HADRONIC JOURNAL, VOLUME 34, NUMBER 4 (August 2011)

MODELING THE ELECTRON AS A STABLE QUANTUM WAVE-VORTEX: INTERPRETATION *α ≈1/137* AS A WAVE CONSTANT

George Kirakosyan
Physics Department, State Engineering University, Yerevan, Armenia
E- mail: gevorge@inbox.ru
P.O. Box 42, Dubai, UAE

Abstract

The connection of alpha (α ≈1/137) to redistribution of intensities in interference of circularly polarized waves it has shown. Obtained number coincides to known one in reached accuracy: 10^{-10}. The photon represented as a quantum wave packet. The electron's model proposed as Compton's circularly polarized standing wave. The origins of the mass and static fields (charges) interpreted as a relativistic mass and pseudo static electromagnetic fields ("halos") arising in interference of quanta. Electron's magnetic moment and g value obtained with 10^{-10} accuracy.
Physical interpretation of de Broglie's wave is proposed.

Keywords: Elementary Particle; Elementary Charge; De Broglie Wave; Compton's Wavelength; Fine Structure Constant; Coupling Constant.

Introduction

As known, there are no theoretical or conceptual accomplished interpretations in contemporary physics of the nature of the basic particle electron as well as of the existence of a fine structure constant $\alpha \approx 1/137$ having great importance in microcosm. Its may be obtained from experimental measurements only according to standard formalism. Many of renowned physicists (such as P. Dirac and R. Feynman) have attempted to obtain α theoretically, which continues to be an open question. We have looked at the problem of fine structure constant in conjunction to the global problem of revealing the physical nature of elementary particles, since α appears indivisible from them, as their deeply peculiarity. It is possible to judge the extreme importance and all complications related to this dimensionless constant from [1]. The continuous attempts to present α by means of artificial combinations of other known constants (numerological representations, etc.) not considered as theoretical interpretations. We will refer to Feynman's known critical remark [2] on this issue. The long-term unsuccessful efforts to obtain α theoretically force us to refer to wave-particle duality principle applied in quantum representations. By mentioning the large circle of phenomena in microcosm where α exposes as an important parameter, we bring also some expressions below related to description of Hydrogen's atom that help us to realize direct interconnection of α with elementary particles (photon, electron). Using known relations $e=(2\varepsilon_0\alpha hc)^{0.5}$ and $m_e=h/c\lambda_e$ we express the speed of electron v_0 on the first Bohr's orbit, the orbit's radius a_0 and Rydberg's constant R by simplest expressions, containing only α, c and Compton's wave length of the electron λ_e:

$$\mathrm{v}_0 = \alpha c\,, \quad a_0 = \lambda_e / 2\pi\alpha \approx 0{,}53\cdot 10^{-10}\, m\,, \quad R = \alpha^2 c / 2\lambda_e \approx 3{,}3\cdot 10^{15}\, s^{-1}$$

From these expressions, we look at α as an independent universal numeric constant defining the **dynamical, geometrical** and **wave** properties of localized particles as well as of the non-localized particles (photons). Mentioned view is pointing to the existence of a certain general principle in formation of all kinds of elementary particles and, to the possibility of linking α to unique nature of localized and non-localized quantum objects.

Our attempts to interpret fine structure constant as well as basic particles correspond to wave-field principle of primordial substance. Einstein, Schrodinger, Heisenberg and other classics of past century were convinced supporters of such approach. We can remark [3], [4] as recent works pointing on this direction. We attempt to show that de Broglie's wave-particle duality principle, electrodynamics and special relativity (STR) allow representing photon as well as the localized particle (electron) from wave-field point of view.

1. Deduction of *α* ≈1/137 as a wave interference redistribution constant

In this chapter we prove the equation:

$$\sum I_m / I \approx 0.085424 \approx e_* = \alpha^{0.5} \qquad (1)$$

Where: I_m is the intensity of *m* peak. *I* is the total intensity of the circularly polarized interfering waves, $\alpha \approx 1/137$ is the Fine Structure Constant, e_* is the value of the elementary charge in the natural system of units; $c = \hbar = 1$. To prove (1) we represent the interference as a standing wave appearing in Compton's localized circularly polarized waves (Fig.1)

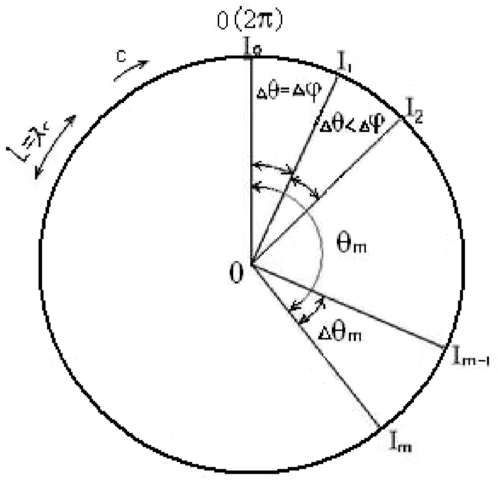

Fig. 1.
Angular distribution of intensities in interference of circularly polarized waves

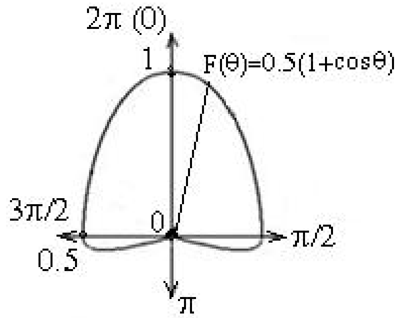

Fig. 2.
The Kirchhoff's function

We have chosen described model of the wave interference as a classical analog to the standing de Broglie's wave on the first Bohr's orbit, implementing following replacements: $l_{orb} = \lambda_c$, where λ_c is the Compton's wavelength and $v_{orb} = c$. We consider number *n* of interfering waves as much greater than one, which corresponds to existing classical representations of quanta. We have used handbook equations (2), (3) to describe the relations between amplitudes and intensities [5] supposing that examined interference satisfies to Huygens – Fresnel's principle.

$$\frac{A_m}{A_0} \approx \frac{2}{(2m+1)\pi}, \quad \frac{I_m}{I_0} = \frac{A_m^2}{A_0^2} \approx \frac{4}{(2m+1)^2 \pi^2} \qquad (2)$$

