Vortex-ring-fractal Structure of Atoms

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***Abstract*—This paper is an attempt to attain a new and profound model of the nature's structure using a vortex-ring-fractal theory (VRFT). Scientists have been trying to explain some phenomena in Nature that have not been explained so far. The aim of this paper is the vortex-ring-fractal modeling of elements in the Mendeleev's periodic table, which is not in contradiction to the known laws of nature. We would like to find some acceptable structure model of the hydrogen as a vortex-fractal-coil structure of the proton and a vortex-fractal-ring structure of the electron. It is known that planetary model of hydrogen is not right, the classical quantum model is too abstract. Our imagination is that the hydrogen atom is a levitation system of the proton and the electron. Structures of helium, oxygen, and carbon atoms are presented too.**

***Index Terms*—Model of atoms, covalent bond, vortex-ring-fractal structures**

I. Introduction

The electrical force decreases inversely with the square of distance between charges. This relationship is called Coulomb's law. There are two kinds of "matter", which we can call positive and negative. Like kinds repel each other, while unlike kinds attract – unlike gravity, where only attraction occurs [1]. When charges are moving the electrical forces depend also on the motion of charges in a complicated way [2],[3],[4],[18].

Fractals seem to be very powerful in describing natural objects on all scales. Fractal dimension and fractal measure are crucial parameters for such description. Many natural objects have self-similarity or partial-self-similarity of the whole object and its part [9].

Most of our knowledge of the electronic structure of atoms has been obtained by the study of the light given out by atoms when they are exited. The light that is emitted by atoms of given substance can be refracted or diffracted into a distinctive pattern of lines of certain frequencies and create the line spectrum of the atom [12].

The careful study of line spectra began about 1880. The regularity is evident in the spectrum of the hydrogen atom. The interpretation of the spectrum of hydrogen was not achieved until 1913. In that year the Danish physicist Niels Bohr successfully applied the quantum theory to this problem and created a model of hydrogen. Bohr also discovered a method of calculation of the energy of the stationary states of the hydrogen atom, with use of Planck's constant h. Later in 1923 it was recognized that Bohr's formulation of the theory of the electronic structure of atoms to be improved and extended. The Bohr theory did not give correct values for the energy levels of helium atom or the hydrogen molecule-ion H_2^+, or of any other atom with more than one electron or any molecule.

During the two-year period 1924 to 1926 the Bohr description of electron orbits in atoms was replaced by the greatly improved description of wave mechanics, which is still in use and seems to be satisfactory. The discovery by de Broglie in 1924 that an electron moving with velocity v has a wavelength $\lambda=h/m_e v$ [4]. The theory of quantum mechanics was developed in 1925 with the German physicist Werner Heisenberg. Early in 1926 an equivalent theory, called wave mechanics, was independently developed by Austrian physicist Ervin Schroedinger. Important contributions to the theory were also made by the English physicist Paul Adrien Maurice Dirac. The most probable distance of the electron from the nucleus is thus just the Bohr radius r_B (r_o); the electron is, however, not restricted to this distance. The electron is not to be thought of as going around the nucleus, but rather as going in and out, in varying directions, so as to make the electron distribution spherically symmetrical [4].

Matter is composed of tiny atoms. All the atoms of any elements are identical: they have the same mass and the same chemical properties. They differ from the atoms of all other elements. Twenties-century X-ray work has shown that the diameters of atoms are of the order 0.2 nm ($2\text{x}10^{-10}$ m). The mass and the positive charge are concentrated in a tiny fraction of the atom, called nucleus. The nucleus consists of protons (p) and neutrons (n). Protons and neutrons are made up of smaller subatomic particles, such as quarks. Both protons and neutrons have a mass approximately 1840 times greater than an electron (e). The more energy an electron has, the further it can escape the pull of the positively charged nucleus. Given sufficient energy, an electron can jump from one shell to higher one. When it falls back to a lower shell, it emits radiation in the form of photons.

II. Electron with vortex-fractal-ring structure

The discovery of the electron was a landmark in physics and led to great technological advances. The electron emission is the process when negative charges in the form of electron, escape for example from the hot filament. Streams of electrons moving at high speed are called cathode rays or electron rays. The rays are deflected by a magnetic field too. If the N pole of a magnet is brought up to the neck of the tube, the rays move upwards, using Fleming's left-hand rule. The ratio of the charge q of an electron e to its mass m_e is called its specific charge and can be found from experiments in which cathode rays are deflected by electric and magnetic

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fields. It was first done by J. J. Thomson in 1897 using a deflection-type tube. His work is regarded as proving the existence of the electron as a negatively charged particle of very small mass and not, as some scientists thought a form of electromagnetic radiation like light.

Electron is defined as a fundamental particle of matter, with negative electric charge, which populates the outer region of atoms.

The electrical force decreases inversely with the square of distance between charges. This relationship is called Coulomb's law. There are two kinds of "matter", which we can call positive and negative. Like kinds repel each other, while unlike kinds attract – unlike gravity, where only attraction occurs[2]. When charges are moving the electrical forces depend also on the motion of charges in a complicated way [3].

Fractals seem to be very powerful in describing natural objects on all scales. Fractal dimensions and fractal measures are crucial parameters for such description. Many natural objects have self-similarity or partial-self-similarity of the whole object and its part [9].

The structure of the electron in Fig. 1 presents the electron as "pure" ring fractal structure. Electrons ${}^0e$ (or e), in the electron ray ${}^0r$, hold together by photon's vortex structures ${}^0f$ (a pair of vortices) [17]-[35]. Generally, in the fractal structure of the electron, the number n defines the level of substructure ${}^ne$. The name osmeron (see Fig. 18) was derived from the name "Osmera" of Egyptian deity with 4 pairs of gods as primary creative forces (from a chaos beginning). Osmerons are too small that is why they have unmeasurable size and mass.

We know that the apparent mass of a particle changes by $1/\sqrt{(1 - v^2/ c^2)}$. Does its charge do something similar? No charges are always the same, moving or not [2]. If the charge of a particle depended on the speed of the particle carrying it, in the heated block the charge of the electrons and protons would no longer balance. A block would become charged when heated. If the charge on an electron charged with speed, the net charge in piece of material would be charged in a chemical reaction. Even a very small dependence of charge on speed would give enormous fields from the simplest chemical reactions. No such effect has been observed [4], and we conclude that the electric charge of a single particle is independent of its state of motion.

For a calculation [17]-[35] of the fractal-ring electron structure we will use the structure that is shown in Fig. 1and Fig. 2. In the ring electron structure (see Fig. 2) the subelectrons e_o rotate with a velocity v_e and subsubelectrons e_1 with a velocity v_o. The radius of the electron is R_e and a radius of axes of subelectrons e_o is r_e. A rough estimation of number of subrings is N and number of subsubring is N^2. The size of number N is determined by the mass m_p of the proton and mass m_e of the electron [25].

