Vortex-ring Modeling of Complex Systems and Mendeleev's Table

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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-fractal theory (VFT). Scientists try to explain some phenomena in Nature that have not been explained so far. The aim of this paper is the vortex-fractal modeling of vortex-ring fractal structure of atoms, molecules, and a creation of elements in the Mendeleev's periodic table with vortex-ring particles which is not in contradiction to the known laws of nature.**
Index Terms - periodic table, vortex-fractal structures

I. Introduction

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 ($2x10^{-10}$ 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. Electrons are arranged in shells at fixed distances from nucleus, depending on their energy. The most shells an atom can have is 7, and each shell can only support a certain number of electrons. Given sufficient energy, an electron can jump from one shell to higher shell. When it falls back to a lower shell, it emits radiation in the form of a photon. The electron belongs to the lepton class of particles, its antiparticle is the positron. Because protons are positively charged and neutrons are neutral, the nucleus of an atom is always positively charged. The number of proton is called the atomic number *Z* or proton number *P*. Protons and neutrons are both nucleons. The number of protons *P* and neutrons *N* is called the nucleon number, or, alternatively, the mass number *A (A = Z + N).* The atomic number Z determines the chemical properties of an element and its position in the periodic table. Isotopes of an element all have the same atomic number *Z* but a different mass number *A* because they have different number of neutrons. When an element has a relative atomic mass, which is not a whole number, it is because it consists of a mixer of isotopes. Isotopes are nuclides of the same element.

The theory of vortex-fractal structures of elements like the theory of black holes was developed before there was any indication that they actually exist in micro-world. It shows the remarkable power and depth of fractal-vortex theory [2-6], [9-13], [17].

Matter has an innate tendency to self-organizing and generating complexity from a chaos [2],[7],[8]. This tendency has been at work since the birth of the universe, when a pinpoint of featureless matter budded from "nothing" at all. Irreversibility and nonlinearity characterize phenomena in every field of complexity. Nonlinearity causes small changes on one level of organization to produce large effects (anomalies) at the same or higher levels. The smallest of events can lead to the most massive consequences. We can see an emergent property, which manifests as the result of positive and negative feedback. But global features of the system cannot be understood only by analyzing the parts separately. Deterministic chaos arises from the infinitely complex fractal structure.

A fractal's form is the same no matter what length scale we use. By using the techniques of parallelism and massive parallelism in computer simulations we come a little closer to explaining basic principles of complex systems. Chaotic systems are exquisitely sensitive to initial conditions, and their future behavior can only be reliably predicted over a short time period. Moreover, the more chaotic system, the less compressible its algorithmic representation is. In essence, the common underlying theme linking complexity of nature with computer models depends on the emergence of a complex organized behavior. Emergency comes from many simpler cooperative and conflicting interactions between microscopic components, such as spinning electrons, atoms etc.

Fractals seem to be very powerful in describing natural objects on all scales. Fractal dimension and fractal measure are crucial parameters for such description [12], [13]. Many natural objects have self-similarity or partial-self-similarity of the whole object and its part. Different physical quantities describing properties of fractal objects in E-dimensional Euclidean space with a fractal dimension D were described in [12]. Fractal dimension D depends on the inter-relation between the number of repetition and reduction of individual object. There is a relationship between the dimensionality and fractal properties of matter, which contains the constant of

golden mean: $\phi = (\sqrt{5} - 1)/2 = 0.618$. Constant ϕ is a special case of fractal dimension D defined by the condition $D(D - E + 2) = 1$ for $E = 3$ [12]. Links between inverse coupling constants of various interactions (gravitational, electromagnetic, weak and strong) in the three-dimensional Euclidean space are discussed in [13]. Different properties of particles (and interactions between them) correspond to the specific values of a fractal dimension. Following values (D = 0, E – 2, E – 1, E) play the most important role in such analysis [13].