Where: A_m is the amplitude of m peak. A_0 is amplitude of ***0*** – peak (main), m = 1, 2, 3 … n. Since the equations (2) are approximations suitable for small angular distribution only, for their implementations to infinite angular distribution we have used the Kirchhoff's function (3), considering amplitudes dependence on direction, according to Huygens – Fresnel's principle:

$$F(\theta) = 0{,}5(1 + \cos\theta) \qquad (3)$$

Where: equation (3) satisfies conditions, $F(\theta) = 1$ at $\theta = 0$ (maximum of amplitude on direction "forward") and, $F(\theta) = 0$ at $\theta = \pi$ (the amplitude becomes zero on direction "backward"), (Fig. 2). Using equation (3) from equation (2) we obtain:

$$\frac{A_m}{A_0} \approx \frac{2F(\theta)}{(2m+1)\pi} = \frac{1+\cos\theta_m}{(2m+1)\pi} \qquad (4)$$

According to initial conditions (Fig.1) the angular distance between first and main peaks will be equal to average value of a phase difference $\Delta\varphi$ for the interfering waves. The angular distances between two consecutive peaks $\Delta\theta_m$ will be consequently decreasing as described further. Considering that, amplitudes of the secondary peaks differ from each other by phase *($\pm 2\pi n$)* we can directly summarize:

$$\sum I_m = I_1 + I_2 + \ldots + I_n = A_1^2 + A_2^2 + \ldots + A_n^2 \qquad (5)$$

From equations (4) and (5) follows:

$$\frac{\sum I_m}{I_0} \approx \frac{1}{\pi^2} \sum_{m=1}^{n} \left(\frac{1+\cos\theta_m}{2m+1} \right)^2 \qquad (6)$$

The secondary peaks are differs at main peak by phase; $\pi/2 \pm 2\pi n$ because the main peak corresponds to 0 by $\Delta\varphi$, meanwhile secondary peaks correspond to; 3π, 5π… $\pi(2m+1)$. Considering the above, we define the distribution of total intensity as:

$$I^2 = I_0^2 + \left(\sum I_m\right)^2$$

From above follows:

$$\sum I_m / I_0 = \tan\Delta\varphi, \quad \sum I_m / I = \sin\Delta\varphi, \quad I_0 / I = \cos\Delta\varphi \qquad (7)$$

Using (7) in (6) we obtain:

$$\frac{1}{\pi^2} \sum_{m=1}^{n\to\infty} \left(\frac{1+\cos\theta_m}{2m+1} \right)^2 - \tan\Delta\varphi \approx 0 \qquad (8)$$

To find functional link between θ_m and $\Delta\varphi$ we use vector diagram (Fig. 3).

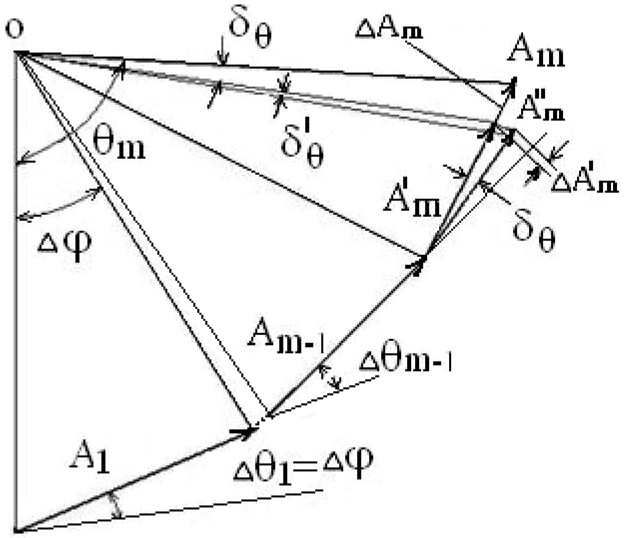

Fig. 3.
Vectorial representation of the secondary interferencial maximums

$A_1 \ldots A_m$	Vectors of secondary maximums corresponding to initial equations: [see eq. (2)]
A_m^I	The vector of *m* maximum after first correction: [see eq. (10)]
A_m^{II}	The vector of *m* maximum after second correction: [see eq. (12)]
θ_m	The angular shift of *m* maximum at the main; [see (Fig. 1)]
$\Delta\varphi$	The phase shift of interfering waves
ΔA_m, δ_θ	The first corrections corresponding to equation (10)
$\Delta A^I{}_m$, $\delta^I{}_\theta$	The second corrections corresponding to equations (11)

Table 1. Explanatory to Fig. 3.

With application of equation (4) instead of (2) small changes of vectors of interfering waves arise as a function at θ_m. Aftermath of that the secondary peaks also will change, by values as well as by locations. The angular distances between two peaks will changed as illustrated in diagram. Some reduction of angle θ_m occurs because of reduction of the vector A_m aftermath of replacement (2) with (4). The correction for the angle $\Delta\theta_m$ we define as:

$$\delta_\theta \approx \frac{\Delta A_m}{A_0}\Delta\varphi \approx [\frac{2}{(2m+1)\pi} - \frac{1+\cos\Delta\varphi m}{(2m+1)\pi}]\Delta\varphi \approx \frac{\Delta\varphi(1-\cos\Delta\varphi m)}{\pi(2m+1)} \qquad (9)$$

Using equation (9) and considering the relative change of angle θ_m the equation (4) becomes:

$$\frac{A^1{}_m}{A_0} \approx \frac{1+\cos\Delta\varphi m(1-\delta_\theta/\Delta\varphi m)}{(2m+1)\pi} \qquad (10)$$

Simultaneously, with reduction of angle between directions A_m and A_{m-1}, the vector $A^1{}_m$ will slightly turn to right, as a result it becomes $A^{11}{}_m$. For this reason the projection of $A^{11}{}_m$ on a direction A_{m-1} increases, that leads to relative increase of their sum by value: $1+(\delta_\theta/\Delta\varphi m)^2$. Mentioned factor leads to a new small change of the angle and causes a new small increase in the vectors sum. We can continue these reasoning infinitely which brings to amendments in the form of Maclaurin series, for the angles and for the vectors accordingly:

$$(\Delta\varphi\, m)^1 = \Delta\varphi m - \delta_\theta[1+(\delta_\theta/\Delta\varphi m)+(\delta_\theta/\Delta\varphi m)^2+\cdots+(\delta_\theta/\Delta\varphi m)^n] = \Delta\varphi m - \delta_\theta/(1-\delta_\theta/\Delta\varphi m)$$

$$A^{11}_m/A^1_m = 1+(\delta_\theta/\Delta\varphi m)^2+(\delta_\theta/\Delta\varphi m)^4+\cdots+(\delta_\theta/\Delta\varphi m)^{2n} = 1/\left[1-(\delta_\theta/\Delta\varphi m)^2\right] \qquad (11)$$

Considering relations (11) we have replaced θ_m in (8) resulting to below equation:

$$\sum_{m=1}^{n\to\infty}\left(\left[\frac{1+\cos[\Delta\varphi m-\delta_\theta/(1-\delta_\theta/\Delta\varphi m)]}{(2m+1)}\right]\times\left[\frac{1}{1-(\delta_\theta/\Delta\varphi m)^2}\right]\right)^2 \approx \pi^2\tan\Delta\varphi \qquad (12)$$

Where: δ_θ as defined above [see equation (9)]

By method of insertion, using numeric calculating, the value satisfying to equation (12) has found:

$$\Delta\varphi \approx 0.0855287810\,2 \qquad (13)$$

According to equations (7) using result (13) we obtain:

$$\sum I_m/I = \sin\Delta\varphi \approx 0.0854245428\,6 \approx e_* \qquad (14)$$

Thus, the result (14) confirms initial assumption and equation (1).