We can calculate parameters of the electron by a vortex-fractal theory [17]-[35]. Subelectrons are accelerated towards the center of the electron ring. The size of the acceleration force F_a has to be in balance with two coulomb forces F_o. A complex force of attraction F_A can be calculated by Ampere's law:

$$F_a = F_A \tag{1}$$

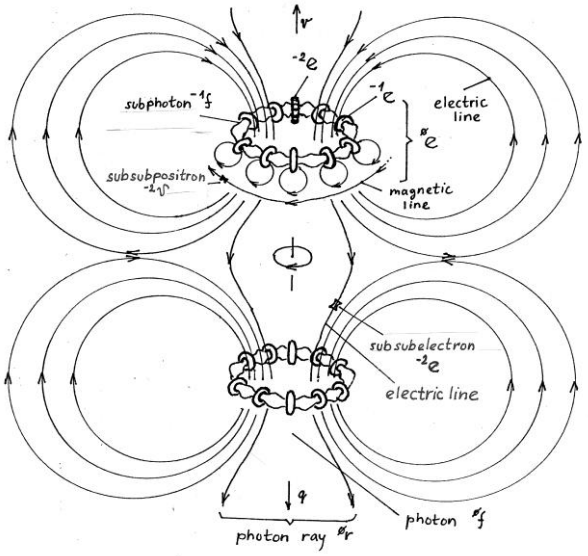

Fig. 1 The vortex-fractal structure of the electron ray with two electrons

The fundamental physical law describing an acceleration force F_a is :

$$F_a \approx m\frac{v^2}{r} \tag{2}$$

where m is mass with velocity v and distance r

The mass m_{oe} of the subelectron e_o for the fractal structure of the electron is:

$$m_{oe} = \frac{m_e}{N} \tag{3}$$

where N is number of subelectrons. To explain a creation of the proton structure and the electron structure from the same very small rings (N^2 subsubelectrons e_1) [10] have to be:

$$N = \sqrt{\frac{m_p}{m_e}} \approx 42 = 2 \cdot 3 \cdot 7 \tag{4}$$

where m_p is the mass of the proton and m_e is the mass of the electron (see Fig. 2).

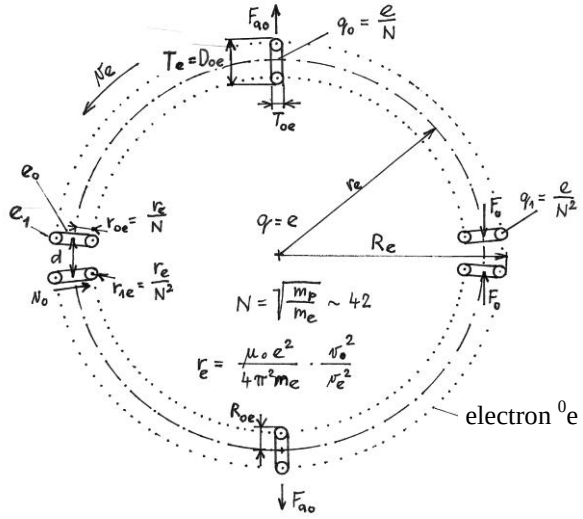

Fig. 2 The fractal-ring structure of the electron

From the fractal structure of the electron on Fig. 2:

$$F_a = F_{ao} \cdot \frac{2}{\pi} \cdot \frac{N}{2} = \frac{m_e}{N} \frac{v_e^2}{r_e} \cdot \frac{2}{\pi} \cdot \frac{N}{2} \tag{5}$$

The average value of forces F_{ao} for $N/2$ subelectrons is on Fig. 3. The average value $2/\pi$ was calculated following way:

$$\int_0^{\pi} \sin x dx = 2 \tag{6}$$

$$\frac{\int_0^{\pi} \sin x dx}{\pi} = \frac{2}{\pi} \tag{7}$$

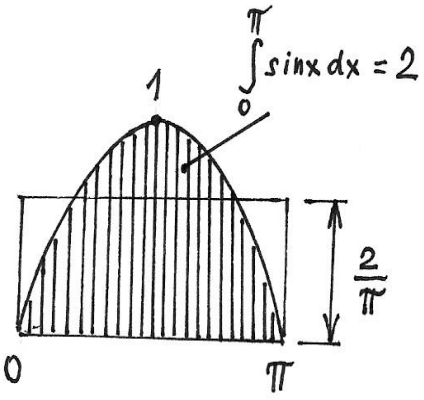

Fig. 3 Average value of the acceleration force F_{ao}

The fundamental physical law for attraction force F_A (Amper's law) between two wires with a current I, a length l, a distance d, and a permeability μ_o of vacuum is:

$$F_A \approx \frac{\mu_o}{2\pi} I^2 \frac{l}{d} \tag{8}$$

Electric charges q_1 in the subring e_1 create the current I:

$$I = \frac{dQ}{dt} = \frac{q_1 N}{T} \tag{9}$$

$$2\pi r_{oe} = v_o T \tag{10}$$

$$q_1 = \frac{e}{N^2} \tag{11}$$

$$I = \frac{\frac{e}{N^2} N}{T} = \frac{e}{NT} = \frac{e v_o}{N 2\pi r_{oe}} =$$

$$= \frac{e v_o}{N 2\pi \frac{r_e}{N}} = \frac{e v_o}{2\pi r_e} \tag{12}$$

$$d = \frac{2\pi r_e}{N} \tag{13}$$

Equation 12 and Eq.13 are inserted into Eq.8:

$$F_A = 2F_o = 2 \frac{\mu_o}{2\pi} \frac{e^2 v_o^2}{4\pi^2 r_e^2} \frac{2\pi \frac{r_e}{N}}{\frac{2\pi r_e}{N}} \tag{14}$$

The force F_a from Eq.5 and F_A from Eq.14 we insert to Eq.1:

$$\frac{m_e}{N} \frac{v_e^2}{r_e} \frac{2}{\pi} \frac{N}{2} = 2 \frac{\mu_o}{2\pi} \frac{e^2 v_o^2}{4\pi^2 r_e^2} \frac{2\pi \frac{r_e}{N}}{\frac{2\pi r_e}{N}} \tag{15}$$

and the radius r_e of the electron (in Fig. 2) is :

$$r_e = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{v_o^2}{v_e^2} \tag{16}$$

Attraction forces calculated by Ampere's law and Coulomb's law between two subrings e_o are:

$$F_{oA} = \frac{\mu_o}{2\pi} \frac{q_1^2 v_o^2}{4\pi^2 r_{oe}^2} \frac{2\pi \frac{r_e}{N}}{\frac{2\pi r_e}{N}} = \frac{\mu_o}{2\pi} \frac{\left(\frac{e}{N}\right)^2 v_o^2}{4\pi^2 \left(\frac{r_e}{N}\right)^2} \frac{2\pi \frac{r_e}{N}}{\frac{2\pi r_e}{N}} \tag{17}$$

$$F_{oC} = \frac{\left(\frac{e}{N}\right)^2}{4\pi\varepsilon_o \left(\frac{2\pi r_e}{N}\right)^2} \tag{18}$$

where ε_o is permitivity of vacuum. It is defined as exactly 10^{-7} times the speed of light squared.

The Ampere's force F_{oA} have to be the same as Coulomb's force F_{oC}:

$$F_{oA} = F_{oC} \tag{19}$$

$$\frac{\mu_o}{2\pi} \frac{\left(\frac{e}{N}\right)^2 v_o^2}{4\pi^2 \left(\frac{r_e}{N}\right)^2} \frac{2\pi \frac{r_e}{N}}{\frac{2\pi r_e}{N}} = \frac{\left(\frac{e}{N}\right)^2}{4\pi\varepsilon_o \left(\frac{2\pi r_e}{N}\right)^2} \tag{20}$$

$$\mu_o v_o^2 = \frac{1}{2\varepsilon_o} \tag{21}$$

$$v_o = \frac{c}{\sqrt{2}} \tag{22}$$

It is in coincidence with Eq.61 and Eq.63.

