for resonant Mossbauer transitions in nuclei (natural width of the first excited state), [23]). Real experiments with hydrogen measure only the mean lifetime (τ_n) of an ensemble of excited atoms. The statistical natural width (Γ_n), and the mean life times (τ_n) of the levels (for different excited states) of an *ensemble* of hydrogen atoms will be found **and compared to the reference data**. Let us assume that N_0 [cm^{-3}] atoms ("thin target") are irradiated by a flux of photons with uniform energy distribution

$\Phi(J) = \Phi_0[\text{cm}^{-2}\text{s}^{-1}] = \text{const.}$ (in the region of some quantum level ***n***). If the effective cross-section of excitation is σ_E, then, the change in the excited level population can be expressed as:

$$\frac{dN}{dt}(t) = \Phi_0 \sigma_E N_0 \left(1 - \exp(-t/\tau_n)\right) \qquad \text{(II.33)}$$

As it is well known, after the irradiation stops, the activity changes with time in the following way:

$$\frac{dN}{dt}(t) = \Phi_0 \sigma_E N_0 \left(\exp(-t/\tau_n)\right) \qquad \text{(II.34)}$$

On the other hand, the differential cross-section ($d\sigma_E$) is:

$$d\sigma_E = \frac{\sigma_0 \Gamma_n dJ}{4(\Delta J)^2 + \Gamma_n^2} \qquad \text{(II.35)}$$

(σ_0 is the cross-section at the maximum; Γ_n is the statistical width of level (n)). Then the integral cross-section (σ_E) will be:

$$\sigma_E = \frac{\pi\sigma_0}{2} \qquad \text{(II.36)}$$

Substituting (II.36) in (II.34) gives the change in the excited state population with time after excitation:

$$\frac{dN}{dt}(t) = \Phi_0 \frac{\pi\sigma_0}{2} N_0 \left(\exp(-t/\tau_n)\right) \qquad \text{(II.37)}$$

Under the same conditions, but using the differential cross-section (II.35), shows how the excited state population $\frac{dN}{dt}(J)$ increases with irradiation time:

$$\frac{dN}{dt}(J) = \frac{\Phi_0 N_0 \sigma_0 \Gamma_n dJ}{4(\Delta J)^2 + \Gamma_n^2}\left(1 - \exp(-t/\tau_n)\right) \qquad \text{(II.38)}$$

To derive an expression for this activity after irradiation, from (II.32) the variation of the "own lifetime" with energy (J) is:

$$dt_i = \frac{3\hbar R dJ}{(\Delta J)^3 n^2} \qquad \text{(II.39)}$$

Because of the symmetry of (II.32), with respect to the energy, within the time interval (dt_i) the atoms decay in the two intervals $|\pm\Delta J|$ on both sides of J_n:

$$dt_i = \frac{3\hbar R dJ}{(\Delta J)^3 n^2} + \frac{3\hbar R dJ}{(\Delta J)^3 n^2} = \frac{6\hbar R dJ}{(\Delta J)^3 n^2} \qquad \text{(II.40)}$$

or

$$dJ = \frac{(\Delta J)^3 n^2 dt_i}{6\hbar R} \qquad \text{(II.41)}$$

Substituting (*dJ*) in (II.38) gives the activity of hydrogen atoms *after irradiation*:

$$\frac{dN}{dt}(J) = \frac{\Phi_0 N_0 \sigma_0 \Gamma_n (\Delta J)^3 n^2 dt_i}{\left(4(\Delta J)^2 + \Gamma_n^2\right) 6\hbar R} \qquad \text{(II.42)}$$

Two expressions for the activities are found: (I.42) depends on the energy of excitation (ΔJ), and (II.37) depends on time (***t***). In the experiments, the two activities (II.42) and (II.37) must be equal:

$$\frac{\Phi_0 N_0 \sigma_0 \Gamma_n (\Delta J)^3 n^2 dt_i}{\left(4(\Delta J)^2 + \Gamma_n^2\right) 6\hbar R} = \Phi_0 \frac{\pi \sigma_0}{2} N_0 \left(\exp(-t/\tau_n)\right) \qquad \text{(II.43)}$$

In the specific case when $\exp(-t/\tau_n)$=1/2, then $\Delta J = \Gamma_n / 2$ (Fig.II.5), and the expression (II.43) becomes:

$$\frac{\Gamma_n^2 n^2 dt_i}{24\hbar R} = \pi \qquad \text{(I.44)}$$

Hence, the natural width (Γ_n) of a statistical ensemble of atoms (per unit time interval, $\boldsymbol{dt_i}$=1) can be calculated as:

$$\Gamma_n = \frac{1}{n}\sqrt{24\pi\hbar R} \qquad \text{(I.45)}$$

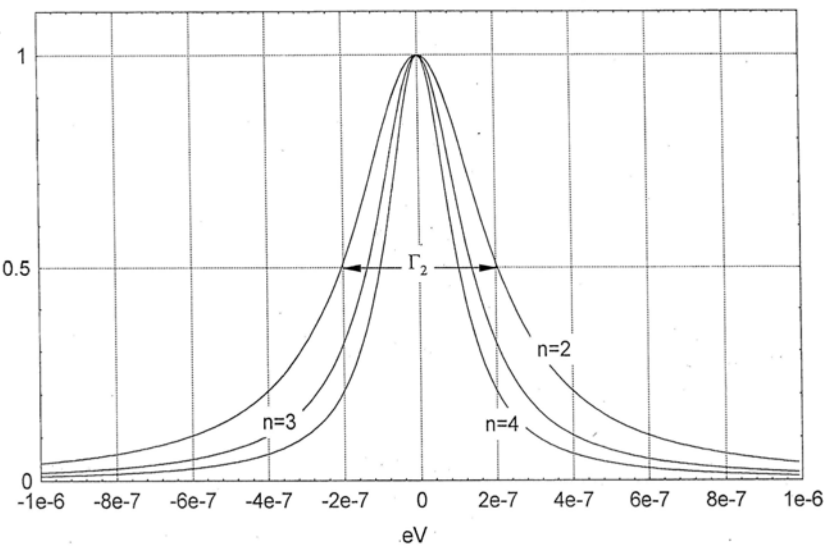


Fig.II.4. Natural width of the level of hydrogen statistical ensemble (n=2,3,4). Horizontal scale in absolute units [eV].

The population of a statistical ensemble and the natural level widths (normalised at the maximum) are shown in Fig. II.4. It is easy to derive the mean lifetime of all excited atoms (at level *n*):

$$\tau_n = \frac{\hbar}{\Gamma_n} = n\sqrt{\frac{\hbar}{24\pi R}} \qquad \text{(II.46)}$$

Thus, to calculate the mean lifetime of a **statistical ensemble** of excited hydrogen atoms at level (***n***), only Rydberg's constant (*R*) and Planck's constant ($\hbar$) are needed. The corresponding decay constants (Einstein's coefficients of spontaneous emission A_n) are $A_n = 1/\tau_n$.

II.10. Comparison with Reference Data (Only Experimental Data Exists).

The numerous reference tables on hydrogen (only experimental data exists) give quite different values for τ_n (especially for low binding energies of the excited states; *n*>2). In Table II.1 the experimental data from [24] (1966) and [25] (1986) is compared to the calculations presented above (formula II.46, published [21], 1999).

Table II.1. ***The values of*** $\tau_n = 1/A_n$ ***from the present paper (1999) are closer to the values of data in column ([25] 1986). The difference between experimental data from column [24] (1966) and [25] (1986) are impermissible.***

	Data references					
	[24] 1966		**[25] 1986**		**[21] 1999**	
n	τ_n, s	A_n, s^{-1}	τ_n, s	A_n, s^{-1}	τ_n, s	A_n, s^{-1}
2	**$2{,}12.10^{-9}$**	**$4{,}7.10^{8}$**	**$1{,}60.10^{-9}$**	**$6{,}25.10^{8}$**	**$1{,}60.10^{-9}$**	**$6{,}23.10^{8}$**
3	**$10{,}0.10^{-9}$**	**$1{,}0.10^{8}$**	**$3{,}94.10^{-9}$**	**$2{,}53.10^{8}$**	**$2{,}40.10^{-9}$**	**$4{,}15.10^{8}$**
4	**$33{,}0.10^{-9}$**	**$0{,}3.10^{8}$**	**$8{,}00.10^{-9}$**	**$1{,}24.10^{8}$**	**$3{,}20.10^{-9}$**	**$3{,}12.10^{8}$**

As it can be seen, for the second excited state (*n*=2) the calculated τ_n is equal to $1.603\text{x}10^{-9}$ s, while in ([24],1966) this time is $\tau_n = 2.127\text{x}10^{-9}$ s and in ([25],1986) $\tau_n = 1.60\text{x}10^{-9}$ s. So, the result from the present calculations (1999) is in **excellent agreement with the reference data (1986) (for *n*=2).** It is necessary to stress that my calculations give values closer to the values from ([25],1986). The differences between the experimental values of [24] and [25] are greater than the differences between the actual calculations and the experimental data [25], (1986). So, *Bohr's model (complemented with de Broglie's-Bohm's ideas) continues to describe hydrogen properties (mean lifetime, natural width of the levels) as exactly as Bohr's hydrogen model describes the frequency of radiation and Rydberg's constant.*

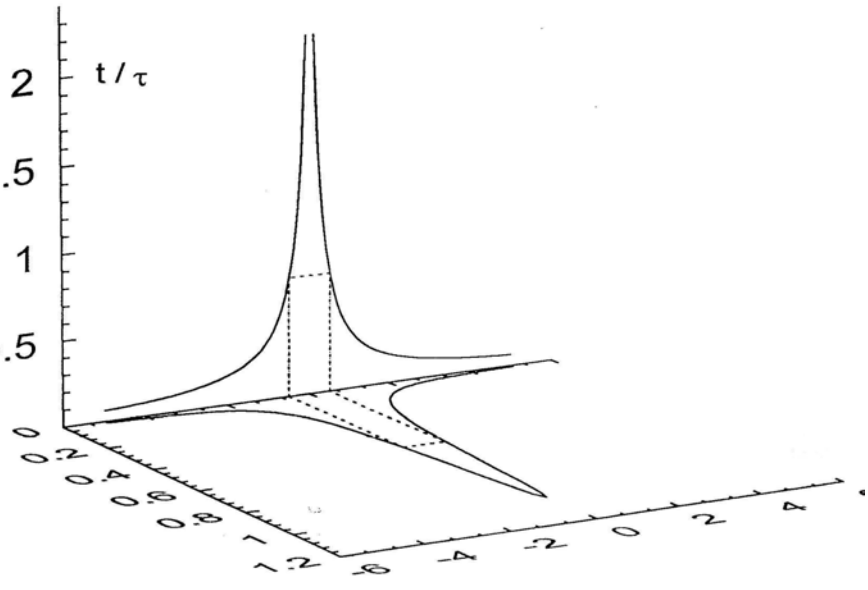


Fig.II.5.Time (t/τ) versus energy of excitations ($\Delta J / \Gamma_n$) and normalized natural width of the first excited state (in nucleus [21,23]). When the decay moves from the wings of the level ($\infty \mapsto |\Delta J|$) to the energy $\Delta J = \Gamma_n / 2$, half of the excited atoms have decayed and exp($-t / \tau_n$)=1/2.

II.11. Inconsistencies in the Reference Data.

As it is known, the experimental accuracy of the frequency measurements is much better in comparison with the accuracy of time measurements. An attempt to explain the large differences in the reference data [24, 25] will be made. Experimental results are good only for the first excited states. The mean lifetimes (up to now) are determined only experimentally. There is not a suitable theory. The experiments are comparatively exact for *n* = 2 only. The differences between the reference data (for *n* > 2) are caused by experimental difficulties and incorrect application of the relation between Einstein's coefficients, which is explained in [21, 26, 27].