Naturalistic explanations of the universe's origin are speculative [1],[2],[7]. But does this mean such inquiries are impotent or without value? The same criticism can be made of any attempt to reconstruct unique events in the past. We cannot complete our knowledge without answering some of the fundamental question about nature. How does the universe begin? What is turbulence? Above all, in a universe ruled by entropy, drawing inexorably toward greater and greater disorder, how does order arise? Although the various speculative origin scenarios may be tested against data collected in laboratory experiments, these models cannot be tested against the actual events in question, i.e., the origin of complex structures. Such scenarios, then, must ever remain speculation, not knowledge. There is no way to know whether the results from these experiments tell anything about the way universe itself evolved. In a strict sense, these speculative reconstructions are not falsifiable; they may only be judged plausible or implausible. In the familiar Popper sense of what science is, a theory is deemed scientific if it can be checked or tested by experiment against observable, repeatable phenomena. The chaos began to unite the study of different systems. A simulation brings its own problem: the tiny imprecision built into each calculation rapidly takes over, because this is a system with sensitive dependence on initial conditions. But people have to know about disorder if they are going to deal with it. Classical scientists want to discover regularities. It is not easy to find the grail of science, the Grand Unified Theory or "theory of everything". On the other hand, there is a trend in science toward reductionism, the analysis of system only in terms of their constituent parts: quarks, chromosomes, or neuron. Some scientists believe that they are looking for the whole.

Just as an electron's random degeneracy motions become more vigorous when one confines the electron to smaller and smaller region [16], so also gravitational vacuum fluctuations are more vigorous in small regions than in large, that is, for small wavelengths rather than for large. In 1955, John Wheeler, by combining the laws of quantum mechanics and the laws of general relativity in a tentative and crude way deduced, that in a region the size of the Planck-Wheeler length (1.62×10^{-33} centimeter) or smaller. The vacuum fluctuations are there so huge that space as we know it "boils" and becomes a froth of quantum foam – the same sort of quantum foam as makes up the core of space time singularity [16]. How the electron can be created from quantum foam is illustrated on Fig.1 and the final vortex-ring electron structure is on Fig.2.

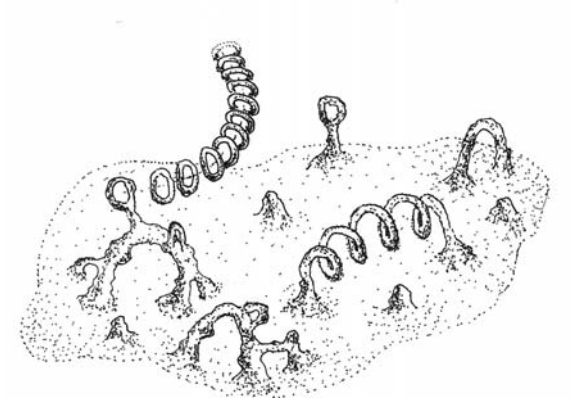

Fig. 1 Quantum foam with vortex-rings (basic parts of the electron structure) and vortex-coils (basic parts of the proton and the neutron structure)

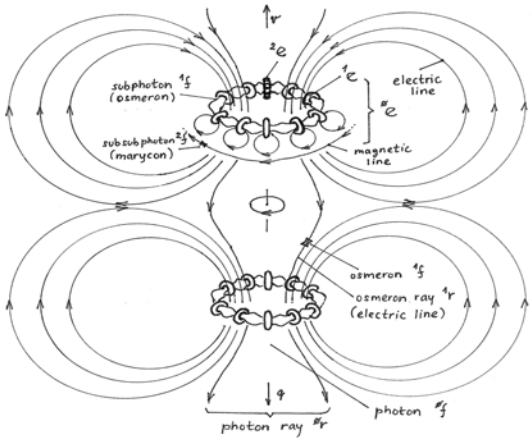

Fig. 2 The vortex-fractal structure model of two electrons (in the electron ray [11])

II. Atomic Spectra

Hydrogen is the lightest and simplest element. In 1885, J.J.Balmer, a Swiss high school teacher, found that the wavelengths λ of the four visible lines produced by hydrogen are described by: $1/\lambda = R\,(1/2^2 - 1/n^2)$, $n = 3, 4, 5, 6$ with $R = 1.097 \times 10^7\ m^{-1}$. It can be generalized to $1/\lambda = R(1/n_2^{\,2} - 1/n_1^{\,2})$, $n_2 = 1,2,3$; $n_1 = (n_2 + 1), (n_2 + 2), \ldots\ldots$ Any detailed model of the atom's structure ought to be able to predict these wavelengths of the light given off by hydrogen, the simplest atom.