Obtained number coincides with elementary charge in relative units in achieved accuracy range of measurements; it corresponds to value of Fine Structure Constant:

$$1/\sin^2\Delta\varphi \approx e_*^{-2} \approx 137.0359999 \approx 1/a \qquad (15)$$

Here are results of last precious measurements *1/a*:

$$1/a \approx 137.0359990 \div 137.0359998 \qquad [6], [7]$$

Thus, as shown, there exists a constant, referring to interference of circularly polarized waves in generalized condition, which correlates to the basic coupling constant. We will interpret *a* as well as the "Interferential Redistribution Constant" considering above.

2. Description of the photon as a quantized wave packet

2.1. We start from classical wave equation:

$$\Delta s = \frac{\partial^2 s}{\partial x^2} + \frac{\partial^2 s}{\partial y^2} + \frac{\partial^2 s}{\partial z^2} = \frac{1}{v^2}\frac{\partial^2 s}{\partial t^2}$$, where: $\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ is the Laplace's operator, s characterizes the amplitude of perturbation and v is propagation speed.

For the harmonic oscillations and sinusoidal waves takes place:

$$\frac{\partial^2 s}{\partial t^2} = -\omega^2 s \qquad (16)$$

Where: ω is the cyclic frequency of the wave

For the vacuum $\varepsilon=\mu=1$ and Maxwell's equations in vector form become:

$$rot\mathbf{E} = -\mu_0\frac{\partial\mathbf{H}}{\partial t},\ rot\mathbf{H} = \varepsilon_0\frac{\partial\mathbf{E}}{\partial t},\ div\mathbf{E} = 0,\ div\mathbf{H} = 0 \qquad (17)$$

From (17) follows:

$$\Delta\mathbf{E} = \varepsilon_0\mu_0\frac{\partial^2\mathbf{E}}{\partial t^2},\ \Delta\mathbf{H} = \varepsilon_0\mu_0\frac{\partial^2\mathbf{H}}{\partial t^2}$$

Considering; $\varepsilon_0\ \mu_0=1/c^2$ we write:

$$\Delta\mathbf{E} = \frac{1}{c^2}\frac{\partial^2\mathbf{E}}{\partial t^2},\ \Delta\mathbf{H} = \frac{1}{c^2}\frac{\partial^2\mathbf{H}}{\partial t^2} \qquad (18)$$

Where the equations (18) satisfy to equation (16)

Considering: the rotor form of Maxwell's equations, that free oscillation may only be harmonic, two mutually perpendicular oscillations of **E**, **H** vectors in a wave flow are equivalent in all means (that looks better from equations (18)), we examine below equations as a particular solution of Maxwell's equations, satisfying mentioned conditions, within conformity to graphic image (Fig. 4)

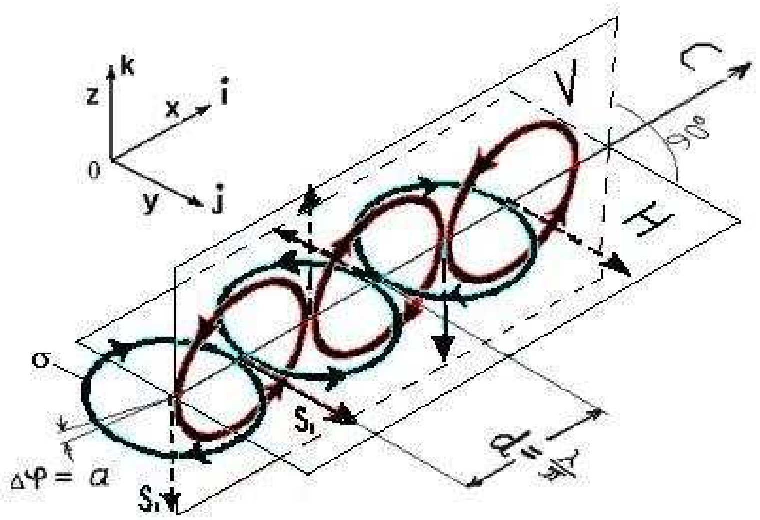

Figure 4. Scheme of quantum wave pocket

$$\mathbf{E} = E_0[\mathbf{i}\sin(\omega t + \alpha) + \mathbf{k}\cos(\omega t + \alpha)]$$
$$\mathbf{H} = H_0[\mathbf{i}\sin(\omega t + \beta) + \mathbf{j}\cos(\omega t + \beta)] \tag{19}$$

Equations (19) correspond to circularly polarized, mutually perpendicular oscillations that correspond to circle's equation in geometric meaning.
Where: E_0, H_0 are the modules of amplitudes of field's tension, $\omega = 2\pi c/\lambda$ is the cyclic frequency of oscillation, λ wavelength, α, β phases of oscillations, **i, j, k** the unit vectors in cartesian coordinate frame (Fig. 4)

The equations (19) are strongly right for an infinite wave flow only; that is the sinusoidal wave. Supposing the ideality of sinusoidal wave flow and the absolute stability of its parameters, considering the constant linear speed of field's circulation (as example; from equations (19) it follows: $V_H = (V_x^2+V_y^2)^{0.5} = c$. Where: V_H is the linear speed of circulation in the "horizontal rings", $V_x = c\sin\omega t$, $V_y = c\cos\omega t$) we got the field's circulation by the circle with λ length. Thus, this ideal imagination brings to infinity of energy's density: $\rho\to\infty$. Considering infiniteness of the sinusoidal wave flow also, we cannot judge anything certainly about total energy of described flow. The similar serious difficulties have risen in early attempts to interpret the mass of localized particles within electromagnetic origin. We attempt to represent the photon as a wave flow having restricted length, which is not sinusoidal. Considering established properties of photon, we will define the length of wave flow as:

$$L \approx \lambda n \approx c\tau \tag{20}$$

Where: n is average quantity of whole waves composing the flow in its stable condition, τ is action time of photon (time of its radiation or, absorption). For example; for the visible light L is about *meter*, λ is about *micron* and;

$$n \approx L / \lambda \approx 10^{6} >> 1$$

Considering (20) we can look at photon's wave flow as a "part of sinusoid" (or, as a "wave packet" as per accepted terminology) within approximations.