In [24], the transition probability for spontaneous emission from an upper state *k* to a lower state *i*, A_{ki}, is related to the total experimental intensity I_{ki} of a line of frequency ν_{ik} by

$$I_{ki} = \frac{1}{4\pi} A_{ki} h \nu_{ik} N_k \text{ (expression (1) on page ii of [24])} \qquad \text{(II.47)}$$

where *h* is Planck's constant, and N_k the population of the state *k*. It was shown in [21, 27] that this relation holds for transitions from any excited state *k* to the ground state *i* only. If (*i*) is also an excited state, then relation (II.47) becomes:

$$I_{ki} = \frac{1}{4\pi}(A_{ki} + \frac{g_i}{g_k} A_{ix}) h\nu_{ik} N_k \qquad \text{(II.48)}$$

where A_{ix} is the full decay constant of level (i) and g_i, g_k are the corresponding statistical weights. Only when A_{ix}=0 (ground state), (II.48) coincides with (II.47). The same applies for the transition probability of absorption B_{ik}, and the transition probability of induced emission B_{ki}, in [24]:

$$B_{ik} = 6.01\,\lambda^3 \frac{g_k}{g_i} A_{ki} \quad \text{(expr. (6), p. vi of [24])} \qquad \text{(II.49)}$$

$$B_{ki} = 6.01\lambda^3 A_{ki} \quad \text{(expr. (7), p. vi of [24])} \qquad \text{(II.50)}$$

(λ is the wavelength in Angstrom units). When (i) is an excited state, these relations are also wrong. According to [21, 27], these relations (in the same units as in [24]) become:

$$B_{ik} = 6.01\,\lambda^3 \left(\frac{g_k}{g_i} A_{ki} + A_{ix} \right) \qquad \text{(II.51)}$$

$$B_{ki} = 6.01\,\lambda^3 \left(A_{ki} + \frac{g_i}{g_k} A_{ix} \right) \qquad \text{(II.52)}$$

It is also seen that if (i) is a ground state, $A_{ix} = 0$, these relations correspond to the relations in [24]. It is clear that even based on experimental results (when $n > 2$), τ_n can have wrong values if expressed using the inappropriate (but commonly accepted) relations.

The mean lifetimes of excited levels of the simplest atom - hydrogen - obtained herein are in surprising agreement with the known data. At the same time, the differences between the reference values for n>2, shows that all reference data for transition probabilities in hydrogen must be critically examined and adjusted accurately according to the present results (formulae II.46, II.48, II.51, II.52). **For the first time, experimental results for the mean lifetime of a hydrogen statistical ensemble are compared with theoretical calculations (obtained with a set of initial conditions for a solitary hydrogen atom).** *The mean lifetime (τ_n) is a characteristics only of a statistical ensemble of excited atoms*.

If a transition occurs between two excited states (J_n = R(1/n^2) and J_k = R(1/k^2), the frequency of the emitted photon is calculated according to: $(J_n - J_k)/\hbar = \omega_{nk}$. The energy spread of many photons (Γ_{nk}) is the sum of the statistical level widths of many atoms: $\Gamma_{nk} = \Gamma_n + \Gamma_k$. So, for a *statistical ensemble* of hydrogen atoms, the distances of electrons from the protons (or energies) are very different. In such an ensemble the probability to find an electron at some from the proton has a maximum at the position of Bohr's stationary orbits. This probability is smaller at other places, but never becomes zero. For the co-ordinate systems related to the *centre of mass of each hydrogen atom*, these probabilities are presented on Fig.II.4 (natural widths). For a laboratory co-ordinate system, the probabilities depend by the motion of the centre of mass at different velocities ($\boldsymbol{V_i}$) (temperature) and different $\lambda_i=\hbar/((\boldsymbol{M}+\boldsymbol{m_e})\boldsymbol{V_i})$. The results are consistent with the experiments. I think that all these solitary objects contradict the Copenhagen's interpretations, but do not contradict Bohm's and de Broglie's point of view.

To pay honour to Luis de Broglie who wrote:

"In the spring of my life, I was obsessed with the problems of quanta and the coexistence of waves and particles in the world of micro-physics: I made decisive efforts, although incomplete, to discover the solution. Now, in the autumn of my existence, the same problem still preoccupies me because, despite of the many successes and the long way passed, I do not believe that the enigma is indeed resolved. The future, a future which I undoubtedly will never see, will probably resolve the problem: it will tell whether my present point of view is an error of an already sufficiently old man who is still devoted to the ideas of his youth, or, on the contrary, this is a clairvoyance of a researcher who all his life has meditated on the most important question of contemporary Physics". (L. de Broglie, ***Certitudes et incertitudes de la Science***, Edition Albin Michel, Paris, 1966, p. 22; a free translation from French).

It is clear that the photon-soliton properties obtained here, and the new initial conditions, are not all necessary initial conditions needed to explain other properties of the soliton, hydrogen and heavier atoms. **It is also clear that Bohm's and de Broglie's point of view cannot be further neglected despite that their concepts require more intellectual efforts to solve the simplest (but most basic) questions "beyond the Quantum Physics".**

III. SPACE-TIME CORRELATED (ENTANGLED) PHOTON-SOLITONS

In the last years of the twentieth century, many theoretical and experimental works dedicated on the two-particle entanglement were published. The experiments with photons confirm the standard theory. Some wrongly interpreted experiments confirm non-locality. The contemporary interpretations permit one of the correlated photons to influence its twin-brother instantaneously at a very large distance. *This illusion* is possible because the two photons have a common wave function that cannot be separated. I hope to show that the common wave function of the two photons describes only the possibility of photon propagation in space. The real gravity waves of the two photons are independent, correlated solitons (particles) that must act in different ways. Also, signals **cannot be sent faster than light velocity**.

III.1. Solitons, Gravity Wave and Common Wave Functions.

We shall assume the electromagnetic field of the soliton to be described by the function, $E(t,x) = E_0 sech((t-x/c)/t_e)$ (II.10, II.11). Because nothing is known about the shape of the gravity field, I assume $G(x,t) \sim E(t,x)$ and will use some other logical assumptions as well:

a) The gravity field volume is $V_g = S_g l_g \geq V_e = S_e l_e$;

b) In spite that solitons and gravity fields have tree dimensions, expanded gravity fields satisfy the common wave function $\varphi = A cos(\omega(t-x/c))$. ($x$ is the axis of soliton propagation (Fig.I.2) and **A** is a normalized constant);

c) Gravity field is $G(t,x) = G_0 sech((t-x/c)/t_g)$ ($G_0 \sim E_0$). The plane of polarization coincide with the maximal electric vector E_0.

d) The gravity field effective volume is many times larger than the electromagnetic effective volume ($S_g l_g >> S_e l_e$), but for simplicity (in the beginning) I accept that (independently of the large difference in their energy density), the two volumes coincide, and ($S_e = S_g$; $l_e = l_g$).

As it will be seen later, these approximations are not essential. If it is assumed that the gravity wave function is proportional to the electric field of soliton and a common wave function, then space-time gravity wave functions of one photon must be:

$$\varphi_g(t) \sim E(t,x) cos(\omega(t-x/c)) \qquad \text{(III.1)}$$

$$\varphi_g(x) \sim E(t,x) cos(2\pi/\lambda)(x-x_0)) \qquad \text{(III.1a)}$$

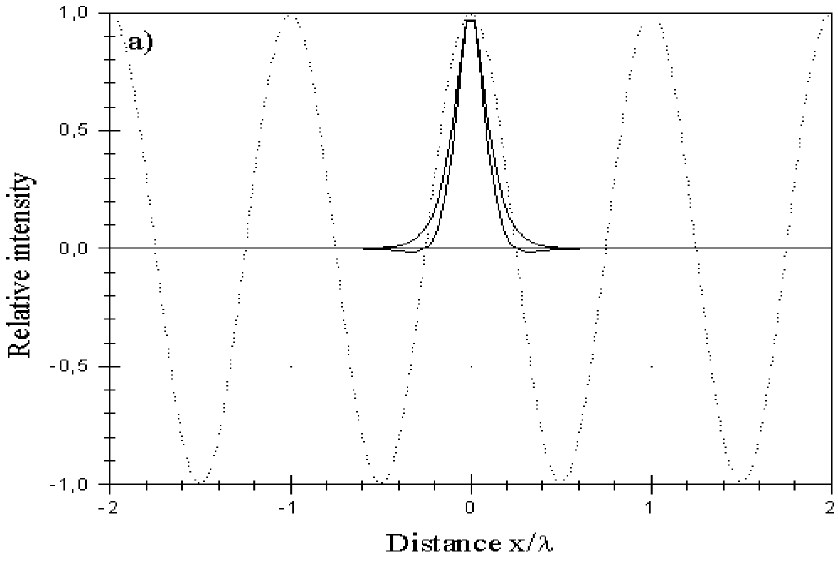
When $E(t,x) \sim G(t,x)$ and x_0 is the distance between the source and the detector, then the initial time of emission is $t_0 = x_0/c$, and (III.1) becomes:

$$\varphi_g(t) = G_0 sech(2\omega(t-t_0)) cos(\omega(t-t_0)) \qquad \textbf{(III.2)}$$

and,

$$\varphi_g(x) = \left(\frac{(2G_0)\cos((2\pi/\lambda)(x-x_0))}{(\exp(4\pi/\lambda)(x-x_0)) + \exp(-4\pi/\lambda)(x-x_0)))} \right) \qquad \textbf{(III.3)}$$

Here $E_0 = K^{1/2}\omega^{3/2} \sim G_0$. For $G_0 = 1$, the function $\varphi_g(x)$ is shown on Fig.III.1.



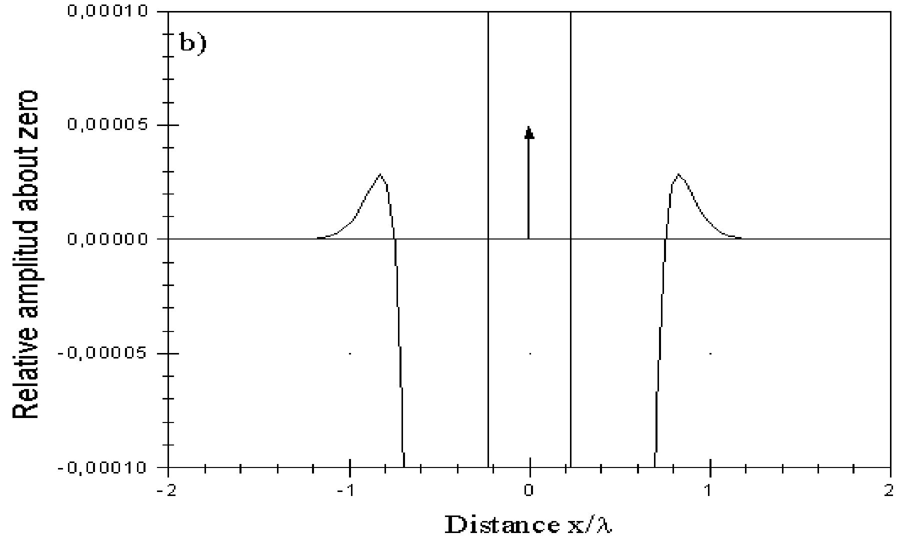


Fig.III.1 One spontaneously emitted soliton: a) Shape of the soliton – larger line at x=0; gravity wave function – thinner line at x=0; common wave function – dotted line b) Solid line – real gravity wave function of one emitted photon-soliton around zero amplitude. The position of the soliton is marked with an arrow.

Expression (III.3) gives the symmetrical gravity wave function of any **spontaneously emitted** separate (solitary) photon. Two spontaneously emitted photons (even with equal energy, frequency and polarization) cannot be described with one and the same common wave function ($\varphi(x)$ or $\varphi(t)$) *because* they are emitted from different points (charges), have different directions, different initial times (t_0), and different positions in space.