Absorption of photons is the reverse process of emission. If a photon with energy equal to the difference in energy of two states of an atom passed by, that photon may be absorbed and its energy will put the atom into a higher energy state. The photon's energy equals the change in energy of the atom because energy is conserved. If the photon's energy is not equal to the difference in energy of two states

of the atom, the photon will not be absorbed. This explains the line spectra observed in absorption spectra. In continuous or white light, photons of all wavelengths are present. Only those with particular energies (or wavelengths) corresponding to differences in energy will be absorbed; all others pass by untouched.

III. Atomic Structure in Quantum Mechanics

Energy is quantized. The *n* in E_n is called the principal quantum number. There are other quantities.
Angular momentum L:
$L = \sqrt{(l(l+1))}\, h/(2\pi)$ $l = 0, 1, \ldots, n-1$, l is called the orbital quantum number
z-component of angular momnentum L_z
$L_z = m_l\, h/(2\pi)$ $m_l = -l, \ldots, -1, 0, 1, \ldots, l-1, l$ where m_l is called the magnetic quantum number.
The intrinsic angular momentum of the electron, often called the electron's spin S:
$S = \sqrt{((1/2)(1/2+1))}\, h/(2\pi)$
z-component S_z of the spin of the electron is
$S_z = m_s\, h/(2\pi)$ $m_s = -1/2, +1/2$

IV. Complex Atoms

As with hydrogen-like atoms, the same quantum numbers describe states that may be filled by electrons in more complex atom (**He** has Z=2):
Principal quantum number n=1

electron number Z	n	l	m_l	m_s
1	1	0	0	+1/2
2	1	0	0	-1/2

Principal quantum number n=2

electron number Z	n	l	m_l	m_s
1	2	0	0	+1/2
2	2	0	0	-1/2
3	2	1	-1	+1/2
4	2	1	-1	-1/2
5	2	1	0	+1/2
6	2	1	0	-1/2
7	2	1	1	+1/2
8	2	1	1	-1/2

The same information can be stated with another notation.
The principle quantum number n is explicitly stated as 1, 2, 3,….,7.
The orbital quantum number *l* is given by a letter:

l = 0 is an **s**-state
l = 1 is an **p**-state
l = 2 is an **d**-state
l = 3 is an **f**-state

The number of electrons in a particular "orbital" is described with an exponent. Here are a few atoms showing which states are filled with electrons:

Element	Z	configuration
H	1	$1s$
He	2	$1s^2$
Li	3	$1s^2 2s$
Be	4	$1s^2 2s^2$
B	5	$1s^2 2s^2 2p$
C	6	$1s^2 2s^2 2p^2$
N	7	$1s^2 2s^2 2p^3$
O	8	$1s^2 2s^2 2p^4$
F	9	$1s^2 2s^2 2p^5$
Ne	10	$1s^2 2s^2 2p^6$

The Pauli exclusion principle requires that no two electrons may have the same four quantum numbers. It follows that, if two electrons in an atom have the same values of n, l and m_l they must have different values of m_s. Their spins must be opposed (the electrons have opposite vortex-ring orientation [10]). Each orbital can hold two electrons with opposite spins. The term shell is used for a group of orbitals with the same principal quantum number. A subshell is a group of orbitals with the same principal and second quantum numbers, e.g. the 3p subshell [14]. An electron moving in an orbit can have only certain amount of energy, not an infinitive number of values: its energy is quantized. It is due to minimum energy to create vortex-photon structure that translates energy to the electron [10,11]. If the energy of the electron is quatized, the radius of the orbit also must be quantized. There is a restricted number of orbits with certain radii, not an infinite number of orbits. The wave theory of the electron replaces the idea of finding the electron in a certain position in its orbit with the idea of the probability of finding the electron in a certain volume: the orbital. The volume of space in which there is a 95% chance of finding the electron is called the atomic orbital. There is 5% probability that the electron will be outside this volume of space at a given instant.