For $v_o = \frac{c}{\sqrt{2}}$ from Eq.22 the radius r_e of the electron in Eq.16 is:

$$r_e = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{v_o^2}{v_e^2} = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{c^2}{2v_e^2} =$$

$$= \frac{e^2}{8\pi^2 \varepsilon_0 m_e} \cdot \frac{1}{v_e^2} \tag{23}$$

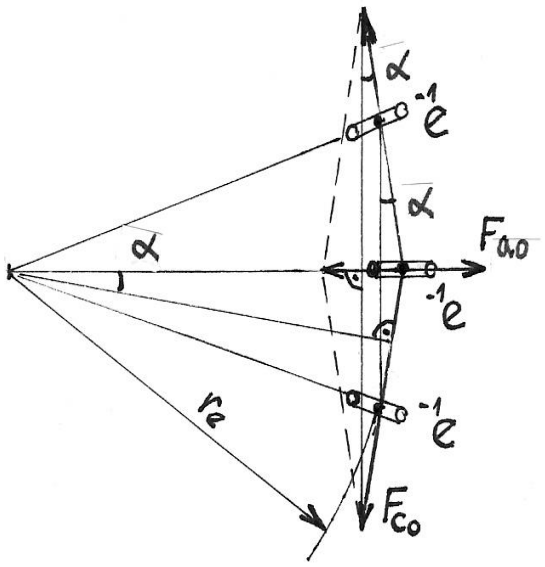

Fig. 4 Forces between two sub-electrons ^{-1}e inside the electron ^{0}e

We can receive the same result with geometry on Fig. 4:

$$\sin\alpha = \frac{\frac{F_{a0}}{2}}{F_{C0}} = \frac{F_{a0}}{2F_{C0}} \tag{24}$$

$$\sin\alpha = \frac{\frac{2\pi r_e}{N}\frac{1}{2}}{r_e} = \frac{\pi}{N} \tag{25}$$

$$\sin\alpha = \frac{F_{a0}}{2F_{C0}} = \frac{\pi}{N} \tag{26}$$

$$F_{a0} = \frac{2\pi}{N}F_{a0} \tag{27}$$

$$\frac{m_e}{N}\frac{v_e^2}{r_e} = \frac{2\pi}{N}\frac{\left(\frac{e}{N}\right)^2}{4\pi^2\varepsilon_0\left(\frac{2\pi r_e}{N}\right)^2} \tag{28}$$

$$r_e = \frac{e^2}{8\pi^2\varepsilon_0 m_e}\frac{1}{v_e^{\,2}} \tag{29}$$

$$m_e = \frac{m_{e0}}{\sqrt{1-\frac{v^2}{c^2}}} \tag{30}$$

For $v_e^2 = \frac{c^2}{2}$ and m_e from Eq.30 the radius r_e is:

$$r_e = \frac{e^2}{8\pi^2\varepsilon_0\frac{m_{e0}}{N}}\frac{1}{v_e^{\,2}}\sqrt{1-\frac{v_e^2}{c^2}}$$

$$r_e = \frac{e^2}{8\pi^2\varepsilon_0 m_{e0}}\frac{1}{v_e^{\,2}}\frac{1}{\sqrt{2}} \tag{31}$$

For $v_e << c$:

$$r_e = \frac{e^2}{8\pi^2\varepsilon_0 m_{e0}}\frac{1}{v_e^{\,2}} \tag{32}$$

The result in Eq.32 is the same as in Eq.23 and Eq.29.

III. THE MODEL OF HYDROGEN WITH LEVITATING ELECTRON

The hydrogen atom can have the electron on left side or on right side (see Fig. 10a, Fig. 10b), thus the difference in exponents of *r* must be *2* then *exp=4*. The attractive force F_+ is the Coulomb's force. A distance *r* between the electron and the proton is :

$$F = F_+ - F_- = \frac{e^2}{4\pi\varepsilon_o}\left(\frac{1}{r^2} - \frac{A}{r^{\exp}}\right) =$$

$$= \frac{e^2}{4\pi\varepsilon_o}\frac{1}{r^2} - \frac{e^2}{4\pi\varepsilon_o}\frac{r_o^2}{r^4} \tag{33}$$

For Bohr distance $r_B = r_o = d_o \approx 5.29\cdot 10^{-11} m$ [18] is *F = 0*.

$$A = r_o^2 \tag{34}$$

$$F = F_+ - F_- = \frac{e^2}{4\pi\varepsilon_o}\left(\frac{1}{r^2} - \frac{r_o^2}{r^4}\right) \tag{35}$$

Let us use Eq.35 as a postulate for next calculations. The distance *r* where *F* has maximum is shown on **Fig. 5**.

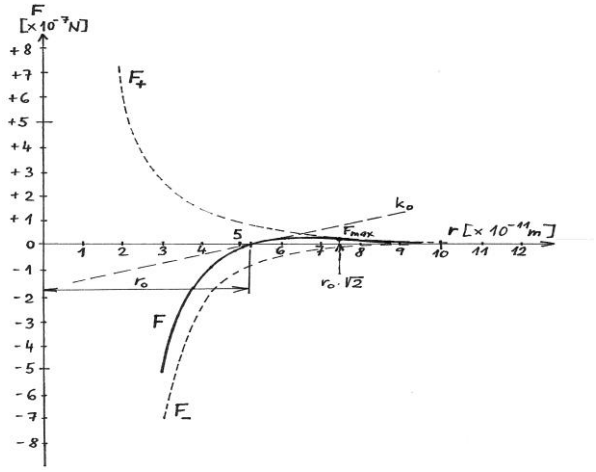

Fig. 5 Forces in the hydrogen atom

$$\frac{dF}{dr} = \frac{e^2}{4\pi\varepsilon_o}\left[-\frac{2}{r^3} - \left(-\frac{4r_o^2}{r^5}\right)\right] =$$

$$= \frac{e^2}{2\pi\varepsilon_o r^3}\left(-1 + \frac{2r_o^2}{r^2}\right) \tag{36}$$

for r_o:

$$\frac{dF}{dr} = \frac{e^2}{4\pi\varepsilon_o r_o^3} = K_o \tag{37}$$

The line k_o in **Fig. 5** is described by:

$$\frac{dF}{dr} = \frac{e^2}{2\pi\varepsilon_o r^3}\left(-1+\frac{2r_o^2}{r^2}\right) = 0 \qquad (38)$$

The solution of Eq.38 for F_{max} is $r_{1,2} = \pm\sqrt{2}r_o$. Energy E of the electron in the distance r:

$$E = \int\frac{e^2}{4\pi\varepsilon_o}\left(\frac{1}{r^2}-\frac{r_o^2}{r^4}\right)dr = \frac{e^2}{4\pi\varepsilon_o}\int\left(\frac{1}{r^2}-\frac{r_o^2}{r^4}\right)dr =$$

$$= \frac{e^2}{2\pi\varepsilon_o r^3}\left(-1+\frac{2r_o^2}{r^2}\right) \qquad (39)$$

The graph of E is on **Fig. 6**. Energy E_o is energy, which must be added to the electron to be free:

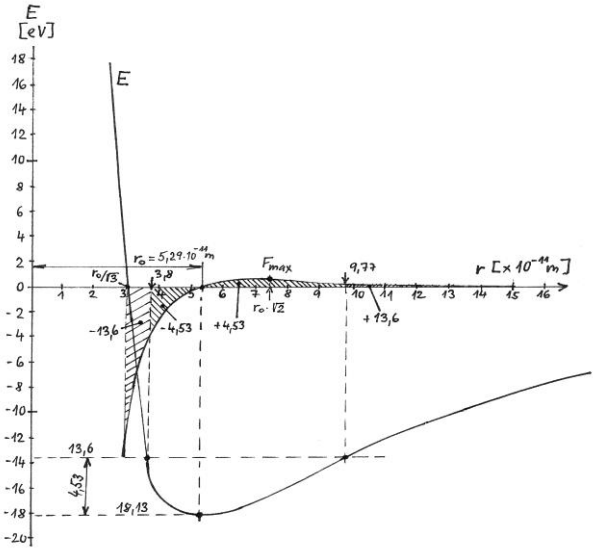

Fig. 6 Energy E and the force F in the hydrogen atom

$$E_o = \frac{e^2}{4\pi\varepsilon_o}\int_r^\infty\left(\frac{1}{r^2}-\frac{r_o^2}{r^4}\right)dr = \frac{e^2}{4\pi\varepsilon_o}\left[-\frac{1}{r}+\frac{r_o^2}{3r^3}\right]_r^\infty =$$

$$= \frac{e^2}{4\pi\varepsilon_o}\left(\frac{1}{r}-\frac{r_o^2}{3r^3}\right) \qquad (40)$$