The stimulated photons are the first that are correlated by common wave functions ($cos(\omega(t-t_0))$ and $cos((2\pi/\lambda)(x-x_0))$. For two stimulated photons the gravity frequency, direction, and fixed polarization exactly coincide, and the phase shift between first (stimulating) and second (stimulated) photons is always constant **-** π [27,28]**.** In time (or space) the superposition of two successively emitted stimulated photons can be represented:

$$\varphi_g(t)= (sech(2\omega(t-t_0))+sech(2\omega(t-t_0-\pi/\omega)))cos(\omega(t-t_0)) \qquad (III.4)$$

$$\varphi_g(x)= (sech(4\pi(x-x_0)/\lambda)+sech(4\pi(x-x_0)/\lambda-0.5))cos(2\pi(x-x_0)/\lambda) \quad (\lambda=1) \qquad (III.4a)$$

For $x_0 = 0$, the superposition (III.4a) is shown on Fig.III.2. This is a real gravity wave superposition of photons correlated in space and time. The correlated double gamma-quanta where observed in the very precise experiments of Davidov's group (Russian, [29]) and explained in [28]. These experiments show that the two gamma-quanta interact independently: if the probability for registration of a single gamma-photon on a detector is (ε), then the probability for registration of two photons simultaneously on the same detector is ε^2, and the registered energy is twice higher. If two detectors are positioned one after the other at a distance d_0, and the probabilities for registration correspond to ε_1 and ε_2, then the common probability for registration of two photons (on different detector) is $\varepsilon_1\varepsilon_2$. The energy registered on each detector is equal to the energy of one photon. The time interval between the registration of each photon will be $\Delta t=d_0/c$.

I must emphasize that although the two solitons (and gravity waves) are coupled strongly and described by a common wave function, they can act in different ways in time, independently from each other (for example the first producing a photo-effect, the second – Compton effect).

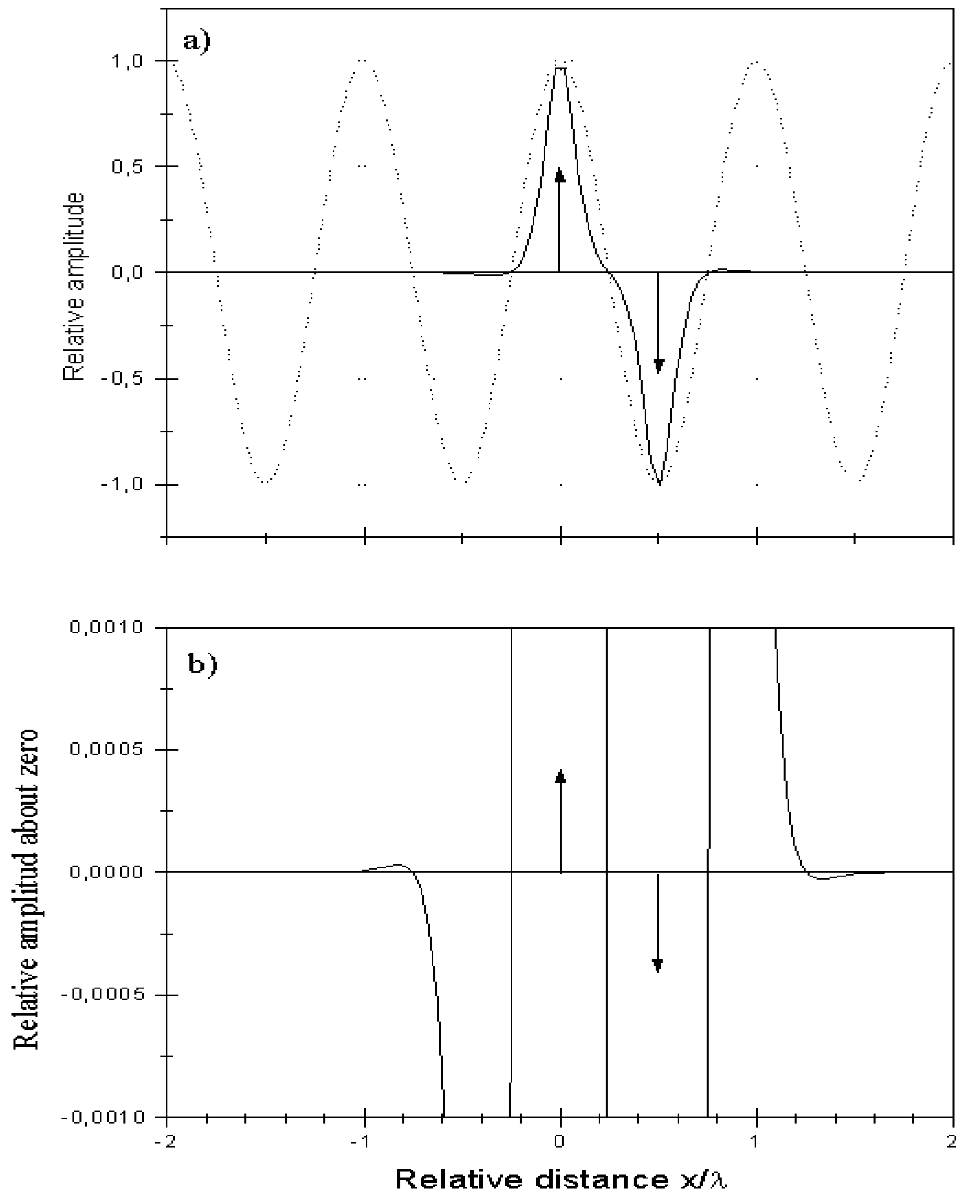


Fig.III.2 Stimulating (arrow at x/λ=0.5) and stimulated photons (arrow at x/λ=0): a) solid line – real gravity wave; dotted line is common for the two soliton wave function. b) The gravity wave function around zero amplitude is very long. The arrows show the positions of the stimulated and stimulating solitons.

A small part of a mirrorless laser beam with a few correlated photon-solitons is shown on Fig.III.3. The enveloping common wave function shows that in some places the number of solitons is smaller than in other places and multiplication grows at the end of the active media. In a mirrorless laser beam, the first soliton remains solitary and the average number of photons grows at the end. As it is known from experiments [30] –

(many photons photo-effect) - when the energy of N photons (solitons) at a maximum (|*cos(ωt)*|) is sufficient for ionization (*J*), then the photo-effect becomes possible ($N\hbar\omega \geq J$). These solitons can interact simultaneously in spite that $\lambda \geq \lambda_0$ (λ_0 is the ordinary maximum characteristic limit for the photo-effect in corresponding medium). If many solitons occupy the same maximum in a common wave function, then they can act simultaneously. From experiments [30] it is clear that they don't have to always act simultaneously.

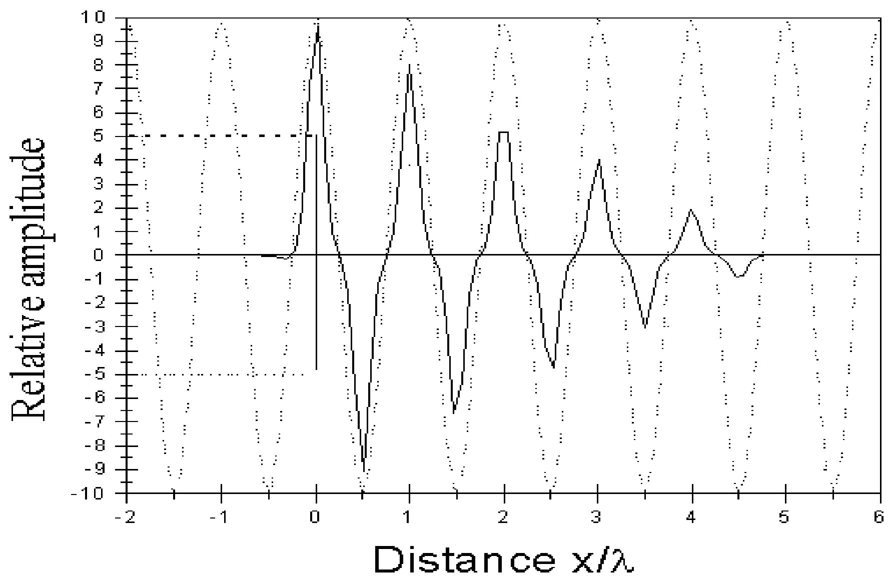


Fig.III.3: A short beam from a mirrorless laser with very small amplification: from one photon in initial position (t=0) to an average of about 10 photons at the end (the relative amplitude shows the number of photons). The common wave function – doted line - is the same as in Fig.III.1 (and III.2). The first maxima are partially empty. Population inversion medium is to the left of zero.

In an ordinary laser the mirrors reflect many times solitons and its *average number* in every maximum of the function (|*cos(ωt)*|) is constant. If a larger number of photon-soliton is absorbed, the remaining photons are described by the same common wave function (Fig.III.3). This is used in many experiments (where coherent photons with very low intensity are necessary).

When a classical antenna emits photons, the situation is different from lasers. Because of synchronization of charges movement (in metals free electrons around positive ions), the charges emit single photon-soliton in a random direction. At a remote point of observation (in comparison with the length of the antenna) many photons arrive from slightly different directions and continue to propagate in different directions. They cannot be exactly correlated in space and time. Because the frequency and polarization of photons can be one and the same, this correlation is possible as an approximation only (at large distance from the antenna and in a relatively small region in space). *Classical electromagnetic waves are an approximation of the photon properties only.*

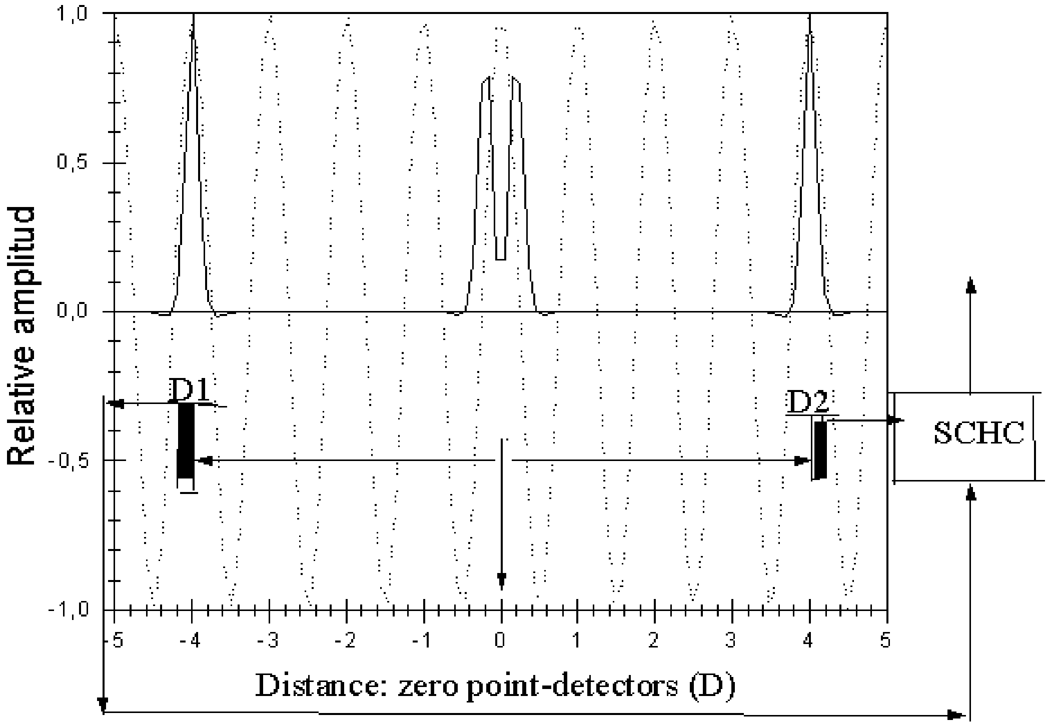


Fig.III.4. Two space-time correlated solitons: the double solid line (at x=0) represents two gravity waves of solitons at a distance x=0.2λ from the charges; the gravity waves at distance x=±4λ (solid) and the common wave function - doted line.

III.2. Space-time Correlation of Two Particle-Solitons Propagating in Different Directions.