2.2. Considering that Maxwell's equations already satisfy to Lorentz transformations and STR (because the propagation speed of electromagnetic wave; υ = *const* = c in all inertial systems), from above mentioned conditions we can judge that our model will be not much far from reality. We can make certain conclusions on this base. Realizing that our judgments and results have approximate meaning, we write the equations of the neighboring pair of whole waves in a restricted wave flow resulting from (19) as:

$$\begin{aligned} \mathbf{E}_V &\approx E_0[\mathbf{i}\sin(\omega t + a) + \mathbf{k}\cos(\omega t + a)] \\ \mathbf{E}_H &\approx E_0[\mathbf{i}\sin(\omega t + \beta) + \mathbf{j}\cos(\omega t + \beta)] \end{aligned} \tag{21}$$

Here we use the same symbol **E** with different indexes to emphasize the symmetry and full equality of two mutually perpendicular circulations in a flow. We do not examine the initial phases of oscillations, which now are out of our study. According to equations (21) the concentration of energy of single circulation has to be of "linear" character [(1)] in the form of "string-ring". We will imagine the energy's distribution as a torus, the section's diameter of which is small compared to its length. We define the energy of one "ring" within classical representation as field's energy:

$$\varepsilon_1 \approx \rho V \approx E_0^2 V \tag{22}$$

Where: E_0 is the amplitude of field's tension, $V \approx \sigma\lambda$ is the volume of its concentration, σ is the section of the "ring"

For total energy in a flow, we write:

$$w \approx 2nE_0^2\sigma\lambda \tag{23}$$

---

1 Assuming other characters of energy's distribution in wave flow ("volume" or, "surface" character) we get other appraises for L, τ, which become unconformable to actual exposed ones.

Where: n is the number of pairs of "rings" that we consider as the number of whole waves.

The wave flow will show some deviation in parameters as a "part of sinusoid". Particularly, the number of whole waves will be an average: n ≈ $n_0 \pm 1/2$. To interpret aforesaid we can image propagation of wave flow as a permanent process of originating new "rings" ahead, with simultaneously annihilation of "rings" end of the flow. In conformity to this imagination, the instant number of whole waves will be changeable in range:

$$\Delta n \approx \pm 1/2 \text{ or, relatively: } \Delta n / n \approx 1/2n \qquad (24)$$

The coherence's time considered as the average time of photon's action in quantum representations (see "quantum optics"):

$$\tau \approx \tau_c \approx \pi / \Delta\omega = 1/2\Delta\nu \qquad (25)$$

Where: ν is the photon's frequency; $\Delta\nu$ is the Heisenberg's uncertainty for frequency.

From equations (20), (25) we get: $n \approx c\,\tau/\lambda = \nu\,\tau \approx \nu / 2\Delta\nu$. From equation (24) we see:

$$\Delta\nu / \nu \approx 1/2n \approx \Delta n / n \qquad (26)$$

We make first important conclusion from above coincidence:

a). *The examined model of photon shows the equality of Heisenberg's Uncertainties with the deviation of parameters in a restricted wave flow* (the phenomenon known as the "beating of wave"). This conclusion shows the compatibility of Heisenberg's Uncertainties (quantum concept) with the deviations of parameters (wave concept) in a restricted wave flow.

However, the seeming main contradiction between wave and quantum representations is the total difference in expressions of energy, accordingly: $\varepsilon \propto A^2$ and, $\varepsilon \propto \nu$. Where: A is the amplitude; ν is the frequency of the wave. Attempting to solve this contradiction, we will use conclusion a). First, we define the uncertainty for the single whole wave's energy as:

$$(\Delta\varepsilon_1 / \varepsilon) = (\Delta\nu / \nu)/n = (\Delta\lambda / \lambda)/n \approx 1/2n^2 \qquad (27)$$

We relate the transformation of energy between neighboring whole waves (coupling energy) in propagation process to a and to uncertainty by equation (27) as:

$$\Delta\varepsilon_{e\mu} / \varepsilon \approx \alpha(\Delta\varepsilon_1 / \varepsilon) \approx \alpha / 2n^2 \qquad (28)$$

Assuming $\Delta\varepsilon_{e\mu}$ as a possible minimal portion of energy (quanta of energy) for the examined wave flow we define it as:

$$\Delta\varepsilon_{e\mu} = h \cdot \mathrm{s}^{-1} \qquad (29)$$

Considering equation (28) we write:

$$\varepsilon \approx 2n^2 \Delta\varepsilon_{e\mu} / a \approx 2n^2 h / a \cdot \mathrm{s} \qquad (30)$$

Equalizing this value to actual energy of photon, we define its frequency:

$$\varepsilon = h\nu \approx 2n^2 h / a \cdot \mathrm{s}$$

$$\nu \approx 2n^2 / a \cdot \mathrm{s} \qquad (31)$$

To define the number of whole waves in the flow we considering the section size of “ring-string” conditioned by changeability (uncertainty) of wavelength as:

$$\sigma \approx (\Delta\lambda)^2 \qquad (32)$$

We define the spatial uncertainty of distribution for the energy as:

$$\Delta V / V \approx \sigma\Delta\lambda / \lambda^3 \approx (\Delta\lambda / \lambda)^3 \qquad (33)$$

Considering universality of α (chap 1), we assume:

$$\Delta\lambda / \lambda \approx \eta\alpha \qquad (34)$$

Where: η is a coefficient, which will be discussed.

According to (34) we interpret α as well as “natural uncertainty of quanta” that equal to the “wave interferential redistribution constant” (chapter 1).

We consider below equation as a condition of stability of wave flow:

$$1/n \approx (\Delta V / V) \approx (\eta\alpha)^3 \qquad (35)$$

We call equation (35) condition of “Symmetry of Uncertainties’ Distribution” (SUD)

2.3. To test our formulas, for $\eta=1$ we get from equation (35); $n_1 \approx 1/\alpha^3 \approx 2.6 \cdot 10^6$ and from equation (31) we define; $\nu \approx 1.8 \cdot 10^{15}$. Using equation (20) we get: $\tau \approx \lambda n/c = n/\nu \approx 1.4 \cdot 10^{-9}$ s.

This numbers are conformable with Rydberg’s constant and to known handbooks appraisements for atomic photons. To test these expressions for other energy level we have used experimentally established properties for γ quanta; $\varepsilon \approx 0.5$ *Mev* ($\nu \approx 10^{20}$ s^{-1}), $\tau \approx 10^{-12}$ s. Using equation (31) we obtain; $n \approx (\alpha\nu \cdot \mathrm{s}/2)^{0.5} \approx (10^{20}/ 2 \cdot 137)^{0.5} \approx 6 \cdot 10^{8}$. From equation (20), we define $\tau \approx n/\nu \approx 6 \cdot 10^{-12}$s that coincides with the actual one.