For $E_o = 0$

$$r_{Eo} = \pm\frac{r_o}{\sqrt{3}} \approx \pm 3.05\cdot10^{-11} m \qquad (41)$$

For r_o in Eq.40 energy E_o is:

$$E_o = \frac{e^2}{4\pi\varepsilon_o}\left(\frac{1}{r_o}-\frac{r_o^2}{3r_o^3}\right) = \frac{e^2}{4\pi\varepsilon_o}\frac{1}{r_o}\frac{2}{3} =$$

$$\frac{e^2}{6\pi\varepsilon_o}\frac{1}{r_o} \approx 18.13 eV \qquad (42)$$

$$E_o = \frac{e^2}{4\pi\varepsilon_o}\frac{1}{r_o}\frac{2}{3} \approx 27.2\frac{2}{3}eV \approx 18.13 eV \qquad (43)$$

Now we can calculate frequency f_o and period T_o of oscillation of the electron in the hydrogen atom. The electron oscillates around r_o. We insert K_o defined in Eq.37 into Eq.44:

$$f_o = \frac{1}{2\pi}\sqrt{\frac{K_o}{m_e}} \approx 9.3\cdot10^{14} Hz \qquad (44)$$

$$T_o = \frac{1}{f_o} \approx 1.075\cdot10^{-15} s \qquad (45)$$

IV. The Spin of the Electron

It was discovered in 1925 that the electron has properties corresponding to its spin S. It can be described as a rotating ring around an axis of of the electron (see Fig. **1** and Fig. 7) [34]. The spin of the electron is defined as angular momentum [18],[34]:

$$\vec{S} = m_e(\vec{r}_e \times \vec{v}_e) \qquad (46)$$

For the spin on axis z:

$$S_z = N\frac{m_e}{N}r_e\bar{v}_e \qquad (47)$$

where m_e is the mass of the electron, r_e is the radius of the electron and N is number of substructures inside the structure of the electron. In [30] the formula for radius r_e of the electron is:

$$\bar{r}_e = \frac{e^2}{8\pi^2\varepsilon_0 m_e}\cdot\frac{1}{\bar{v}_e^2} \qquad (48)$$

$$\bar{v}_e = \bar{v} = \pm\frac{2}{\pi}v_{me} = \pm\frac{2}{\pi}v_m \qquad (49)$$

$$v_m = \frac{e^2}{4\varepsilon_0 h} \qquad (50)$$

where $\bar{r}_e$ is mean radius, $\bar{v}$ is mean velocity of the electron [30], $\bar{v}_e$ is mean velocity of the subelectron, v_m is maximum translation velocity of the electron and v_{me} is maximum velocity of the subelectron ^{-1}e (maximum rotational velocity of the electron) if the electron has distance $d_{o\ \text{from the proton}}$ (see Fig. 2 and Fig. 7) and minimum energy E_{qo}, see Eq.33.

The mean radius $\bar{r}_e$ is:

$$\bar{r}_e = \frac{e^2}{8\pi^2\varepsilon_0 m_e}\cdot\frac{\pi^2}{4v_m^2} =$$

$$= \frac{e^2}{8\varepsilon_0 m_e}\cdot\frac{1}{4v_m^2} =$$

$$= \frac{e^2}{32\varepsilon_0 m_e}\cdot\frac{16\varepsilon_0^2 h^2}{e^4} = \frac{\varepsilon_0 h^2}{2m_e e^2} = \frac{d_o}{2} \qquad (51)$$

The spin S_z on axis z:

$$S_z = m_e\bar{v}_e\bar{r}_e = \pm m_e\frac{2}{\pi}v_m\bar{r}_e =$$

$$= \pm m_e\frac{2}{\pi}\cdot\frac{e^2}{4\varepsilon_0 h}\cdot\frac{\varepsilon_0 h^2}{2m_e e^2} =$$

$$= \pm\frac{1}{2}\cdot\frac{h}{2\pi} = \pm\frac{1}{2}\hbar = m_s\hbar \qquad (52)$$

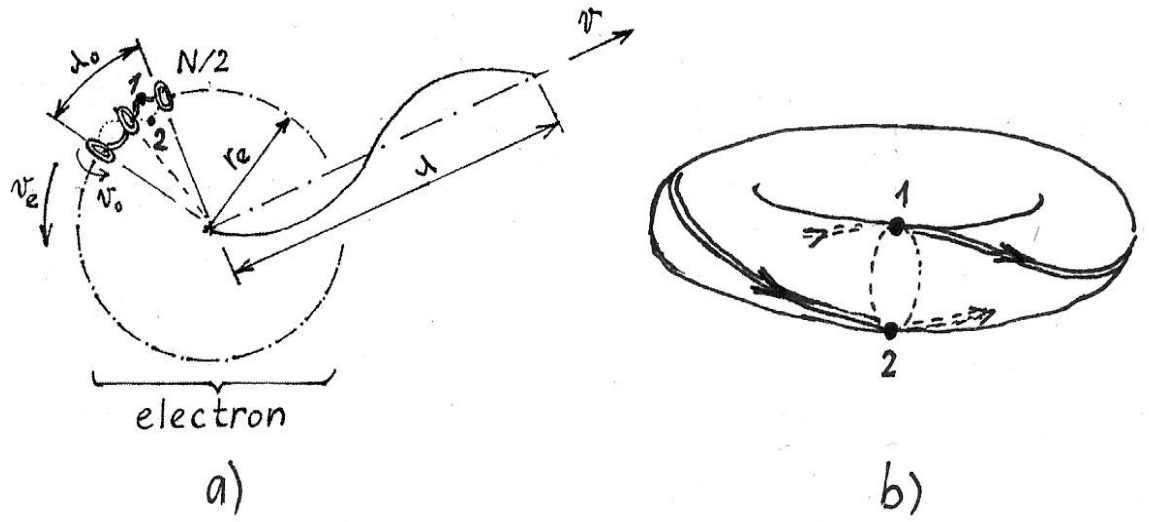

Fig. 7 The electron, which is moving with velocity v has a wavelength $\lambda=h/m_e v$ (de Broglie's equation):
a) Relation between λ and λ_o in the fractal-ring structure of the electron,
b) The ring of the electron with spin quantum number: *1/2* (twice around a annuloid to match)

where

$$m_s = \pm\frac{1}{2} \tag{53}$$

The result in Eq.52 is in coincidence with the generally equation for the spin, where m_s is spin quantum number [34].

We can suppose that a fractal structure of the electron has wavelength $\lambda = N\,\lambda_o$ (see Fig. 7a):

$$2\pi r_e = \lambda_o \frac{N}{2} = \frac{\lambda}{N}\cdot\frac{N}{2} = \frac{\lambda}{2} \tag{54}$$

or from Fig. 7b

$$2\cdot 2\pi r_e = \lambda \qquad r_e = \frac{\lambda}{4\pi} \tag{55}$$

where N is number of subparts (for example: number of subelectrons). Equation 7 with Eq.10 lead to:

$$|S_z| = m_e|\bar{v}_e|r_e = \frac{1}{2}\cdot\frac{h}{2\pi} = N\cdot\frac{m_e}{N}\cdot|\bar{v}_e|\cdot r_e =$$

$$= N\cdot\frac{m_e}{N}\cdot|\bar{v}_e|\cdot\frac{\lambda}{4\pi} \tag{56}$$

$$\lambda = \frac{h}{m_e|\bar{v}_e|} = N\cdot\lambda_o = \frac{h}{m_e|\bar{v}|} = \pm\frac{h}{m_e\bar{v}} \tag{57}$$

$$\bar{v}_e = \bar{v} \tag{58}$$

It can be an explanation of de Broglie's equation for a wavelength $\lambda=h/mv$. We suppose that the electron energy E_t of translation movement is the same as the rotational energy E_r of the rotating electron [18].