At the end of the last century, the technology of some special crystals excited with laser beams allows the receiving of two space-time-correlated photons. They are created in the same small volume (almost a point $\boldsymbol{P_0}$ in comparison with $\boldsymbol{l_e} < \lambda$), propagate at the speed of light in different directions and can be described by a common wave function. In the case when two solitons are simultaneously created at point $\boldsymbol{P_0=0}$ on axis $\boldsymbol{x}$ (due to the laser pumping) and the two waves propagate in positive and negative directions, the **common wave function** is:

$$\varphi(x)=(1/2)(\cos((2\pi/\lambda)(x-x_0))+\cos((2\pi/\lambda)(-x-x_0))); \quad (x_0 = ct_0) \qquad \text{(III.5)}$$

The real **gravity wave** containing two solitons with equal polarization is:

$\varphi_g(x)=(1/2)(\cos(2\pi(x-x_0)/\lambda)\operatorname{sech}(4\pi(x-x_0)/\lambda)+\cos(2\pi(x+x_0)/\lambda)\operatorname{sech}(4\pi(x+x_0)/\lambda))$ (III.6)

The positions of the two photons with a common wave function are shown on Fig.III.4. The two particles (solitons plus gravity fields) move always together at the phase velocity of the common wave function maximum (in Fig.III.4 for solitons at $x=\pm0.2\lambda$ this is not shown).

III.3. Spin of the Photon and Other Possible Properties?

It was accepted that the plane of polarization of soliton is defined by the maximum electric vector, $E_0 \sim G_0$. If a solioton is created by charges similar to the hydrogen atom, then the electric field ***E(x)*** is slightly torsion with respect to the plane of polarization. According to classical electrodynamics, ***E(x)*** must be simultaneously perpendicular (in later moment, ***x/c***) to the charge acceleration vector and the vector of propagation. The last vector coincides with the ***x***-axis. So, the vectors ***E(x=0)*** and $E(x=l_e=\lambda/4\pi)$ have to make an angle Ω, when looking in direction perpendicular to the orbit plane (Fig.III.5).

Probably the soliton can be emitted in one or in other direction with respect to the orbit plane and the sign of the torsion angle (Ω) will be left or right. I must emphasize that the angle between vectors $E(l_e)$ *and* ***E(0)* is constant in space and time**. The polarization (plane of vector E_0) is also constant. ***The electric field does not rotate*** in space *about the* ***x*** *axis because the emission of the electric field stops together with the charge acceleration,* and the vector E_0 preserves its direction (in the space). The angle (Ω) can be calculated using the effective path, H_{nk}:

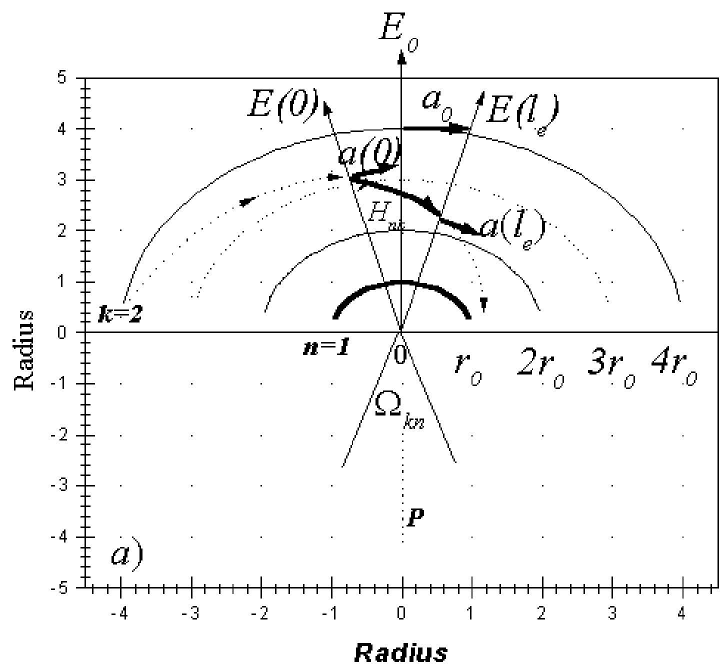
$H_{nk}=(\hbar^2/e^2 m_0)/(1/2n-1/2k)$,

which is in the orbit plane. The distance l_e (perpendicular to orbits plane) is:

$$l_e = ct_e = c/2\omega = \frac{c\hbar^3}{e^4 m_0}\left(\frac{1}{n^2}-\frac{1}{k^2}\right)^{-1} \qquad \textbf{(III.7)}$$

where l_e is the effective length of the soliton in space. For the period $t_e=1/2\omega$ from acceleration vector ***a(x)*** (perpendicular to radius in point $H_{nk}=0$) changes from ***a(0)*** to acceleration vector $a(l_e)$ (perpendicular to radius in the end of H_{nk} (arrows)). Somewhere between these two points must be found the maximal acceleration vector a_0. From Fig.III.5 the torque of photon for transition (***k,n***) must be:

$$\Omega_{nk}(l_e) = H_{nk}/ l_e = (e^2/c\hbar)(1/2n+1/2k) \qquad \textbf{(III.8)}$$



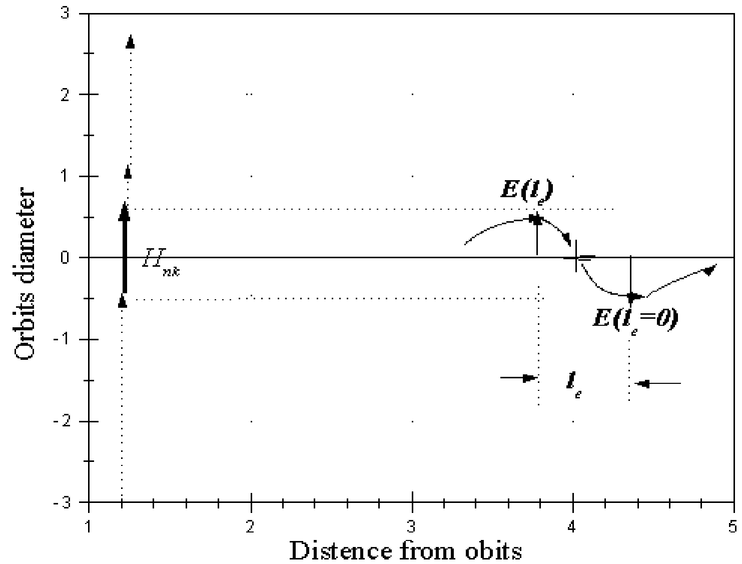


Fig.III.5: Up) Schematic view perpendicular to orbit's plane: r_0, r_4 – two orbits (n=1;k=2). Transition trajectory – doted line with arrows. The photon can be emitted either in our direction or in the opposite direction. The angle, Ω - between the vectors a(0) and $a(l_e)$ corresponds to (E(0), $E(l_e)$); effective path, H_{nk} – thick line. Vertical line, P - plane of polarization. In this plane the electron acceleration a_0 has a maximum, and soliton has a maximum amplitude E_0 (perpendicular to a_0). Below: Schematic view parallel to the orbit and polarization planes. l_e=ct_e is distance between vector E(0) and $E(l_e)$ (parallel to orbit's plane) .

This probably is a very important result because ***$\Omega_{nk}(l_e)$ may be connected with the spin of photons,*** and ***$(e^2/c\hbar)=\alpha$*** $\approx 1/137$ is the well known universal constant – **the fine structure constant.**

When ***n***=1, ***k***=2, ***$\Omega_{nk}(l_e) \approx 0.00547$ rad*** or ***$\Omega_{nk}(l_e)$*** $\approx 1.97^o$. (Compare with the results for the ratio between the average velocity ***v_{nk}*** and the speed of light ***c*** (II.15)). From **(III.8)** follows: ***$2\Omega_{nk}(l_e) = (e^2/c\hbar n)+(e^2/c\hbar k) = \Omega_n+\Omega_k$; $\Omega_n=(e^2/c\hbar n)$; $\Omega_k=(e^2/c\hbar k)$.***

The corresponding electron velocities are: ***$V_n=c\Omega_n=(e^2/\hbar n)$*** and ***$V_k= c\Omega_k=(e^2/\hbar k)$.*** So, the spin of a photon (***S_{ph}***) **must be** the difference between the angular momenta of two states of the hydrogen atom:

$$S_{ph}= (e^2/\hbar k)r_k m_0 - (e^2/\hbar n)r_n m_0 = (k-n)\hbar \qquad (III.9)$$

Probably the gravity field is parallel to the electric field, and the torque angle is the same ***$\Omega_{nk}(l_e)$***. When the soliton is emitted in a direction which is different relatively to the orbit plane, then the torque**, *$\Omega_{nk}(l_e)$*,** and spin **(*S_{ph}*)** (vectors) must be opposite.

III.4. Soliton Electric Field and Gravity Field.

Here I will discuss different (new) possibilities of a photon structure**.** The results of the following paragraph are only some guessed properties of the photons and must not be assumed real. They show only that the *relative dimensions and the shape of the soliton and gravity fields are not essential and cannot change the common properties of photons.* It becomes possible for the volumes of the electromagnetic soliton and the gravity field to no longer be symmetrical and equal in the space. After the maximum acceleration (***a_0***), the velocity of emitting charge is larger than before acceleration ***a_0*** (Fig.II.1). The required time to travel a distance (***X_1)*** between ***E(0)*** and ***E_0*** is larger than the required time to travel a distance (***X_2***) between ***E_0*** and ***$E(l_e)$***. So, ***$X_1<X_2$***, but (by definition, part I), we always have ***$X_1+X_2=l_e$.*** Even if ***E(t)*** is a symmetrical function with respect to it center ***E_0***, the function ***E(x)*** is larger in the direction of propagation, than in the opposite direction (with respect to ***$E_0\sim a_0$***). The volume of the gravity field (***$S_g l_g$***) is probably many times larger than the volume of the electromagnetic soliton (***$S_e l_e$***). One example of asymmetrical soliton (***$X_2=2X_1$***) and gravity field length ***$l_g=10l_e$*** is shown on **Fig.III.6**.

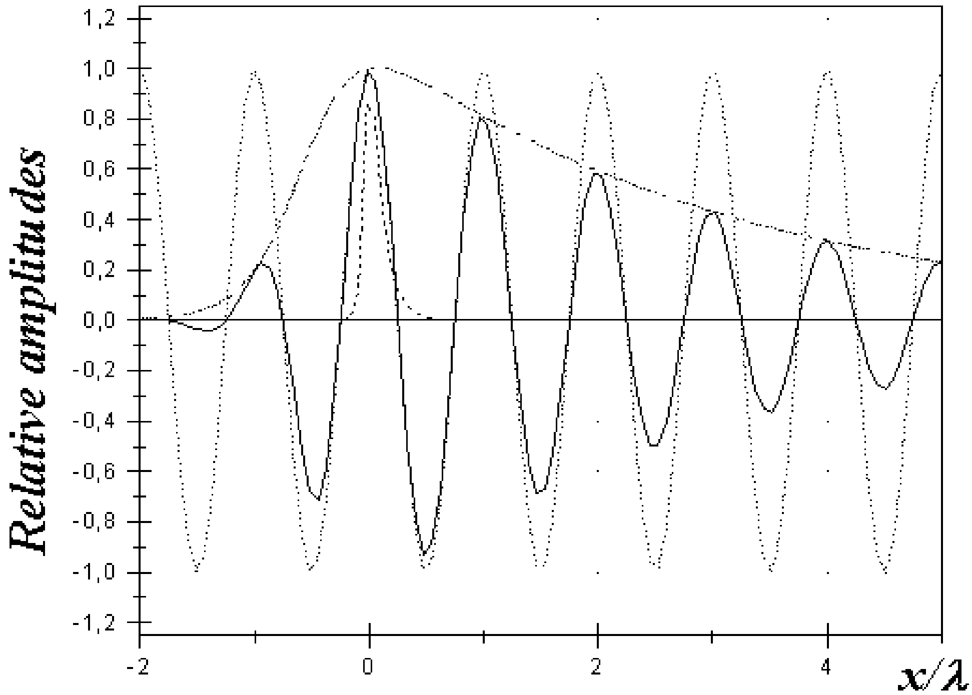


Fig.III.6. Asymmetric soliton (electric field) - dot line around x=0; gravity field - dot-dash line; gravity wave function - solid line; common wave function – dot line.