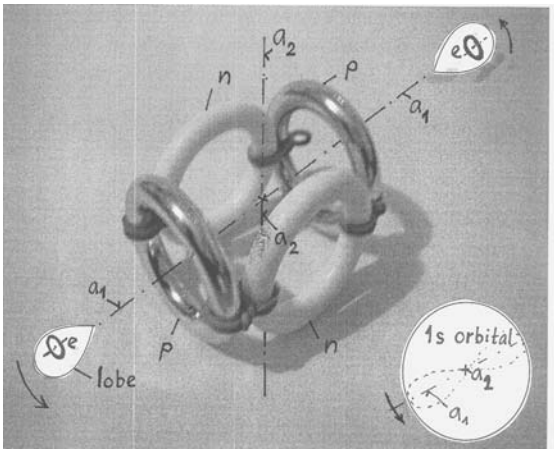

Fig. 3 The vortex-ring structure of the nucleus of the helium ${}_2{}^4$**He** (alpha particle) and its orbital **1s**

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. The bonds in methane CH_4 are such to carbon has completed its octet. In carbon dioxide, the carbon atom shares two electrons with each of two oxygen atoms, in order to give all three atoms a full octet of valence electrons. In CH_4 and NH_{4+} all the bonds are the same. The structures are perfect tetrahedra with the tetrahedral angle $\alpha = 109.5^o$. In NH_3 the bond angle is 107^o, and in a molecule of water H_2O it is 104.5^o. Diamond is the hardest naturally occurring substance. The extraordinary properties of diamond arise from its structure (see Fig.5).