The structure of electron on Fig. 7b may be the 21-multiple "double-helix-line" structure (here it is only one "double helix" with markers 1, 2).

V. MODEL OF HYDROGEN ATOM

In a new model of the hydrogen atom with a levitating electron [18],[19] there is attractive (electric) force F_+ and (magnetic) repellent force F_- (see Eq.35):

$$F = F_+ - F_- = \frac{e^2}{4\pi\varepsilon_o}\left(\frac{1}{d^2} - \frac{d_o^2}{d^4}\right) \tag{59}$$

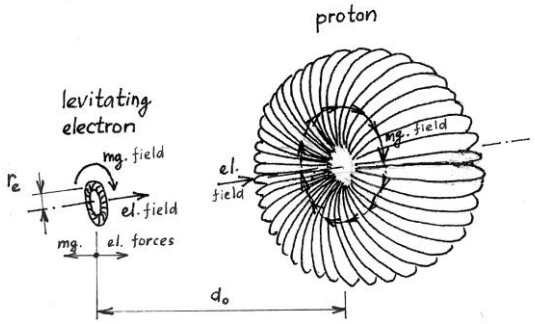

Fig. 8 The levitating electron in the field of the proton (the fractal model of hydrogen **H** is simplified [18]).

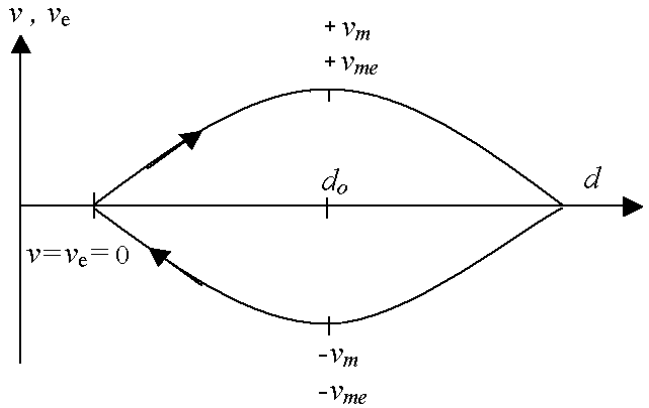

Fig. 9 Displacement velocity v and rotation velocity v_e of the electron on Fig.2

The hydrogen atom can have the electron on left side of the proton or on right side (see Fig. 10a, Fig. 10b). The attractive force F_+ is Coulomb's force. The repellent force

F_- is caused with magnetic field of the proton and the electron (see Fig. 8). The distance d between the electron and the proton is described in Eq.59. The electron moves as a "Yo-Yo" toy (see Fig. 9)

The Bohr radius r_B (or r_o) has the same size as the distance $d_o \approx 5.29 \cdot 10^{-11} m$ [4] in our vortex-fractal-ring model [18].

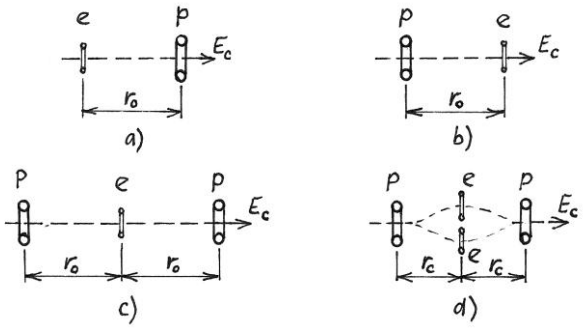

Fig. 10 Distances $d_o = r_o$ between proton and electron [18]
a) left side orientation of hydrogen
b) right side orientation of hydrogen
c) the hydrogen molecule-ion H_2^+
d) the hydrogen molecule H_2 with a covalent bond

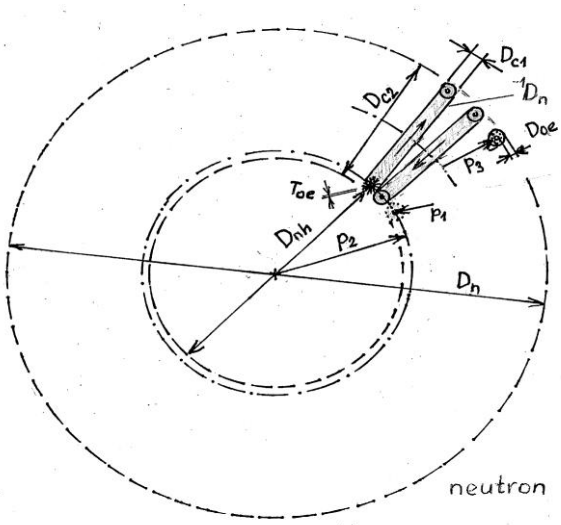

Fig. 11 Vortex-fractal structure of the neutron [18]

To calculate quantum model of hydrogen we use radius r_e of the electron, which was derived in Eq.16[30]:

$$r_e = \frac{\mu_o e^2}{4\pi^2 m_e} \frac{v_o^2}{v_e^2} \tag{60}$$

for $v_o = \frac{c}{\sqrt{2}}$

$$v_o^2 = \frac{c^2}{2} = \frac{1}{2\varepsilon_o \mu_o} \tag{61}$$

$$r_e = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{v_o^2}{v_e^2} = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{c^2}{2v_e^2} =$$

$$= \frac{e^2}{8\pi^2 \varepsilon_0 m_e} \cdot \frac{1}{v_e^2} \tag{62}$$

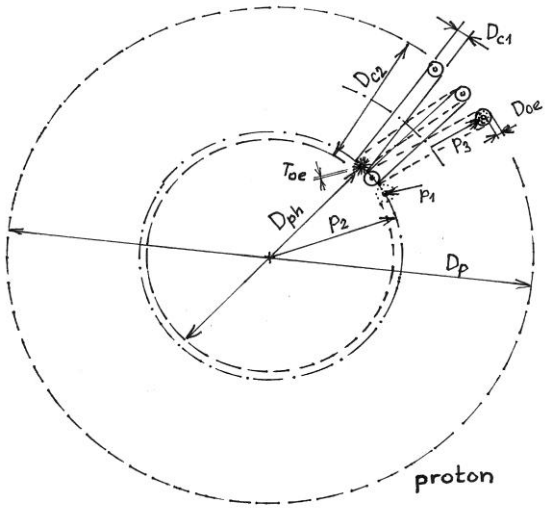

Fig. 12 Vortex-fractal structure of the proton [18]

VI. STRUCTURE OF ELECTROMAGNETIC FIELD

Electric lines or rays with different substructures (positron and electron substructures) repel each other (see Fig. 14). The same types of substructures (lines) attract each other and create braids. The similar behavior has magnetic field - magnetic lines or rays with electron and positron substructures repel each other (see Fig. 15). Electric lines are formed from electron subparts (^{-4}e) or/and positron subparts (^{-4}v). Magnetic lines are formed from electron subparts ($^{-3}$e) or/and positron subparts (^{-3}v). Electric lines or rays are perpendicular to magnetic lines or rays. The ray is a "braid" of lines (see Fig. 14).