The difference with Fig.III.1 can not influence our investigations and now we cannot decide how many times the gravity volume is greater than the soliton volume. One may think that the ratio between the gravity volume and the soliton volume is inversely proportional to the energy density of soliton (ρ_s), and the energy density of the corresponding gravity field (ρ_g):

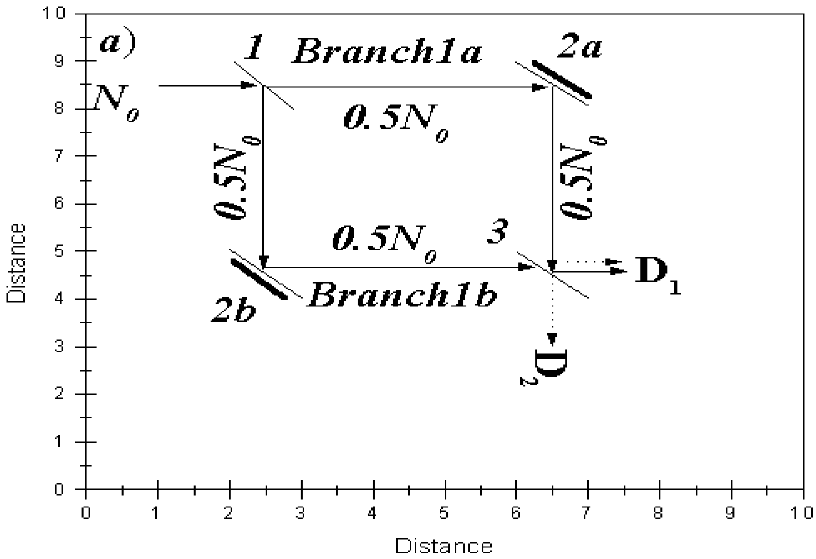
$$(V_g = S_g l_g)/(V_e = S_e l_e) \sim \rho_s/\rho_g. \qquad \textbf{(III.10)}$$

The energy of the gravity field is many times smaller than the energy of the electric field:

$$V_g \rho_g << V_e \rho_s \qquad \textbf{(III.11)}$$

Fig.III.6 is only an example; it brings another point of view; it is not essential, but it is shown for better understanding that **not all photon-soliton properties are precisely known**. As it is seen from the comparison of Fig.III.1 and Fig.III.6, in the second Figure, the gravity waves **get ahead of and drop behind** the electromagnetic soliton at different rate, which depends on the ratio $l_g/l_e \geq 1$. Expression (III.10) allows calculating ρ_g if the gravity volume ($l_g S_g$) can be estimated (or vice versa). This allows for better understanding of interference experiments [31-33], problems in books [34,35] and better (visual) understanding of **experiments like these of Alley** [36, 37].

The simplest scheme of Alley's experiments is shown on Fig.III.7. It represents an interferometer with two branches. The first mirror (***1***) splits the photon beam (***N_0*)** in two, with equal photon number (***$0.5N_0$***) in each branch. In the "empty" branch propagates only the gravity wave. The mirrors ***2a*** and ***2b*** reflect almost completely the gravity waves, and the mirror ***3*** is semi-transparent. The sum of registered photons at the two outputs must be equal to the number ***N_0*** (neglecting absorbed photons). The authors made many interesting experiments, but I choose only one result, which is very important for me. If the optical path difference (in two branches) is smaller than the photon length of coherence (effective gravity wave length), and the output distance from mirror (***3***) to detector **D_2** is a multiple of ***$\lambda/2$*** but the output to detector **D_1** is a multiple of λ, then the detector **D_1 must register *N_0*** photons and detector **D_2 zero photons**. This was observed experimentally. In the direction of detector **D_2,** the gravity amplitude of de Broglie's wave (because of destructive interference) becomes zero, and contrary, the gravity amplitude of the wave in the direction of detector **D_1** (because of constructive interference) becomes greater (compared to a separate gravity amplitudes). So, the solitons pass only towards the detector **D_1**. The particle (soliton) does not exist at positions of zero gravity amplitude (compare this with the electron in an excited state of hydrogen, part II). The mirror ***3*** becomes completely transparent for photons in ***branch 1b,*** and completely reflecting for photons in ***branch 1a***. In this way it **must be accepted** that the soliton gravity wave can be split, scattered or absorbed by other particles. Gravity waves can exist and act independently of the particles and their infinitely feeble energy can be transferred to other particles and cannot be observed at present. The described experiments are probably indirect observations of gravity waves. The interference of gravity waves (like the "gloves" of solitons) is possible if the interfering parts arise from one and the same photon (self-interference). This must be accepted because in this case the conditions for interference are fulfilled: equal polarization, frequency, phase shift, torsion angle and common wave function. These conditions are fulfilled for different but stimulated laser photons.



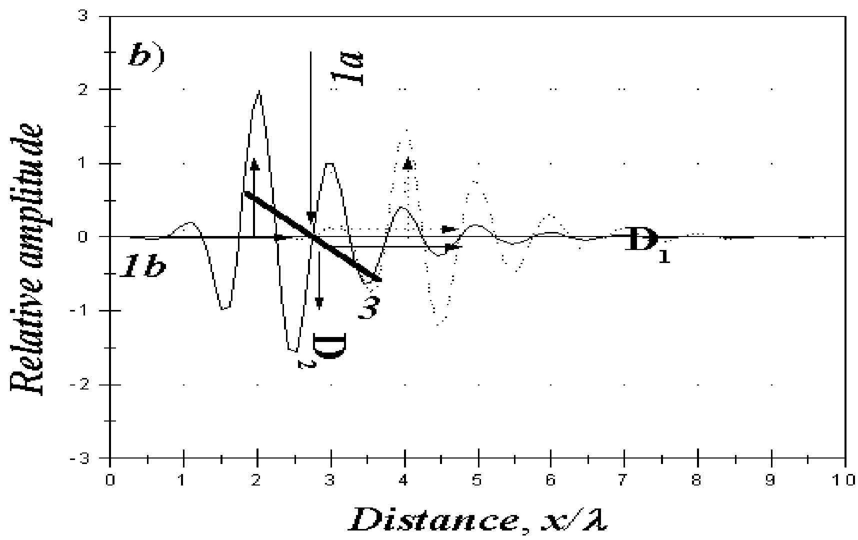


Fig.III.7. a): An interferometer with two equal branches (1a and 1b). Outputs – towards detector D_1 and towards detector D_2 can be different (here output D1 is multiple to λ but output D_2 is multiple to $\lambda/2$).

b): Part of the interferometer around mirror 3. At the output towards detectors D_1 the interference of gravity waves is positive, and towards detector D_2 (multiple to $\lambda/2$) it is negative. All input soliton-photons pass toward detector D_1.

III.5. Executed and Not Executed Experiments.

Here I will discuss some already executed experiments with correlated photons and will propose new experiments beyond the contemporary quantum predictions (and expectations).

The following calculations are consistent with the known experimental results and confirm the assumptions that the photon, may be, consists of an electromagnetic particle-soliton (not a point), and a gravity wave. The assumption that the photon is a soliton plus a gravity wave makes the correlated photons (twin-brothers) independent and separable from their **mathematical** common wave function. For example, when one of the photon is absorbed, then the other is no more correlated (but does not disappear). The real soliton is inseparable from it gravity wave package – the wave of de Broglie – because the energy of any particle includes the gravity field energy. When the photon interacts with charged particles, its energy (electric, magnetic and gravity) changes intermediary soliton's electric field.

Beyond the contemporary experiments. With the help of two space-time correlated photons it becomes possible to perform the double-slit interference experiments in which the particle-soliton must pass **obligatory** only through one of the slits, but the gravity wave passes both opened slits (contradicting Copenhagen's interpretation). My point of view shows an unexpected result: when one of the twin brothers (soliton) *is **obliged** to pass only one of the slits* (*two slits open)*, then the interference pictures are very good. Such experiment was impossible with ordinary photons. It is also shown that the "ghost" interference pictures are possible when one of the soliton pair passes a double-slit but other passes a transparent homogenous plate. In an executed experiment [31] instead of a transparent homogeneous plate, a "Heisenberg's lens" is used. Some of the results obtained here are already confirmed experimentally, but the others expect to be verified in the experiments – contradicting some of the Copenhagen's expectations.

For experimental check, the theory of spontaneous parametric down-conversion (SPDC) is the most effective source of two-photon light, consisting of pairs of entangled photons (Dopfer, 1998 [31], Strekalov, 1995 [32], Zeilinger, 1999 [33]).

The two entangled photons must make equal angles with the direction of the laser beam (pump) and must lie in the plane of the laser beam. Only in this case they are twin brothers: created in one and the same moment and position, with equal frequencies, constant phase shift and constant difference of polarization (E_{01} and E_{02}). Here it is assumed that the correlated photons contain solitons with the properties described in this work. I analyze the two-slit interference of the space-time-correlated photons and show that the results of the calculations are consistent with the already known experimental data [31-33, 38-42]. New essential experiments are proposed.

III.6. Two double-slits with the two beams.

On the Fig.III.8, a scheme of a simplified experimental arrangement is shown. The source (S) of spontaneous parametric down-conversion (SPDC) of correlated pairs is placed between two double slits (1) and (2) at distances L_1 and L_2. The direction of the laser beam (pump) is perpendicular to the plane of the Fig.III.8 at the place of the source on the axis (O,O). After the beam of photons passes the slits, the two photons can be registered by the detectors D_1 and D_2 at corresponding distances (r_1 and r_2) between the double-slits and the detectors. The difference from [31,33] is that we assume the source dimensions (S) to be small in comparison with the distances (L_1,L_2), and a standard Young's interference picture could be observed after each double slit. In the following the possibility of Young's interference observation is referred as a "point-like source". In [31] the second double-slit is replaced with a "Heisenberg lens". Later in this work, the "Heisenberg lens" will be replaced by a transparent parallel plate.

So, as an ordinary source of spontaneously emitting photons, the two independent interference pattern can be observed (Young's interference) by the independent detectors D_1 and D_2 (without coincidences). The interference pictures depend on geometrical arrangements of the two double-slit (1, 2), the distances (L_1, L_2, d_1,d_2) and the slits widths (a, b). For simplifier the calculations it is accepted $a = b < \lambda = (2\pi c/\omega)$. Using the classical assumptions [34, 35] for interference of the waves and accepting that each photon contains an electromagnetic particle – soliton, which cannot exist without its real gravity wave (de Broglie's λ) one can write for the amplitudes (A_1 and A_2) after the two double-slits (Fig.III.8).