These two examples show the “workability” of examined model in a large interval of energy.

2.4. Equalizing equation (23) with the actual energy of photon; $h\nu$ we write:

$$2E_0^2 \sigma\lambda n = h\nu \qquad (36)$$

The left and right sides of equation (36) are the total energy of wave flow, within classical and within quantum representations accordingly.

From equation (36) we define; $E_0 = (\omega/2\pi)(h/2c\sigma n)^{0.5}$. According to Fig. *4*, we can define the phase shift ($1/\omega$) for $\mathbf{E}_V$, $\mathbf{E}_H$ and write equations (21) as:

$$\mathbf{E}_V \approx \frac{\omega}{2\pi}\sqrt{\frac{h}{2c\sigma n}}\left[\mathbf{i}\sin\ \omega(t-\frac{x}{c})+\mathbf{k}\cos\ \omega(t-\frac{x}{c})\right]$$

$$\mathbf{E}_H \approx \frac{\omega}{2\pi}\sqrt{\frac{h}{2c\sigma n}}\left[\mathbf{i}\sin\ \omega(t-\frac{x}{c}-\frac{1}{\omega})+\mathbf{j}\cos\ \omega(t-\frac{x}{c}-\frac{1}{\omega})\right] \qquad (37)$$

Resulting from above, we mark:
b). *The equations* (37) *are approximate form* **(2)** *of quantized wave equations, which simultaneously satisfy to classical conceptions taken for the single whole wave, as well as to quantum conceptions taken for the restricted wave flow*.
As shown above, mentioned consensus becomes possible in case of "String-ring" form of energy's concentration in the wave flow.

2.5. The presented approximate representation provides an opportunity to move ahead and make new conclusions.

Attributing to photon an impulse; $P = \hbar k = \hbar\omega/c$ and the relativistic mass $m = \hbar\omega/c^2$ in conformity to quantum representation and STR, we image distribution of mass by the length of "rings". From graphic image (Fig. 4) and equation (36) we define the moment of impulse for each "ring" as:

$$S_1 = cm_1 r = cmr/2n = c(\hbar\omega/c^2)(\lambda/2\pi)(1/2n) = \hbar/2n$$

The scalar sum of moments in the wave flow we define as:

$$S = \sum S_1 = 2nS_1 = \hbar \qquad (38)$$

Considering spatial distribution and directions of circulations (Fig. 4) for the vector sum of moments we get:

$$\mathbf{S} = \sum \mathbf{S}_1 = 0 \qquad (39)$$

From equations (38), (39) we make conclusion:
c). *The summary impulse moment (scalar sum) of the photon is equal to* $\hbar$ (accepted as unit).

---

2 To find the exact form of these equations it's necessary to establish the correct functions; $\omega = F_1(n)$, and $\sigma = F_2(n)$ that we have done approximately. We can expect that these functions will contain specific factors similar to Fourier or, Maclaurin series arising because restrictions of photons wave flow. This issue can be subject to study the theoretically as well as experimentally.

d). *The photon's spin distributed discretely, by wave flow's length within mutually perpendicular directions, perpendicular to direction of its propagation* (Fig. 4)

3. Description of the electron as a Compton's standing wave

3.1. We start with examination of the meaning of η in SUD (*2.2.*). We have accepted in above example (*2. 3.)* $\eta = 1$. It means $n = 1/\alpha^3$ number of whole waves filling a full length of wave flow. From examined model of photon becomes clear that n is an individual parameter of quanta defining its peculiarities. We are free to suppose that on the length of a flow can be located $n = (2/\alpha)^3$, $(3/\alpha)^3$…etc, whole waves, as well as we can take; $n = (1/2\alpha)^3$, $(1/4\alpha)^3$…etc, which means we assume; $\eta = m/p$, where m, p are whole positive numbers. In such way, we can "construct" photons having different energies and parameters, satisfying (approximately) to actually exposed properties of photons. We examine now the special condition: $\eta \approx 1/2\pi$. We suppose that in this case the quant is able to form localized condition. We imagine above said as a possibility to "wrap" a restricted wave flow symmetrically by volume. We consider the mentioned condition necessary for stability of the localized quant. The graphic illustration of described concept presented (Fig. 5).

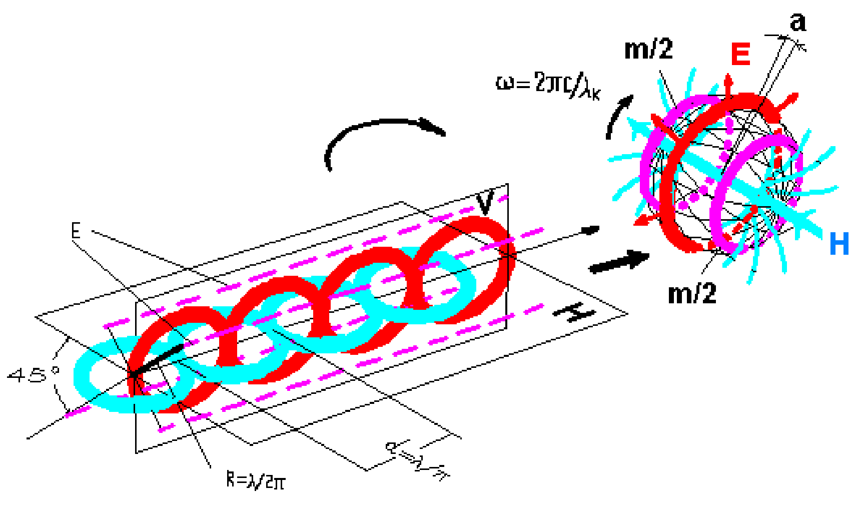

Fig. 5 The localization of quanta

Supposing that wave flow "wraps" in vertical flat by *0* radius, we conclude that "vertical rings" simply become to the same place, meanwhile the "horizontal rings" are distributed in space within axial symmetry. We "construct" the elementary particle as the localized wave-vortex (Fig. 6) by means of described mental operation [(3)].

3.2. We define the energy *(ν)* corresponding to value: $\eta \approx 1/2\pi$ from equations (31), (35):

$$n \approx (1/\eta\alpha)^3 = (2\pi/\alpha)^3 \approx 6.4 \cdot 10^8 \qquad (40)$$

$$\nu \approx 2n^2/\alpha \cdot \mathrm{s} \approx 1.12 \cdot 10^{20} \mathrm{s}^{-1} \qquad (41)$$

Obtained number (41) definitely is near to electron's rest energy ($\nu_e \approx 1.24 \cdot 10^{20}$ s^{-1}). Considering the mentioned coincidence we examine described localized quant as the electron's model. We present rest mass of the particle as a relativistic mass of quant:

$$m_e = \varepsilon / c^2 = h\nu_e / c^2 = h / c\lambda_e \qquad (42)$$

Where: $\lambda_e \approx 2.426 \cdot 10^{-12}$m is the Compton's wavelength for the electron.