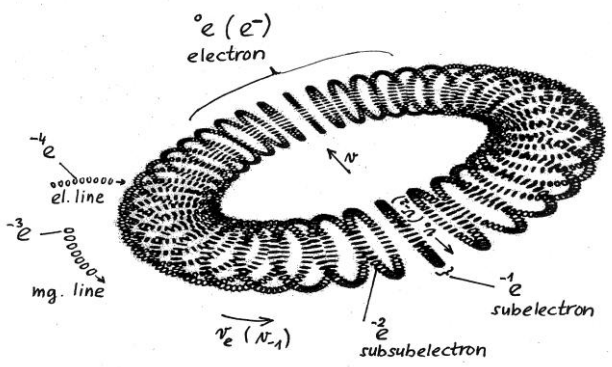

Fig. 13 Vortex-fractal ring structure of the electron [18],[31]

Energy E_o of the quite and free electron ^0e [35], which has velocity $v=0$ and quite mass m_{eo}, can be calculated from kinetic energy of their subparts: subelectrons ^{-1}e with velocity v_{-1} (v_e), subsubelectrons ^{-2}e with velocity v_{-2} (v_o), subsubsubelectrons ^{-3}e with velocity v_{-3}, subsubsubsubelectrons ^{-4}e with velocity v_{-4} , and subsubsubsubsubelectrons ^{-5}e with velocity v_{-5} (see Fig. 18).

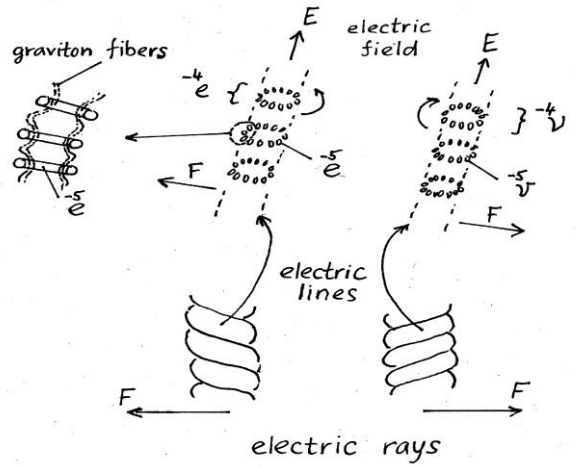

Fig. 14 Structure of the electric field

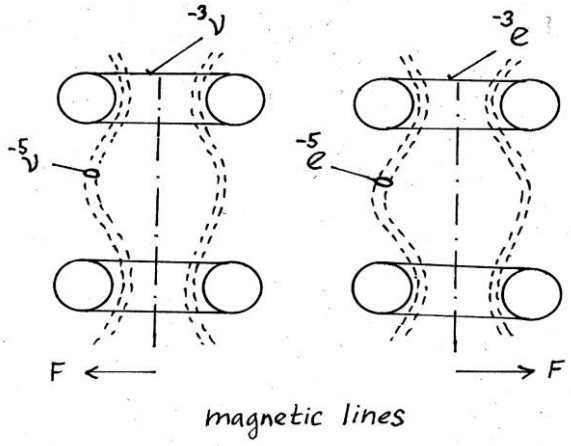

Fig. 15 Structure of the magnetic field

If velocities of substructures are [18],[32]:

$$v = v_e = 0 \qquad v_o = v_{-3} = v_{-4} = v_{-5} \approx \frac{c}{\sqrt{2}} \tag{63}$$

then their inner kinetic energy is:

$$E_o \approx \frac{1}{2}\frac{m_{eo}}{N^2} v_o^2 N^2 + \frac{1}{2}\frac{m_{eo}}{N^3} v_{-3}^2 N^3 + \tag{64}$$

$$+\frac{1}{2}\frac{m_{eo}}{N^4} v_{-4}^2 N^4 + \frac{1}{2}\frac{m_{eo}}{N^5} v_{-5}^2 N^5 = m_{eo} c\ E_o \approx m_{eo} c^2 \tag{65}$$

This result is in coincidence with the well-known Einstein's law. Mass is a measure of the amount of matter in an object. The object's inertia is proportional to its mass, and Einstein showed that mass is actually a very compact form of energy.

Fig. **17** explains a particle structure of the photon and a wave-energy structure of the light ray, which consists from more photons arranged in the series (sequence, string). A vortex pair is created from "bath" vortex V_B an a "tornado' vortex V_T with flow of energy E [22],[27],[29],[30].

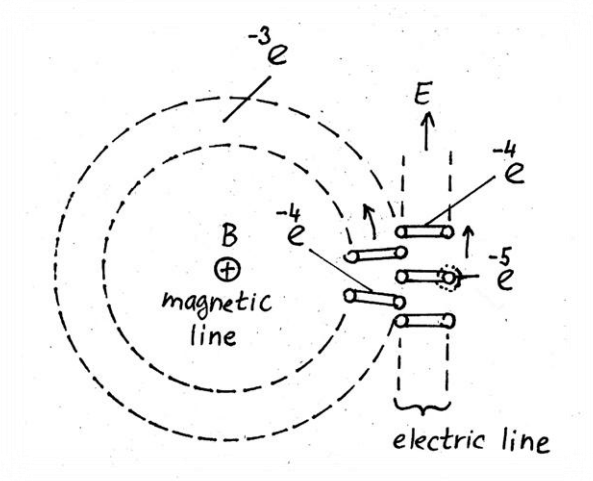

Fig. 16 Structure of the electromagnetic field (the electric line is perpendicular to the magnetic line)

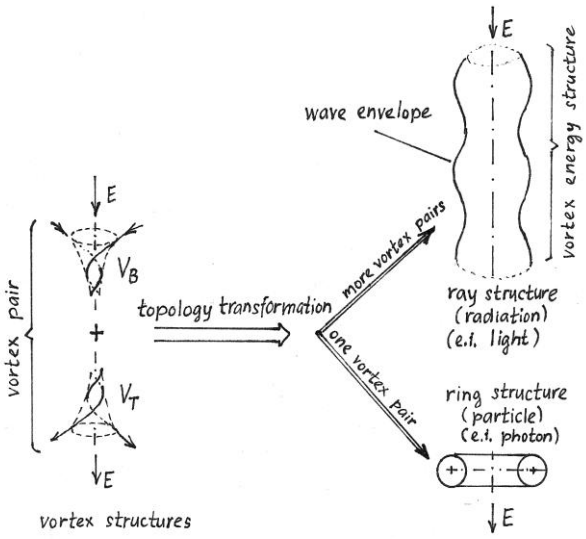

Fig. 17 Structure of light as a ring particle or a wave-energy structure

VII. QUANTUM MODEL OF HYDROGEN

To calculate a quantum model of hydrogen we use radius r_e of the electron, which was derived in Eq.16:

$$r_e = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{v_o^2}{v_e^2} \tag{66}$$

$$2\pi r_e = 2\pi \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{v_o^2}{v_e^2} \tag{67}$$