Young's interference. When on the double-slits one of the *slits is closed* (no interference), then the amplitudes at the places of the detectors $\mathbf{D_1}$ and $\mathbf{D_2}$ (using complex representation [34]) are:

$$A_{01}(r_1,\vartheta_1) = F_1 exp(-i\omega t_1); \qquad F_1 = (1/r_1)\,|cos\vartheta_1| \qquad \text{(III.12)}$$

$$A_{02}(r_2, \vartheta_2) = F_2 exp(-i\omega t_2); \qquad F_2 = (1/r_2)\,|cos\vartheta_2| \qquad \text{(III.13)}$$

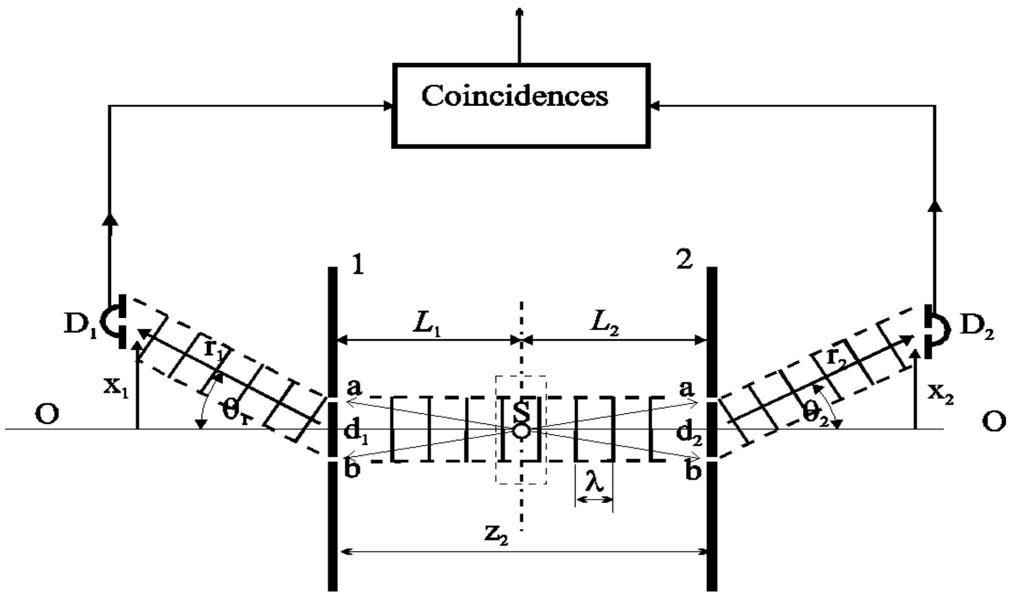


Fig.III.8. Two double slit interference. The arrangement is an enfolded version of the experiments described in [31]. The source (S) is a point in comparison with $L=L_1=L_2$.

When the *two slits are open*, then the soliton can pass only one of them, but the gravity wave pass the two slits and interfere. The soliton can be found in some (and only one) direction (ϑ_1, ϑ_2). The amplitudes of the gravity waves at the detectors' positions are:

$$A_1 = F_1 exp(-i\omega t_1)[(exp(-i\omega d_1/2c) sin\vartheta_1) + (exp(i\omega d_1/2c) sin\vartheta_1)] \quad \text{(III.14)}$$

$$A_2 = F_2 exp(-i\omega t_2)[(exp(-i\omega d_2/2c) sin\vartheta_2) + (exp(i\omega d_2/2c) sin\vartheta_2)] \quad \text{(III.15)}$$

One can make the substitutions:

$$[(exp(-i\omega d_1/2c) sin\vartheta_1) + (exp(i\omega d_1/2c) sin\vartheta_1)] = C_1$$

$$[(exp(-i\omega d_2/2c) sin\vartheta_2) + (exp(i\omega d_2/2c) sin\vartheta_2)] = C_2$$

$$C_1 = 2|cos((\pi d_1/\lambda) sin\vartheta_1)|; \quad sin\vartheta_1 = x_1/r_1 \quad \text{(III.16)}$$

$$C_2 = 2|cos((\pi d_2/\lambda) sin\vartheta_2)|; \quad sin\vartheta_2 = x_2/r_2$$

The interference pattern observed independently by two detectors will be:

$$|A_2|^2 = F_2^2 C_2^2 = (1/r_2)^2 cos^2\vartheta_2 4cos^2((\pi d_2/\lambda) sin\vartheta_2) \quad \text{(III.17)}$$

$$|A_1|^2 = F_1^2 C_1^2 = (1/r_1)^2 cos^2\vartheta_1 4cos^2((\pi d_1/\lambda) sin\vartheta_1) \quad \text{(III.17a)}$$

These are the standard Young's interference pictures observed behind the two double-slits. These pictures depend only on the geometry of experiments (distances: d, r, λ and the variables ϑ). The registered photons *can be both correlated twin brothers and not correlated photons.* The conditions for distinguishing only space–time correlated photons are not fulfilled.

*The correlated (entangled) photons***.** The pairs of correlated photons must be created simultaneously (t = 0) in some point of the source (SPDC), and must propagate exactly at equal angles with respect to the direction of the pump laser beam (in the same plane with the laser beam). In the enfolded version of the experiments (Fig.III.8), the correlated solitons are with anti parallel momenta, created in a point-like region. If one of the pair passe the slit 1a, then with probability equal to one its twin brother must pass the slit 2b. The sufficient conditions for this are: $L_1/L_2 = d_1/d_2$ and the source (S) and the centers of the two parallel double-slits must be at one and the same axis (O,O) (Fig.II.8). The two twin brothers must be registered simultaneously by the two detectors (D_1,D_2). The time elapsed between the moment of creation of photons (in S, point P_0=0) and their registration by the detectors is not necessary for Young's interference (III.17) and was not introduced. This time must be introduced for observation of correlated photons (coincidences). To simplify further the investigation, it is supposed that the distances between the source and the two double-slits (1, 2) are equal ($L_1 = L_2 = L$), and the dimensions of the double-slits are also equal ($d_1 = d_2 = d$). In this case one can be sure that when a photon passes the slit 1a, its twin brother passes the slit 2b and vice versa (Fig.II.8). One can write for the two identical amplitudes (including the time ($t_0 = L/c$)) necessary for two twin brothers to reach the corresponding double-slit: $(1/L)\exp(-i\omega t_0)$. The amplitudes at the two detectors are:

$$A_{D1} = F_1 exp(-i\omega t_1) C_1 (1/L) exp(-i\omega t_0) \qquad \text{(III.18)}$$

$$A_{D2} = F_2 exp(-i\omega t_2) C_2 (1/L) exp(-i\omega t_0) \qquad \text{(III.19)}$$

The simultaneous amplitude of two twin brothers at the detectors is the sum ($A_{D1}+A_{D2}$). The probability for registration of photons (W_{12}) is proportional to:

$$W_{12} = |A_{D1}+A_{D2}|^2 = [F_1^2 C_1^2 + F_2^2 C_2^2 + 2F_1F_2C_1C_2 |cos(\omega(t_2 - t_1))|]/L^2 \qquad \text{(III.20)}$$

The two first terms of (III.20) are time-independent, and cannot be observed in coincidences. They correspond exactly to the case of a "standard Young's interference" (III.17). The third term of (III.20) depends on the time difference ($t_2 - t_1$) and the coincidences can been observed only when

$$(t_2 = t_1), \text{ or } \quad P = |cos(2\pi c(t_2 - t_1)/\lambda)| = 1; \qquad \text{(III.21)}$$

The period between the moment of creation of two twin brother-solitons, and the moment of registration of the first soliton by detector D_1 is $T_1 = t_0 + t_1$. This period for the second correlated soliton is $T_2 = t_0 + t_2$ (D_2). So, $(t_2 - t_1) = (T_2 - T_1)$. The distances r_1 and r_2 are related with the time:

$$r_1 = ct_1; \ r_2 = ct_2; \text{ and } r_1 = r_2 = r \ \ (\text{c – speed of light}) \qquad \text{(III.22)}$$

The conditions (III.21) and (III.22) are very strict because P can be represented also as the optical path difference between the two detectors: ($c(T_2 - T_1) = \Delta \boldsymbol{x}$). This leads to:

$$\mathbf{P} = |\boldsymbol{cos}(\mathbf{2\pi\Delta} \boldsymbol{x}/\boldsymbol{\lambda})| \qquad \textbf{(III.21a)}$$

(For $\boldsymbol{\Delta x/\lambda}$**=0, 1, 2…n,** **P=1** and coincidences are possible).

The optical path difference ($\Delta \boldsymbol{x}$) can change by different causes: distances, very low acoustic waves and acoustic vibrations, temperature and thermal differences, optical not-homogeneity and others. These can change the sign of the wave, but the interaction of solitons with charged particles does not depend on the sign.

The optical path difference ($\Delta \boldsymbol{x}$) can in principle be reduced to about 3 – 10 *nm*. In the discussed experiments [31, 32, 33], λ = 702 *nm* ($\Delta x/\lambda \to 0$) and it is accepted in further calculations that $P = |cos(2\pi\Delta x/\lambda)| \approx 1$. At the moment when $\boldsymbol{c}(\mathbf{T_2 - T_1}) \neq \mathbf{n\lambda}$, only *chance* coincidences could be observed. The probability of coincidences only is obtained by extracting (III.17 and III.17a) from (III.20):

$$W_{12}(\vartheta_1,\vartheta_2) = 8/(Lr)^2 |cos\vartheta_1||cos\vartheta_2||cos((\pi d/\lambda)sin\vartheta_1)||cos((\pi d/\lambda)sin\vartheta_2)|P \qquad \text{(III.23)}$$

This is the counting rate of pairs coincidence. The two variables ϑ_1 and ϑ_2 are the corresponding angles between the direction of the detectors and the axis (O,O). The eq. (III.23) can be used practically only when one of the variables is fixed or when the two variables are equal, $\vartheta_1 = \vartheta_2 = \vartheta$, ($8/(Lr)^2$ =constant = 1):

$$W_{12}(\vartheta,\vartheta) = cos^2\vartheta(cos^2((\pi d/\lambda)sin\vartheta))|cos(2\pi c(t_2-t_1)/\lambda)| \qquad \text{(III.24)}$$

Eq. (III.24) is normalized if we substitute $|cos(2\pi c(t_2-t_1)/\lambda)| = P = 1$. It becomes:

$$W_{12}(\vartheta,\vartheta) = cos^2\vartheta(cos^2((\pi d/\lambda)sin\vartheta)); \qquad \text{(III.25)}$$

When the two detectors are at the same position, ($\vartheta_1 = \vartheta_2 = \vartheta$), then the function of the coincidence counting rate corresponds to the standard Young's interference. If one of the variable is fixed (f. e. $\vartheta_2 = 0$), then from (III.23) the probability for coincidences $W_1(\vartheta_1)$ *must have* an interference pattern:

$$W_1(\vartheta_1) = |cos\vartheta_1||cos((\pi d/\lambda)sin\vartheta_1)|P \qquad \text{(III.25a)}$$

It can be seen from (III.23), that if one of the variables (f. e. ϑ_2) is fixed at the position where $|cos((\pi d/\lambda)sin\vartheta_2)| = 0$, then for any positions of $D_1(\vartheta_1)$ the coincidences do not exist ($W_1(\vartheta_1) = 0$). The counting rate of D_1, (without coincidences; point-like source) must be proportional to $\boldsymbol{cos^2(\vartheta_1)(cos^2((\pi d/\lambda)sin\vartheta_1))}$.

The probability (III.25) is the case when the coincidence counting rate is exactly that of Young's interference picture. Although the difference between (III.25) and (III.25a) is very small, it can be distinguished experimentally because:

$$\boldsymbol{cos^2\vartheta(cos^2((\pi d/\lambda)sin\vartheta))P \neq |cos\vartheta||cos((\pi d/\lambda)sin\vartheta)|P.}$$

In the following illustrating Figures, these differences are shown.

III.7. One double-slit and one single slit.

When the conditions for coincidences are fulfilled ($L_1 = L_2 = L$; $d_1 = d_2 = d$), then the dimensions of the source (S) can be greater [31] in comparison with the conditions for Young's interference because the pairs of correlated photon-solitons must pass the two opposite slits and the coincidences are possible only when the two twin brothers photons are created in a small region around the center of the source. A larger source is shown on Fig.III.8 with a dotted rectangle, but the effective source dimension (in coincidences only!) is the small region (in circle) about the point (S) determined from the experimental setup.