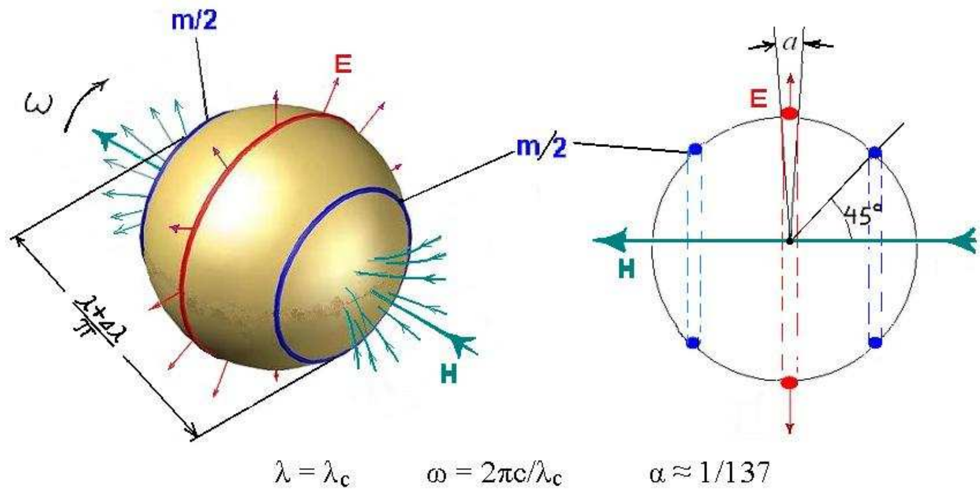

Fig. 6. The Model of the Electron

Considering previous interpretations of *a* (chapters 1, 2) we represent m_e as the energy of main interferential maximum in localized quanta. We represent the electromagnetic energy of electron as the energy of pseudo static fields, which are conditioned by energies of secondary interferential maximums (we can imagine it as "halos" of interference). Within conformity to above said we define:

---

3 Conservation's laws prohibit the transformation of single photon to a single localized particle.

$$\varepsilon_{e\mu} = \varepsilon_e + \varepsilon_\mu = \alpha h\nu = \alpha hc / \lambda_e = \alpha c^2 m_e \quad (43)$$

Where: ε_e, ε_μ are energies of electric and magnetic fields accordingly. Their equality follows from initial condition (21). From equation (43), we write:

$$\varepsilon_e = \varepsilon_\mu = 0.5\varepsilon_{e\mu} = 0.5ah\nu = \alpha hc / 2\lambda_e \quad (44)$$

The quantity and locations of "rings" for masses as well as for secondary maximums presented in graphic (Fig. 6). We come to presented image considering previous conclusions and certain reasons about symmetry of "construction" of formed particle.

We present the electrical energy (44) as traditional "charged" sphere's energy:

$$\varepsilon_e = q^2 / 8\pi \varepsilon_0 r \quad (45)$$

Where: ε_0 is the electric constant. Equalizing equations (45) and (44), considering $r = \lambda_e/2\pi$ we get:

$$q = \sqrt{2\varepsilon_0 \alpha hc} = \pm e \quad (46)$$

3.3. We define particle's moment impulse (spin) by analogy to photon's spin (*2.5.*), (Fig. 6). Considering: $r = \lambda_e/2\pi$ and (42) we get:

$$S = 2(\frac{1}{2} m_e r \sin\frac{\pi}{4} c \sin\frac{\pi}{4}) = \frac{m_e rc}{2} = \frac{\hbar}{2} \quad (47)$$

3.4. To define particle's magnetic moment, considering equation (44) we present it as produced from circulation of the "elementary charge" by its diametric length:

$$\mu = ecr / 2 = ec\lambda_e / 4\pi = ech / 4\pi\ cm_e = e\hbar / 2m_e = \mu_B \quad (48)$$

Where: $\mu_B = e\hbar/2m_e$ accepted as unit (*Bohr magneton*). The results (46), (47), (48) are in conformity with actual values of charge, spin and magnetic moment of the electron (see: *electron's g factor*).

We can make correction to μ considering previous representations. Some enlargement in the sizes of the particle will occur as localized wave, in view of its uncertainty. That brings to a corresponding small change of magnetic moment. We will define the actual magnetic moment of electron using expression:

$$\mu_e \approx \mu\ (1 + k_1 + k_2 + k_3 + ... + k_n) \quad (49)$$

We define correction factor k_1 as a parameter of enlargement of particle's diameter caused by natural uncertainty of quanta (34), (Heisenberg's uncertainty for the localized quantum):

$$k_1 = \Delta r / r\ = \Delta\lambda / \lambda = \alpha / 2\pi \approx 0.001161409725.. \quad (50)$$

We can interpret k_1 as an illustration to *Swinger's Correction*.

We define k_2 as a factor of smallest reduction of effective radius R_{ef} of circulation in relation to H axis, caused by enlargement of "charge's" distribution, corresponding to angle α within conformity to previous point (see Fig.7)

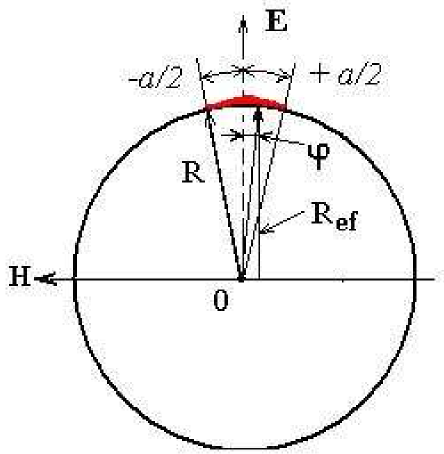

Fig. 7.
The distribution of charge (α shown much bigger)

We obtain from figure:

$$k_2 = \frac{\Delta R}{R} = \frac{R_{ef} - R}{R} = \frac{1}{\alpha}\int_{-\alpha/2}^{+\alpha/2} \cos\varphi \, d\varphi - 1 = \frac{2\sin\alpha/2}{\alpha} - 1 \approx -2.21888 \cdot 10^{-6} \qquad (51)$$

Thus, the factors (k_1, k_2) obviously derives from examined model. Their sum gives:

$$\mu_e / \mu_B \approx 1 + k_1 + k_2 \approx 1.0011591908\ldots \qquad (52)$$

This number differs from experimentally measured one by 10^{-8} digit only. To define k_3 we assume that it conditioned by non-homogeneity of "charge's" distribution in the range of angle α. We test this assumption in the form of an excitation (by analogy of QED methods) considering equations (35), (40) within conformity to below expression:

$$k_3 = \alpha^3 (1 + 1/2\pi + 1/4\pi^2 + \cdots + 1/2^n \pi^n) \qquad (53)$$

Using Maclaurin's series formula, we get:

$$k_3 = a^3/(1 - 1/2\pi) \approx 4.621146 \times 10^{-7} \qquad (54)$$

Considering k_3 we get:

$$\mu_e / \mu_B \approx 1 + k_1 + k_2 + k_3 \approx 1.0011596529 \ ... \qquad (55)$$

This number differs from the measured one by less than 10^{-10} digit:

(1.0011596522…) [6]

New small corrections are possible define as effects of mutual actions of mentioned factors. However, we cannot be sure in rightness of ours results because (55) already is comparable to experimental capabilities.