Let us assume that [8]:

$$v_o^2 = \frac{c^2}{2} = \frac{1}{2\varepsilon_o \mu_o} \tag{68}$$

On a circumference of a circle with r_e (see Fig. 7) have to be $n = N$ of a half-wavelength (Eq.54): $\lambda/2 = h/2m_e v$ (n is quantum number) [18]:

$$2\pi r_e = 2\pi \frac{\mu_o e^2}{4\pi^2 m_e} \frac{v_o^2}{\bar{v}_e^2} = \frac{\mu_o e^2}{2\pi m_e} \frac{c^2}{\bar{v}_e^2} = \frac{e^2}{4\pi\varepsilon_o m_e} \frac{1}{\bar{v}_e^2} =$$

$$= n\frac{\lambda}{2} = n\frac{1}{2}\frac{h}{m_e \bar{v}_e} = n\frac{1}{2}\frac{h}{m_e \bar{v}} \tag{69}$$

$$\frac{e^2}{2\pi\varepsilon_o}\frac{1}{\bar{v}_e} = nh$$

$$\frac{e^2}{2\pi\varepsilon_o}\frac{\pi}{2v_m} = nh \tag{71}$$

where v_m is maximum velocity of the electron if the electron has the distance d_o and minimum energy Eqo [18]:

$$v_{mn} = \frac{1}{n}\frac{e^2}{4\varepsilon_o h} \tag{72}$$

Energy E_t of translation movement of the electron is:

$$E_t = \frac{1}{2} m_e v_m^2 = \frac{1}{n^2}\frac{m_e e^4}{16\varepsilon_o^2 h^2} \tag{73}$$

Energy E_r of the rotation of the electron has the same size as energy E_t of the translation movement. There is a tendency to have a maximal symmetry. Total energy E_q of the rotating and moving electron is:

$$E_q = E_t + E_r == 2E_t = \frac{1}{n^2}\frac{m_e e^4}{8\varepsilon_o^2 h^2} \tag{74}$$

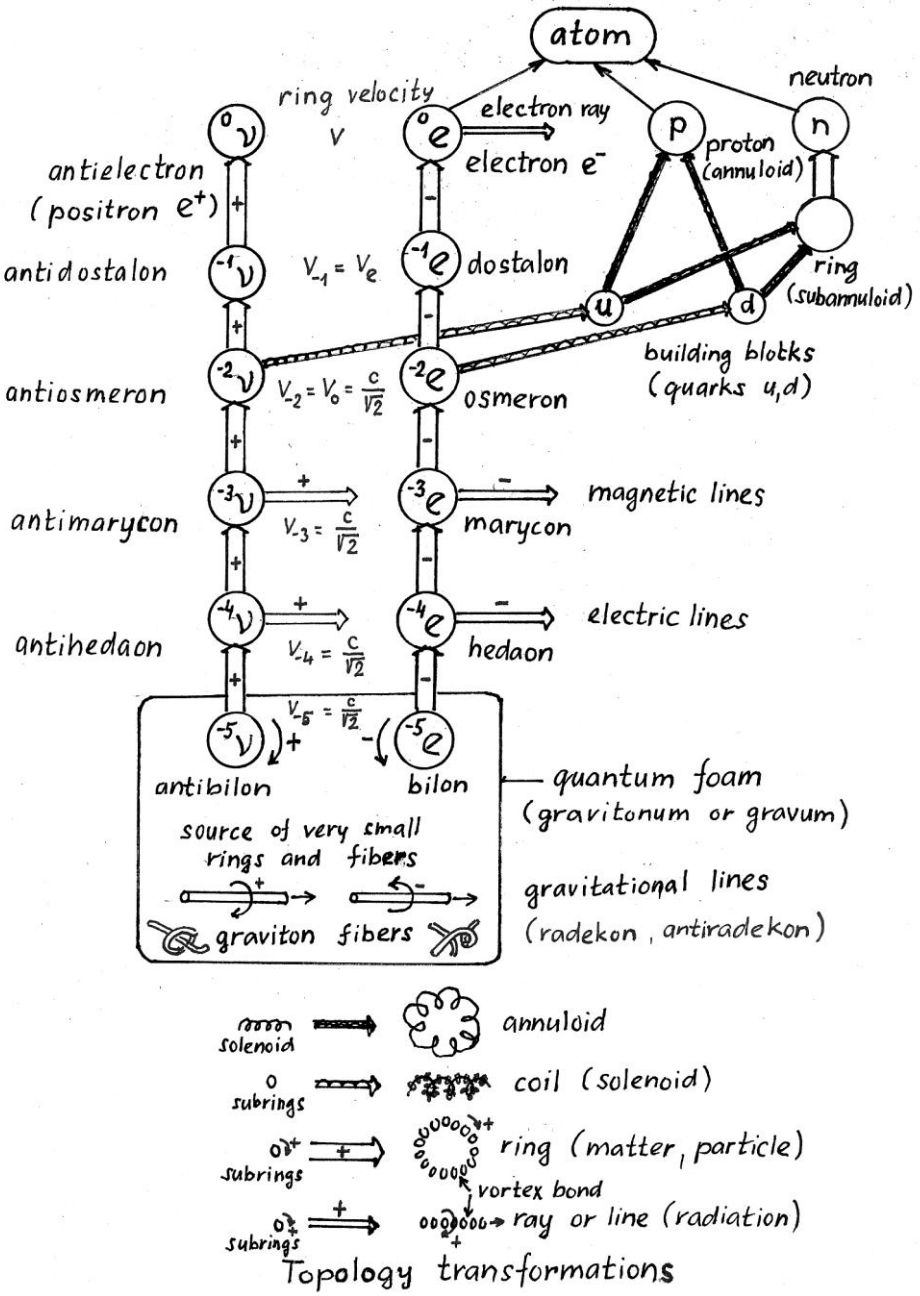

Fig. 18 Fractal-ring structure of Universe (ring theory) [18], [23], [24]

For quantum number *n=1*

$$E_{qo} = \frac{m_e e^4}{8\varepsilon_o^2 h^2} \approx 13.6eV \tag{75}$$

$$E_{qo} = E_o \frac{3}{4} = \frac{e^2}{6\pi\varepsilon_o}\frac{1}{d_o}\frac{3}{4} = \frac{e^2}{8\pi\varepsilon_o}\frac{1}{d_o} \approx 13.6eV \tag{32}$$

$$E_{qo} = \frac{m_e e^4}{8\varepsilon_o^2 h^2} = \frac{e^2}{8\pi\varepsilon_o}\frac{1}{d_o} \tag{76}$$

$$d_o = \frac{\varepsilon_o h^2}{m_e e^2} \approx 5.29 \cdot 10^{-11} m \tag{77}$$

It is the same result as Bohr obtained [4] but with quite different hydrogen model.

$$d = n^2 \frac{\varepsilon_o h^2}{m_e e^2} = n^2 \cdot 2\bar{r}_e \tag{78}$$

where $\bar{r}_e$ is radius of the free electron and can be calculated following way:

$$\bar{r}_e \approx N^{2\cdot -2} r_e = \frac{\mu_o e^2}{4\pi^2 m_e} = 0.89 \cdot 10^{-15} m \tag{79}$$

where $^{-2}r_e$ is the radius of osmeron ^{-2}e which is almost constant comparing it with radius r_e of the electron (see Fig. 18):

$$^{-2}r_e = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{v_{-2}^2}{v_{-3}^2} \cdot \frac{1}{N^2} = \frac{\mu_o e^2}{4\pi^2 m_e} \cdot \frac{1}{N^2} = 0.50 \cdot 10^{-18} m \tag{80}$$

where $v_{-2}^2 = v_{-3}^2 = \frac{c}{\sqrt{2}}$ and $N = 42$

For quantum number *n=1* we calculate the maximum velocity v_m from Eq.72 and the couple constant α is:

$$v_m = \frac{e^2}{4\varepsilon_o h} \tag{81}$$

$$\frac{c}{2v_m} = \frac{2\varepsilon_o hc}{e^2} = \frac{1}{\alpha} \approx 137.036 \tag{82}$$