New proposed experiment. In the case of a "point-like source", one can close the slit 2a and the coincidences will be possible only when a particle-soliton pass the slit 1a, because its conjugated twin brother must passes the opened slit 2b. De Broglie's assumption that the real wave package of a photon is essentially larger than the particle (the gravity wave passes the double-slit) allows to find the two amplitudes, (A_{D1} and A_{D2}). The amplitude of the wave after the double-slit 1 is the same, and the amplitude of the first photon is:

$$A_{D1} = F_1 exp(-i\omega t_1)C_1(1/L)exp(-i\omega t_0) \qquad \text{(III.26)}$$

Its twin brother soliton (and the wave) passes only the opened slit 2b, ($C_2 = 1$), and the amplitude (A_{D2}) must be:

$$A_{D2} = F_2 exp(-i\omega t_2)(1/L)exp(-i\omega t_0); \quad (C_2 = 1) \qquad \text{(III.27)}$$

The corresponding square of the amplitude sum (III.26) plus (III.27) determines the probability:

$$W = |A_{D1}+A_{D2}|^2 = F_1^2C_1^2+F_2^2+2F_1F_2C_1|\cos(\omega(t_2 - t_1)| \quad \text{(III.28)}$$

So, when one soliton pass slit 1a, its twin brother must pass the slit 2b only ($C_2 = 1$). The gravity wave of the first soliton passes the two opened slits (1), but the gravity wave of the second soliton must pass only the opened slit 2b. This interference picture depend essentially on the angle ϑ_1 because after the single slit (2b), the angle ϑ_2 is responsible only for diffraction of the gravity wave. For coincidences only it is

$$W_{12}(\vartheta_1,\vartheta_2) = 2F_1F_2C_1|\cos(\omega(t_2 - t_1)| \quad \text{(III.29)}$$

The normalized probability is:

$$W_{12}(\vartheta_1,\vartheta_2) = |\cos\vartheta_1||\cos\vartheta_2||\cos((\pi d/\lambda)\sin\vartheta_1)|P \quad \text{(III.30)}$$

The probability ($W_1(\vartheta_1)$) which concern only the variable ϑ_1 (when $\vartheta_2 = 0$) is:

$$W_1(\vartheta_1) = |\cos\vartheta_1||\cos((\pi d/\lambda)\sin\vartheta_1)|P \quad \text{(III.31)}$$

This is the coincidence counting rate of the interference picture when scanning the angle ϑ_1; ($\vartheta_2 = 0$).

When the angle $\vartheta_1 = 0$ is fixed, then a pattern such as a standard diffraction pattern must ben observed after the single slit (2b):

$$W_2(\vartheta_2) = |\cos\vartheta_2|P \quad \text{(III.32)}$$

In Fig.III.9, an example of interference picture is shown (for the case $d = 2\lambda$). Such experiments are difficult namely because there are difficulties in arranging the experimental setup precisely ($L_1 = L_2 = L$; $d_1 = d_2 = d$; and the point-like source on the axis). Such experiments will show that when a particle – soliton – passes only one of the two opened slits, its photon gravity wave passes the two slits and a pattern, *like* the standard interference pattern, must be observed (contrary to Copenhagen's interpretation).

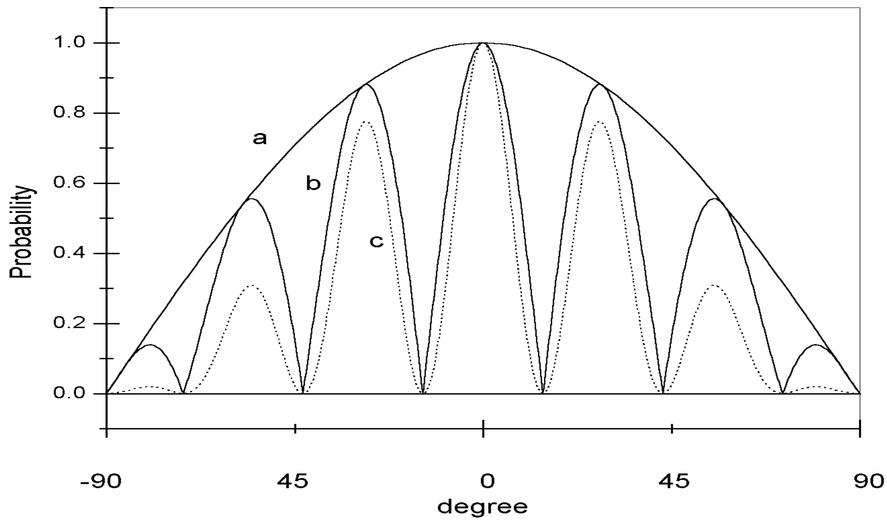


Fig.III.9. Proposed experiments. The expected results of experiments – double-slit, single slit: a) solid line - the coincidence counting rate of detector D_2 after the single-slit (D_1 fixed at $\vartheta_1 = 0$). b) solid line – "like" an interference picture ($\vartheta_2 = 0$). c) doted line – a standard interference picture.

III.8. One double-slit and one transparent parallel plate.

The mentioned above difficulties can probably be avoided replacing in (Fig.III.8) the double-slit (2) with a Heisenberg lens [31]. Here a simpler case is examined, where the double-slit (2) is replaced by a homogenous transparent thin parallel plate (3). This is shown schematically on Fig.III.10.

The distance (L) between the source (S) and the transparent plate is the same as the distance between the source and the double-slit. The correlated particle-solitons pass through the slit 1a or the slit 1b of the double-slit (1), but its twin brothers particle-solitons must pass only the corresponding positions 3b and 3a on the transparent plate (3). The wave of such photons passes everywhere through the transparent plate, but *only electromagnetic particle-soliton can be scattered elastically*. The scattered soliton (and gravity wave) in the place 3b (at angle ϑ_2) is superposed with the gravity wave, which pass the place 3a. Because of the necessary conditions for coincidences (in the time) (III.21, III.22, and III.23), this soliton can interact with the detector D_2. The same is true for the photon which can be *scattered elastically* on the place 3a, but is superposed with the gravity wave passing through the position 3b.

The waves which pass at other positions through the transparent plate cannot be superposed with the scattered soliton wave (coincidences only! Eqs.III.21 and III.22). So, when coincidences are used, after the transparent plate 3, the interference picture must correspond to the results given by expression (III.24). **Without coincidences (point-like source)** only standard interference pattern after the double-slit 1 can been observed, and after the transparent plate (3), the counting rate will be almost constant.

New proposal for experiments. When the point-like source (S) is on the axis, then the distance L_2 is not essential because for coincidences the following conditions have to be fulfilled:

$$\boldsymbol{L_2/L_1 = d_2/d_1.} \qquad \textbf{(III.33)}$$

d_1 and L_1 are fixed by the distance between the source and the double-slit aperture 1, and the conjugated solitons automatically find the places d_2 at distance L_2 through which its must pass and can be scattered at angle ϑ_2. If $L_2 > L_1$, then the new distance (d_2) on the transparent plate where the conjugated solitons pass is $d_2 > d_1$.

This could be observed experimentally because the maximuma of interference fringes, registered by the detector D_2, will be more (in number) and closer to each others (compared with the interference picture of D_1). The properties of a parallel transparent plate can be confirmed experimentally without the difficulties mentioned for experiments described in Fig.III.8. If $L_2 = 2L_1$, then obligatory $d_2 = 2d_1$ and the simultaneous (coincidences) registration of solitons becomes:

$$W_{12}(\vartheta_1,\vartheta_2) = |\cos\vartheta_1||\cos\vartheta_2||\cos((\pi d_1/\lambda)\sin\vartheta_1)||\cos((2\pi d_1/\lambda)\sin\vartheta_2)|P \qquad \text{(III.34)}$$

When one of the angle is fixed ($\vartheta_2 = 0$), then the probability for coincidences is:

$$W(\vartheta_1) = |\cos\vartheta_1||\cos((\pi d_1/\lambda)\sin\vartheta_1)|P \qquad \text{(III.35)}$$

If the other angle is fixed ($\vartheta_1 = 0$), then the corresponding probability is:

$$W(\vartheta_2) = |\cos\vartheta_2||\cos((2\pi d_1/\lambda)\sin\vartheta_2)|P; \qquad \text{(III.36)}$$

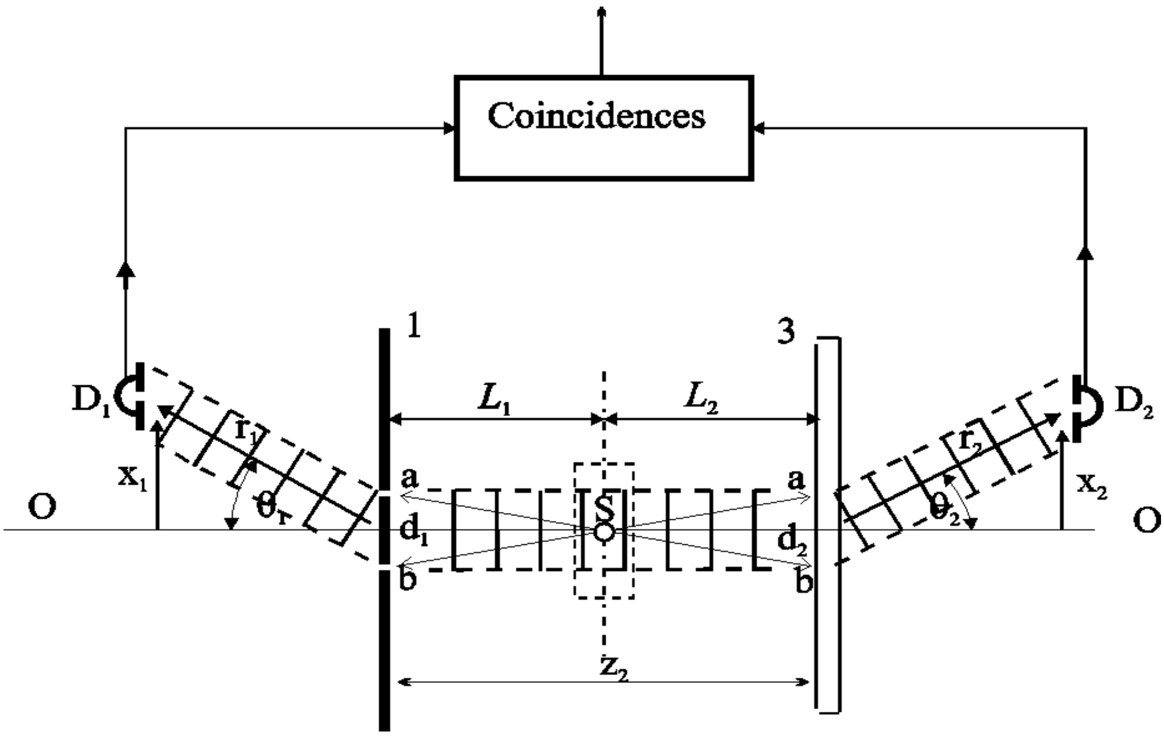


Fig.III.10. The scheme of a double-slit and a transparent parallel plate. This must be consistent with experiments [31], where, instead of a transparent plate (3) a Heisenberg lens is used and the detector D_2 scans the focal plane ($\vartheta_1 = \vartheta_2$).

On the Fig.III.11, the results corresponding to (III.35) and (III.36) are shown for $d_1 = 2\lambda$. The two pictures are different and expression (III.36) depends on the distances ($d_2=2d_1$).