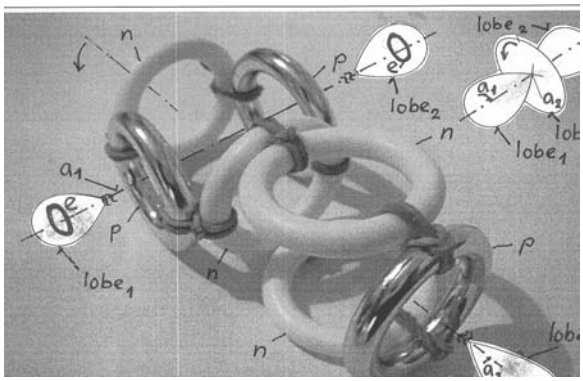

Fig. 4 The vortex-ring structure of the atom ${}_3{}^7$**Li**

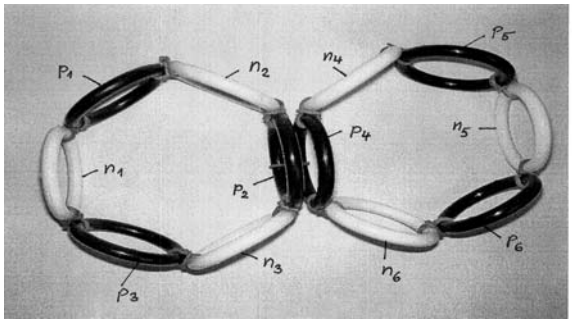

Fig. 5 The vortex-ring structure of the atom ${}_6{}^{12}$**C**

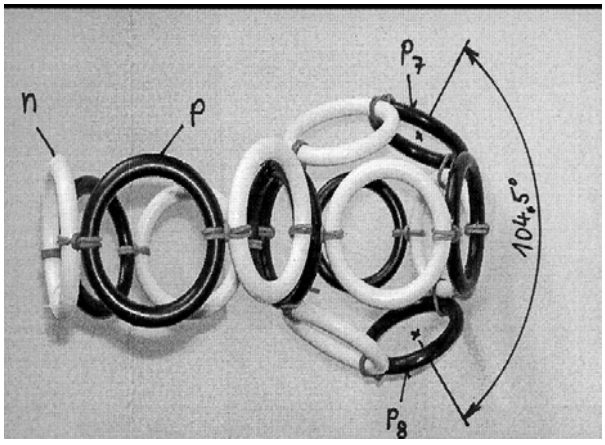

Fig.6 The vortex-ring structure of the atom ${}_8{}^{16}$**O**

Intermolecular forces and bonds are of a number of types: dipole-dipole interactions, van der Waals forces and the hydrogen bond. Polar molecules have a dipole. Dipole consists of two electric charges of equal magnitude and opposite signs separated by a small distance. Water molecules are attracted to ions in the crystal. In a snowflake the hydrated ions are surrounded with six water molecules.

There are three simple rules how to create atoms:

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 be nuclear bond)
3) Two protons can levitate each other on one rotational axis (see p_2 and p_4 in Fig.5)

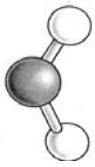

Fig.7 The classical structure model of the molecule **H_2O** (compare with structure model on Fig.6)