3.5. In conformity to photon's model, (chap. 2) there is no difference between mutually perpendicular two vectors $\mathbf{E_v}$, $\mathbf{E_h}$. It means the "left" and "right" systems, formed by two vectors with the vector of propagation, will be compatible. Thus, the photon's "mirror particle" will be the same as the original, which means it cannot have its "antiparticle". The mentioned equality of two vectors becomes disturbed in localized quantum (Fig. 5, 6) because different kind of symmetry (axial and central) arises for its pseudo static fields (in distributions of electric and magnetic "charges"). It means the localized quanta and its "mirror particle" become incompatible. This illustration allows interpreting the existence of particle-antiparticle pairs for localized quanta as its "left" and "right" circulations, as well as contrary signs of "charges" (*3.2.*)

3.6. To test the "workability's" of electron's model we examine the possibility of communicating it with de Broglie's wave. De Broglie's wave presented in handbooks as:

$$\Psi(\mathbf{r}, t) = Ce^{i(\frac{Et}{\hbar} - \frac{\mathbf{pr}}{\hbar})} \qquad (56)$$

Where: **r** is radius vector of free point, *t* is time, *E* is energy of moving particle, **p** impulse.

It has shown in courses that propagation speed of de Broglie's wave coincides to particle's speed within all directions:

$$V_x = \partial E / \partial p_x \,,\ V_y = \partial E / \partial p_y \,,\ V_z = \partial E / \partial p_z$$

$$\text{Or, in vector form: } \mathbf{V} = \nabla_{\mathbf{p}} E = \mathbf{v} \qquad (57)$$

The equation (57) means that de Broglie's wave moves with the particle. Its wavelength connected to the particle's impulse as $\boldsymbol{p} = \hbar\boldsymbol{k}$ where: $k = 2\pi / \lambda$. For the low speed; v << c the energy becomes; $E = p^2/2m_0$ and wave length becomes:

$$\lambda_D = \frac{2\pi\hbar}{\sqrt{2Em_0}} \qquad (58)$$

We will replace λ_D by corresponding frequency and write equation (58) as:

$$\nu_D = \frac{c}{\lambda_D} = \frac{c\sqrt{2Em_0}}{2\pi\hbar} \qquad (59)$$

We represent a mass of particle as relativistic energy of localized quanta as per examined model: $m_0 = h\nu_c/c^2$ (*3.2.*). Expressing kinetic energy as $E = m_0V^2/2$, from equation (59) we get:

$\nu_D = \nu_c(\mathrm{v}/c)$. Or, for the wavelength; $\lambda_D = \lambda_c(c/V) = h/m_0V$ (60)

Where: λ_c, ν_c are Compton's wavelength of particle and its frequency (as a localized quanta).

The equations (60) correspond to Doppler's known effect by its form, which points on the physical meaning of de Broglie's wave.

3.7. We will show below that it is possible to get the same result and conclusion from equations (37) without referring to quantum representation. For simplicity we will examine the movement of one "vertical ring" only (Fig. 4), assuming the observation point is *0* and movement by *x* axis (Fig. 8).

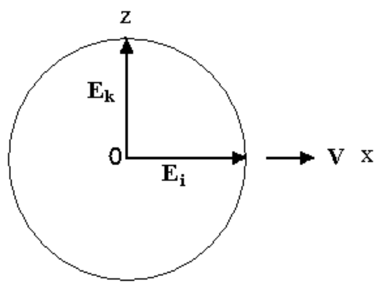

Fig. 8. The movement of localized quanta

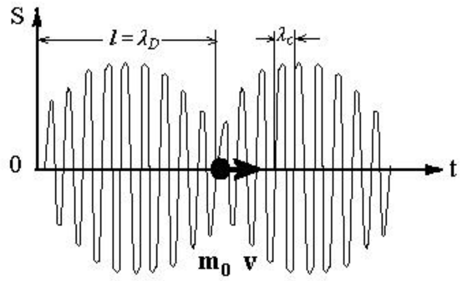

Fig. 9. De Broglie's wave illustration

The oscillations $\mathbf{E_k}$, $\mathbf{E_i}$ will look in observer's system with some changed frequencies as transverse and longitudinal Doppler effects accordingly. For frequencies we write:

$$\omega_k = \omega_c\sqrt{1-(\mathrm{v}/c)^2}\ ,\ \omega_i = \omega_c\sqrt{\frac{1-\mathrm{v}/c}{1+\mathrm{v}/c}}$$

Accepting; v << *c* we write: $\omega_k \approx \omega_c$ and $\omega_i \approx \omega_c(1-\mathrm{v}/c)$. We define summary oscillation as per sum of two oscillations having close frequencies (see handbook):

$$S = 2A_0\cos(\frac{\omega_k - \omega_i}{2}t)\sin(\frac{\omega_k + \omega_i}{2}t)$$

Considering above we get:

$$S = 2A_0 \cos(\frac{\mathrm{v}\omega_c t}{2c}) \sin \omega_c t \qquad (61)$$

Equation (61) corresponds to “wave beating” as shown in graphic (Fig. 9). Accepting; $\omega_c = \omega_e$ we define the length of one “beating packet” as:

$$l = (1/2)(2c/\mathrm{v})(2\pi\ c/\omega_e) = \lambda_e(c/\mathrm{v}) = h/m_0\mathrm{v} = \lambda_D \qquad (62)$$

Presented interpretation clarifies the physical meaning of de Broglie’s wave as *Doppler Effect arising from movement of Compton’s standing wave* (elementary particle).

3.8. Comparing the examined model of the electron with experimentally established its peculiarities we can see some opportunities that can help us to interpret these. Particularly, the intriguing problem of defining the actual size of electron gets new aspects. As it seems from graphic, (Fig. 6) the electron is mostly “empty” by its “construction” (similar to atom’s “construction”). This circumstance may open new possibility to explain its interaction with the high-energy hadrons and other heavy particles (for example, it seems probable that heavy particles can just pass through the electron without seeming energetic transformations). It explains the seeming “absence of sizes” of the electron, although its actual size is much bigger than hadrons. On the issue we can point on theoretical conclusions of some renowned researchers about; *“Impossibility of localization of the electron in a space less than Compton’s wavelength”* (L. Landau, R. Peirls).