When the variables are $\vartheta_1 = \vartheta_2 = \vartheta$, then the coincidence counting rate, $W_{12}(\vartheta,\vartheta)$, is:

$$W_{12}(\vartheta,\vartheta) = \cos^2\vartheta\,|\cos((\pi d_1/\lambda)\sin\vartheta)|\,|\cos((2\pi d_1/\lambda)\sin\vartheta)|\,P \qquad \text{(III.37)}$$

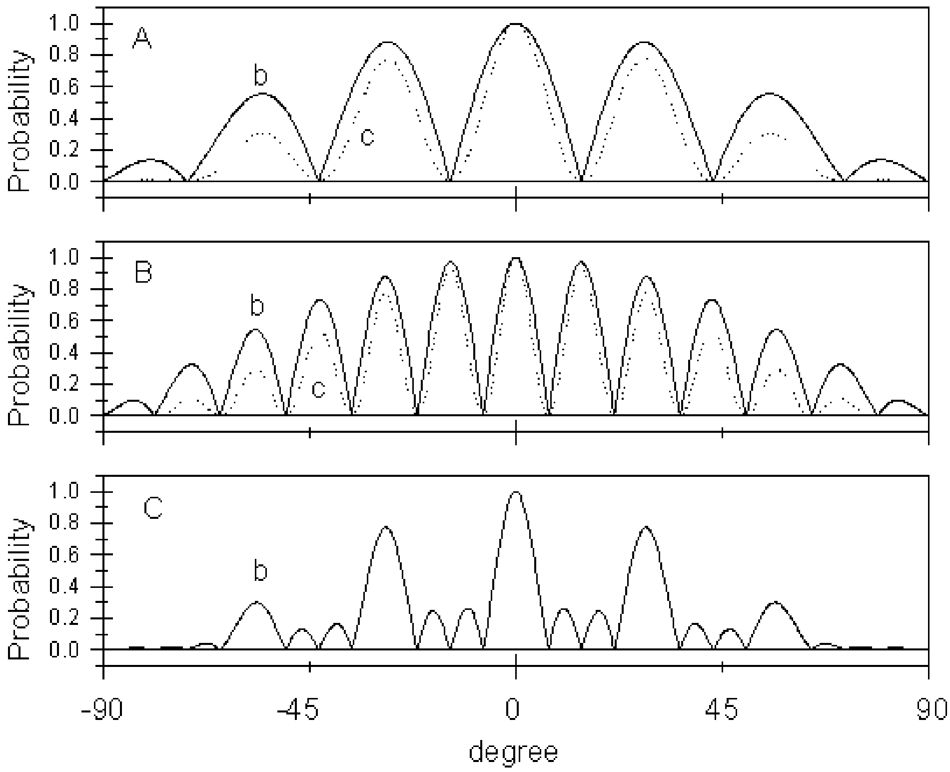


Fig.III.11. The expected results: double-slit and transparent plate; $L_2 = 2L_1$; A) Solid line (b) shows the coincidences $W(\vartheta_1)$, when $\vartheta_2 = 0$; B) Solid line (b) is the probability $W(\vartheta_2)$, when $\vartheta_1 = 0$; C) The probability $W(\vartheta,\vartheta)$, when $\vartheta = \vartheta_1 = \vartheta_2$. Dotted lines (A, B) correspond to a standard Young's interference picture.

III.9. Sending signals.

In principle, the two correlated photon-solitons can be emitted from a source at a very large distance (for example on the Moon, or a planet). These photons can be separated in two Earth-laboratories and used for interference and diffraction experiments. In principle an observer in the first laboratory can change the conditions for coincidences very quickly (one double-slit with a single slit for a time t < 0.1s). An observer in the second laboratory can register the changes immediately (1s > t >0.1s). **But this is not deviation of locality**. The signals from the first observer are not sent to second observer via the Moon. (The necessary time for this will be more than 2 s). The photons registered in such experiment are sent from the Moon's source as **twin brothers** and they cannot arrive on the Earth with different properties. The two observers can only confirm this fact. Such confirmations cannot be made faster than the speed of light (f. e. with the help of coincidence circuits). This is the same as if two twin brother cosmonauts (different color of clothes, red and blue) are sent from the Moon with different space ships, arriving at different places on Earth at the same moment (independently of the flight-time). If the first observer receives a "blue" cosmonaut, then it is sure that the second observer (simultaneously with the first) will welcome a "red" cosmonaut.

The experiments checking simultaneously some property of correlated photons frequently use the constant difference of polarization of correlated photons. In this case the authors think that polarization devices can change instantly the plane of polarization of a **common wave function** (Fig.III.4). On this Figure, the polarization of two photon is equal ($\boldsymbol{E_{01}} = \boldsymbol{E_{02}} = \boldsymbol{E_0}$) and this can be used for sending signals. Now it is clear that correlated solitons preserve their polarizations ($\boldsymbol{E_{01}}, \boldsymbol{E_{02}}$) independently from the distance. When someone observes polarization $\boldsymbol{E_{01}}$ then he is sure that the correlated soliton (at the same moment) has a polarization $\boldsymbol{E_{02}}$ (and vice versa). *Without coincidence circuits, the polarization of the twin brothers also cannot be confirmed.* Because coincidences are possible only when two photons are born as twin brothers, then the first observer changing the plane of his observed polarization necessarily changes the corresponding soliton (twin brother) for the second observer. The **two experimentalists observe instantly one other pair of twin brothers (independently of distance between them)**. Such experiments only show that any pair of twin brother has a constant angle between their polarization planes (electric vectors $\boldsymbol{E_{01}}$ and $\boldsymbol{E_{02}}$). Polarization devices cannot change the plane of polarization of a common wave function at a distance between the two observers (f. e. via the source). The common wave function is only a mathematical possibility to know the plane of two vectors ($\boldsymbol{E_{01}}$ and $\boldsymbol{E_{02}}$) which act independently from each other. (Non-local is only possibility to change (writing) simultaneously the mathematical plane of polarization). So, despite that the properties of different pairs can be observed simultaneously (independently of distance), the signals cannot be sent faster than the speed of light because a coincidence circuit between the two observers must be used, and it works with speeds equal or smaller than the speed of light. Obviously, the Copenhagen illusion that because of possible nonlocality, signals can be send faster than the speed of light (and other "stupidities", as wrote Schrodinger), are due to misunderstanding of the particle's properties described in this work.

III.10. Some new problems.

Bohm and Hiley [3] (p.128) write: "*In doing this we assume, as we have been emphasising throughout this chapter, that the underlying reality is not just the wave function, but that is also has to include the particles*."

The wave of de Broglie and the gravity wave are formally equivalent. The gravity wave cannot be registered with photo-detection - we don't know any other detector for such low gravity energy. When one initial photon ($\hbar\omega=(E_0)^2V_e$) passes two different branches (ways) in some interferometer (according to the gravity wave properties discussed here), it is sure that one of the branches is "empty" of soliton and other contains soliton. Probably the empty gravity wave energy must propagate with the speed of light, and must conserve frequency (ω), polarization, torsion angle, spin and phase. When interacting with other particles (probably by means of gravity forces), the empty gravity wave can interchange gravity energy, can be reflected (scattered) or be absorbed by other particles. The "full" branch contains soliton and its new gravity wave - new photon. The energy of this photon must be smaller than the energy of the initial photon, but this energy difference is completely negligible, and the new wave-length λ_f cannot be distinguished from the initial photon wavelength λ. The photon in the "full" branch can interact with the particles in the same manner as the initial photon. In any new full branch the photon can be split, reflected (scattered), recombined or absorbed. **These properties follow from the present work, but are not proved**. If these properties exist, many new problems arise and some of them are:

Is registration of gravity waves possible? What must be used for a direct registration of such low energy? If one photon can be split successively great many times (without recombination), can its energy (frequency ω_f, compared to the initial photon (ω)) be distinguished? How many splittings are necessary for that?

Such splittings, I think, are possible only when photons arrive from very large distances – far from Earth – from deep universe. The splitters (particles, atoms, ions, powder) in cosmic space must split the photon, scattering forward a soliton with negligible decrease of energy. If these splitters are great many, the loss of photon's energy must be noticed in observatories (laboratories) as a red frequency shift $\Delta\omega$. Such red frequency shift is observed - Doppler's shift of **an expanding universe**. Almost all galactic velocity projections (***v***) are directed away (opposite) from Earth. Is it possible to distinguish the Doppler effect from the red frequency shift due to photon splitting? It is reasonable that photon's **red splitting shift** cannot be distinguished from **the red Doppler shift. (**Except if someone discovers a stationary Universe. In the last years, at a very large distance from Earth, about 10^{10} light years, an old galactic was observed with a structure corresponding to our "old galactic Milky Way". This can collapses our knowledge of Universe).

Conclusions: The Main.

I think that the main results of this "Essay" are the described properties of the photon and the hydrogen atom "beyond" the contemporary quantum physics. One part of these properties is confirmed from old experimental investigations of quantum objects. These experimental results are well known in science, but only now can be understood. The other part is results that can be verified with new experiments proposed here (also beyond the contemporary quantum physics).

First, I will repeat the experimentally proven results.

1. The main relation between the soliton's electric amplitude $\boldsymbol{E_0}$ and the frequency ω of the photon

$$E_0^2 = K_0\omega^3 \qquad \text{(III.38)}$$

is confirmed from the relation between the electric field (E) of K-shell for all elements, and the photon frequencies corresponding to the energy of ionization (experiments with accuracy better than ±15%). This relation is consistent with the experimentally proven for a long time Plank's density of radiation.

2. The volume of the soliton ($\boldsymbol{V_e = S_e l_e}$) was obtained from the effective time of transition in hydrogen ($\boldsymbol{t_e = l_e}/c = 1/2\omega$) and (III.38). The classical cross section of the soliton ($\boldsymbol{S_e}$) determine photo-effect cross-sections:

$$\boldsymbol{\sigma_\tau = (1+\pi\hbar c/2e^2)S_e}.$$

Here (σ_τ) are experimentally observed photo effect cross sections for the K-shell of all elements, and $\boldsymbol{S_e}$ are the soliton cross sections calculated in this work (for energies equal to the ionization energy of the K-shells). The experimental uncertainties are about ±15%.

3. The effective time of soliton emission $\boldsymbol{t_e}=1/2\omega$ is confirmed experimentally with both the effective time of transition in the hydrogen atom, and the acceleration of the electron. The accelerations of the electron in atomic transitions corresponds to all energies emitted by the hydrogen atom. So, the properties of the soliton and the hydrogen atom complement each other and prove the soliton length $\boldsymbol{l_e = \lambda/4\pi}$ with experimental accuracy known in science.

4. "Own lifetime" ($\boldsymbol{t_i}$) of the hydrogen atom is used to calculate the mean lifetime (τ) for the first time (with accuracy better than experimental accuracy). These calculations are impossible from Copenhagen's point of view. The own lifetime of hydrogen is consistent with the relative "own lifetime" of a nucleus [23]. These results only (*own*

lifetime, $\boldsymbol{t_i}$) are sufficient to understand that **disintegration is not a chance event but follows exact quantum laws.**

5. All existing experiments with correlated photons are explained with the help of soliton-gravity wave (photon).

Proposed new experiments.

1. "One slit - double slit" experiment contradicting Copenhagen's predictions can prove the reality of gravity waves (de Broglie's waves) and their mathematical description.
2. "Double slit – transparent plate" experiments also show that gravity waves are something real but not statistical.

I think that the experiments proposed here are inevitable.

In the beginning of the Twenties Century, Planck, in spite of his inner, inherent resistance, guessed that light must consists of particles. The Age of Quantum physics opened and Einstein, Bohr, de Broglie, Schrodinger, Bohm and many others reached significant results that are important nowadays. Because the initial conditions of Bohr's hydrogen model was incomplete it was not possible to explain all experiments **with a statistical ensemble of atoms**.

Copenhagen's quantum physics**, as was noticed successfully from Einstein**, is a repetition of ***Classical Thermodynamics*** role in statistical physics. Classical thermodynamics is a very exact science **for existing information** of the things, before knowing for the atoms and the molecules ("beyond" the classical thermodynamics). In the last years many scientists think that quantum mechanics is not explanation of the world, but it is a science which examine existing **in our mind** information for quantum objects. This can been accepted, but it is not acceptable the assertions that world exists **only** in our minds. **The illusions exist, but our world is not "a collective hallucination"** [43]. Many of my colleagues objected to the title of this *Essay,* because there is no quantum method, but only classical methods of the investigations. I agree that this investigations are "*beyond the quantum methods*" but they examine in more *details the solitary quantum objects* [21,44].

As it was seen in this work, in the classical physics there are also many incomplete assertions. But in the classical physics, with classical methods, Russel (1884) [I.10] studied hydrodynamic solitons, which have simultaneously the properties of the waves and the particles. If his observation of solitons in Thames and the experimental results are not forgotten, maybe, Copenhagen school cannot forbid the investigation in this field and **cannot introduce in science (but not in Nature) inherent uncertainties and probabilities.**

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