In the hydrogen molecule H_2 the covalent bond has $n_e = 2$, $n_p = 1$ (see Fig. 10d):

$$F = F_+ - F_- = \frac{e^2}{4\pi\varepsilon_o}\left(\frac{n_e n_p}{d^2} - \frac{d_o^2}{d^4}\right) \tag{83}$$

$$F = \frac{e^2}{4\pi\varepsilon_o}\left(\frac{2}{d^2} - \frac{d_o^2}{d^4}\right) = 0 \tag{84}$$

$$d_c = \pm\frac{d_o}{\sqrt{2}} \approx \pm 3.75 \cdot 10^{-11} m \tag{85}$$

$$d_{cp} = 2d_c \approx 7.5 \cdot 10^{-11} m \tag{86}$$

It is in coincidence with the distance between two protons for their covalent bond [19],[32]. For the hydrogen molecule-ion H_2^+ is $n_e = 1$, $n_p = 1$ then d_p^+ (see Fig. 10c):

$$d_{p+} = 2r_o \approx 10.6 \cdot 10^{-11} m \tag{87}$$

VIII. The Size of the Electron in Hydrogen Atoms

For maximum velocity of the electron v_{em} we use [18]:

$$v_{em} = \pm\frac{v_m}{2} \tag{88}$$

If we insert v_m from Eq.81 into Eq.62 and Eq.88 then we receive the maximum radius of the electron:

$$r_{e\max} = \frac{e^2}{8\pi^2\varepsilon_0 m_e} \cdot \frac{4}{v_m^2} = \frac{2\varepsilon_0 h^2}{\pi^2 m_e e^2} = 3{,}38 \cdot 10^{-11} m \tag{89}$$

For minimum radius of the electron where *v=0* :

$$2\pi r_{e\min} = ND_{oe} \tag{90}$$

$$r_{e\min} = \frac{ND_{oe}}{2\pi} = 0{,}29 \cdot 10^{-15} m \tag{91}$$

The levitating electron changes the size from very small to relatively large size [31] (see Fig. 9).

IX. The Structure of Molecules

Atoms combine to form a molecule. Their shared air of electrons is called a covalent bond. They occupy the same orbital with opposite spins. The H_2 molecule atoms H share electrons. Each hydrogen atom shares its electron with another hydrogen atom to gain a full outer *s* shell of 2 electrons. Covalent bonding is important in carbon compounds.

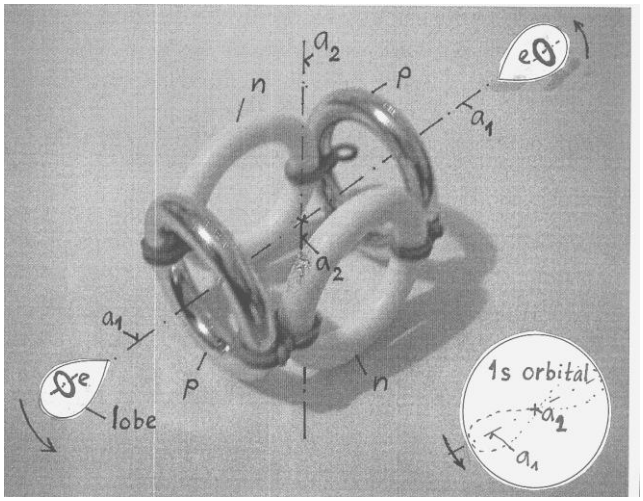

Fig. 19 The vortex-ring structure of the nucleus of the helium (alpha particle) and its orbital *1s*

There are two simple rules how to create atom nuclei:

1) Only two protons can be on one rotational axis
2) Two protons cannot be connected directly with vortex nuclear bond (only the proton with the neutron can have the nuclear bond)

X. Examples of nucleus structures

In the next figures the protons are black rings and the neutrons are grey rings.

Fig. 20 The structure of helium nucleus (alpha particle) [18]

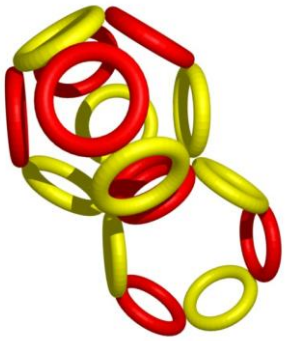

Fig. 21 The structure of oxygen nucleus [18]

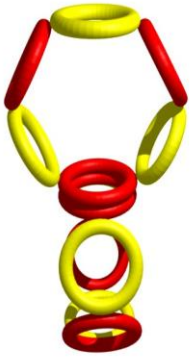

Fig. 22 Structure of carbon nucleus in the methan CH_4 [18]

Fig. 23 The vortex-ring structure of the carbon nucleus of ${}_6{}^{12}C$ which can create the benzene molecule C_6H_6 [32].

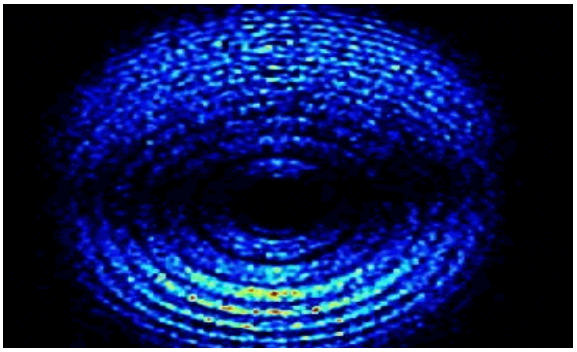

Fig. 24 Coherent electron scattering captured by an attosecond quantum stroboscope [14] (ring structure)

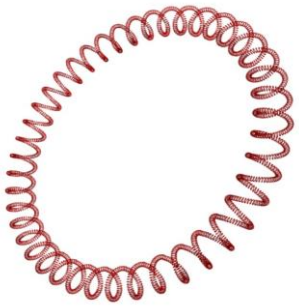

Fig. 25 The coil-fractal structure of the proton [18]

Fig. 26 Two threads of the coil-fractal structure on Fig.25

XI. Conclusions

It seems that gravitation lines (created from graviton fibers) are in the same axes as levitating electrons [18]. Gravitation lines repel each other and due to the two bodies are attracted. The gravitation lines are braids, which are created from graviton fibers. A quantum-foam-space that is full of graviton fibers and ring structures we would like to call *gravitonum* (or shortly *gravum)* to distinguish from the terms: vacuum, ether etc. The gravum is a space where are highly organized and lower organized substructures. It means they are in a different level of self-organizational state (see Fig. 18). Smaller substructures can create dark matter and dark energy. Osmerons are very small and have immeasurable size and mass. The structure of the electron, the proton and the neutron can be created from the basic rings (osmerons) [19].

The exact analysis of real physical problems is usually quite complicated, and any particular physical situation may be too complicated to be analyzed directly by solving the differential equations. Ideas as the field lines (magnetic and

electric lines) are very useful for such purposes. We think they are created from self-organized subparts of gravum (see Fig. 18, Fig. 14, and Fig. 15). A physical understanding is a completely nonmathematical, imprecise, and inexact, but it is absolutely necessary for a physicist [1]. It is necessary to combine an imagination with a calculation in the iteration process [4]. Our approach is given by developing gradually the physical ideas – by starting with simple situations and going on towards the more and more complicated situations. But the subject of physics has been developed over the past 200 years by some very ingenious people, and it is not easy to add something new that is not in discrepancy with them. The vortex model (see Fig. 1) of the electron was inspired by vortex structure in the PET-bottle experiment with one hole connector ($3 souvenir toy, Portland, Oregon 2004) [25], our connector with 2 or 3 holes [25],[26], levitating magnet "levitron" (physical toy), black holes [8], and topological description [7]. The "ring theory" is supported by experiments other authors too, e.g. in [13],[14], and [11]. Now we realize that the phenomena of chemical interaction and, ultimately, of life itself are to be understood in terms of electromagnetism, which can be explain by vortex-ring-fractal structure in different state of self-organization inside gravum.

In future we would like to optimize proposed models by evolutionary optimization [6],[16].

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