We remark that examined model removes some serious problems as well, concerning to “infiniteness” of electron’s electrical energy, to its spin and “rotation speed” etc, which arise from its representation as “material point”.

We remark [8] as a resent conclusion pointing to “string-ring” form of the electron’s mass by size comparable to Compton’s wavelength. The mentioned aspects maybe subjects to future study.

Discussion

A constant relation is revealed concerning exclusively to wave properties, not considered yet. It correlates with the electromagnetic coupling constant, which is currently inexplicable.

The obtained coincidence principally is possible to proof experimentally. That could confirm the wave origin of the electromagnetic coupling constant and wave-field nature of basic particles, as different kinds of quantum-wave formations.

The universality of α and its exposition in extremely large group of phenomena in microcosm becomes explainable; as a constant conditioned by wave-dynamic unique character of primordial substance (analogical π).

The absolute stability of α becomes clear, which means it is really “a constant”; it cannot vary with time as some researchers are inclined to see.

Proposed interpretation shows deep roots of wave-particle duality principle and its applicability in quantum electrodynamics level as well. It points on the unique nature of material world and on the possibility of unifying quantum and classical representations.

Presented approach and methodology may open an alternative way to study microcosm, empowering current research capabilities.

Methods

We have used the general conceptual principle and approach in our attempts to solve the examined problems, based on the unique wave-field nature of primordial substance.

Our method of analyses’ is based on the geometric-imaginary representations and calculations allowing approximations. As an important criterion of trustfulness’ of our approach we have looked at obtained series of known fundamental physical values, based on a unique concept.

We propose below described experiment as an independent confirmation of presented interpretation of the fine structure constant (see; “Results”, chap. 1)

Proposed concept of Fine Structure Constant demands some correction to redistribution of interferential intensities. According to initial equations (2), we can obtain:

$$\Sigma I_m / I_0 = \tan\Delta\varphi \approx \sum_{m=1}^{n\to\infty} \frac{4}{\pi^2 (2m+1)^2} \approx 0{,}094715. \qquad (63)$$

This value corresponds to *Δφ ≈ 0.094433…* that differs from (13). The task of experiments should be to define the actual value of *Δφ*, by the same to check the rightness of deduced results (13), (14). For such measurements we propose to use Fraunhofer’s Single Slit Diffraction. The total intensity of the beam of light and intensity of main peak are necessary to establish in experiment, using photometric measurements with the same (P) photometer (or two calibrated ones) behind the slits S1, S2 (Fig. 10).

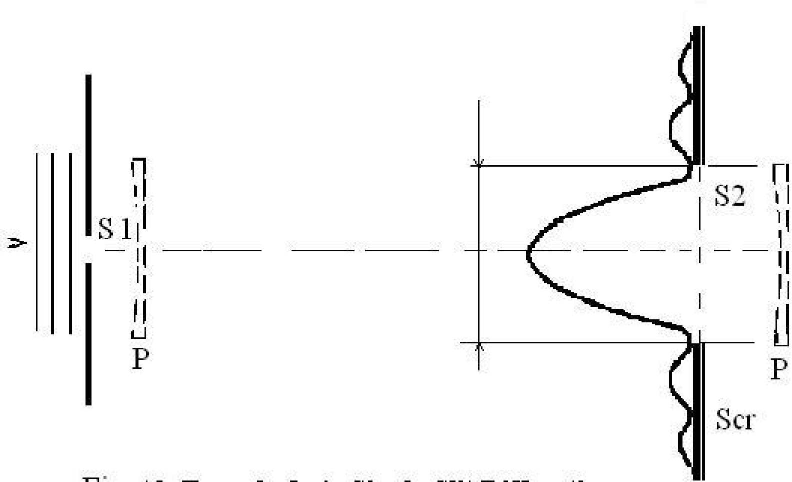

Fig. 10. Fraunhofer's Single Slit Diffraction

It is necessary to define the constant relation between its values. The exactness of results will mostly conditioned by exact coincidence of the sizes of the slit S2 with the displayed sizes of main peak of interference. (The direct measurement summary intensity of secondary peaks for a full angle of redistribution seems difficult from technical point).

By measured values I_0, I we can define: $I_0 / I = \cos\Delta\varphi$. In case (63), it has to be:

$$I_0 / I \approx 0.995544... \tag{64}$$

In case (13) it has should be:

$$I_0 / I = \cos(\arcsin e_*) \approx 0.996344... \tag{65}$$

The relative difference of two numbers is about $\delta \approx 8*10^{-4}$. The implemented collaboration laser-optics technique should to satisfy to mentioned conditions. The experiment will prove the wave origin of the “elementary charge” (e_*) as well as of the particle’s mass.

Acknowledgment

This paper supported by H. Khorchmazyan - PHD, Professor of Physics Department, state Pedagogical University Yerevan. A. Khachatryan - PHD, Professor of Physics Department, state Engineering University Yerevan, verified the calculations. The valuable advices of Professor M. Auci [3] and Dr. John Lestone (Los-Alamos National Laboratory) are considered. Author is deeply grateful to named scientists.

References:

[1] James G. Gilson, “Fine Structure Constant”,
http://www.maths.qmul.ac.uk/~jgg/page5.html

[2] Richard P. Feynman, “QED: The Strange Theory of Light and Matter”, ISBN 069102417

[3] Massimo Auci, Guido Dematties , “An Approach to Unifying Classical and Quantum Electrodynamics”, http://arxiv.org/ftp/arxiv/papers/0901/0901.2752.pdf, // International Journal of Modern Physics B, Vol. **13**, No 12 (1999), 1525-1557

[4] Nitin Ramchandra Gadre , “Mathematical model I. Electron and quantum mechanics”
AIP Advances **1**, 012105 (2011)

[5] B. M. Yavorsky, A.A. Detlaf, “Directory of the Physics“ (*Rus.)*, Science 1985, ВВК 22.3 – Я 22 – УДК 53

[6] D. Hanneke, S. Fogwell and G. Gabrielse,"New Measurement of the Electron Magnetic Moment and the Fine Structure Constant" , Phys. Rev. Lett. **100**, 120801 (2008) and arXiv:0801.1134v1 [physics.atom-ph]

[7] G. Gabrielse, D. Hanneke, T. Kinoshita and others, “New Determination of the Fine Structure Constant from the Electron g Value and QED”- *Phys. Rev. Letters* **97**, 030802 (2006)

[8] Alexander Burinskii, “Gravity versus Quantum theory: Is electron really pointlike?”
http://arxiv.org/abs/1104.0573