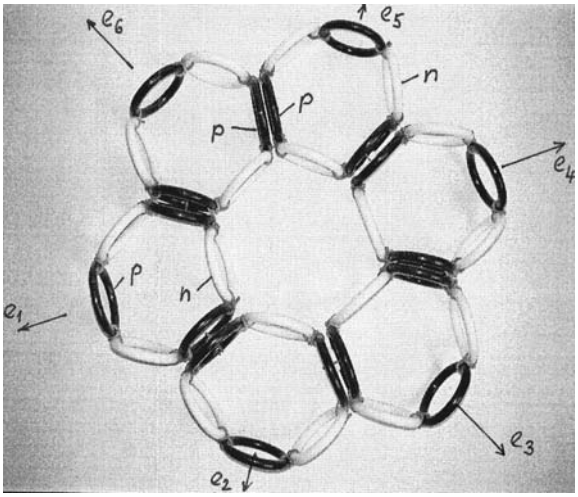

Fig. 8 The vortex-ring structure model of the benzene molecule

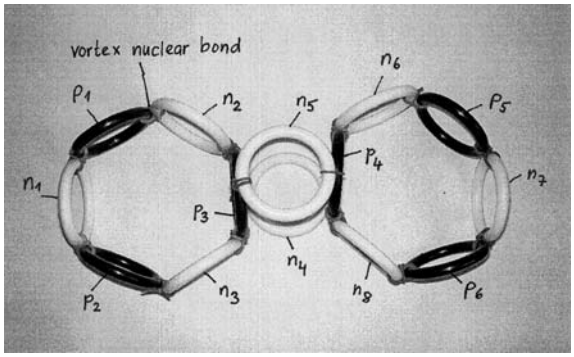

Fig. 9 The vortex-ring structure of the atom ${}_6{}^{14}$**C**

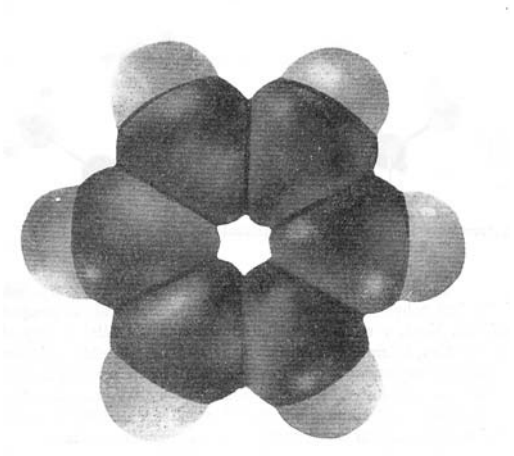

Fig. 10 The classical model of the benzene

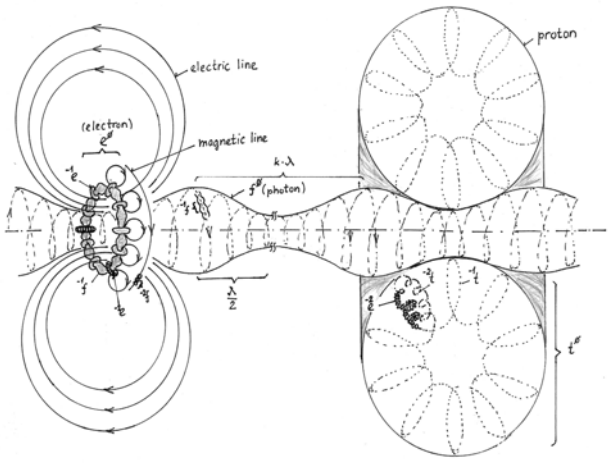

Fig.11 The vortex-ring structure of the hydrogen $_1{}^1$**H**

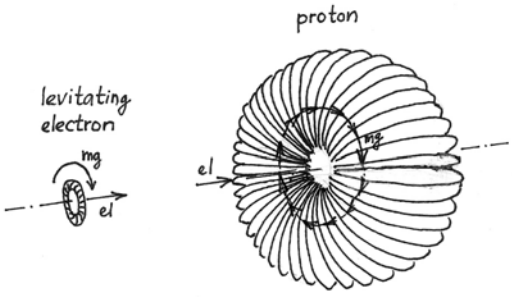

Fig. 12 The levitating electron in the field of the proton (the fractal structure model of hydrogen **H** is simplified to compare with **H** on Fig.11)

V. The Electron with Vortex-Fractal Structure

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 [1]. One part of the force between moving charges is called the magnetic force. That is why we call the subject "electromagnetism". We find, from experiment, that the force that acts on a particular charge – no matter how many other charges there are or how they are moving – depends only on the position of that particular charge, on the velocity of the charge, and on the amount of charge. We can write the force $\boldsymbol{F}$ depends on a charge q moving with a velocity v as

$$\boldsymbol{F} = q\,(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B}). \qquad (1.1)$$

We call $\boldsymbol{E}$ the electric field and $\boldsymbol{B}$ the magnetic field at the location of the charge. For an arbitrary closed surface, the net outward flow – or flux – is the average outward normal component of the velocity multiplied by the area of the surface.

To get consistent picture of nature, we must imagine that something holds electron together. It must be included in the energy and momentum calculation. Our hypothesis presuppose that vortex rings hold together by photon vortexes (see Fig.11, 13 and 14). The structure of the electron in Fig. 2 presents the electron as "pure" fractal structure. Electrons ^{0}e (or e) in the electron ray ^{0}r hold together by photon's vortex structure ^{0}f (a pair of vortices) [11]. Each photon consists from subphotons ^{1}f (osmerons) [6]. The electric line is osmeron ray ^{1}r. The magnetic line is marycon ray ^{2}r that consists from subsubphotons ^{2}f (marycons). The name osmeron 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 have unmeasurable size and mass (see Fig. 2). Osmerons on osmeron's trajectory creates an osmeron ray.

Generally, in the fractal structure of the electron, the number *n* defines the level of substructure. For example the photon has a second sublevel where n = 2 (with two prefixes sub) and it is subsubphoton ^{n}f = ^{2}f. Because the magnetic line ^{2}r has n = 2 and electric line ^{1}r has n =1, the electric field of the electron is much stronger than the magnetic field of the electron.

The vacuum isn't empty space. Matter can be defined as a space with closed vortex-fractal structures (rings: electrons, protons and neutrons etc.).

VI. Conclusions

Our science creates terrific demands on the imagination. To understand the electromagnetic field requires a high degree of imagination. The degree of imagination that is required is much more extreme than that required for some of the ancient ideas. The modern ideas are much harder to imagine. We usually use mathematical equations and rules, but we used a lot of pictures to describe very complex

vortex-fractal models. There is not easy to formulate mathematical models. We can't allow ourselves to seriously imagine things, which are obviously in contradiction to the known laws of nature. And so our kind of imagination is quite a difficult game (or a puzzle). One has to have the imagination to think of something that has never seen before, never been heard before. At the same time the thoughts are restricted or limited by the conditions that come from our knowledge of the way nature really is. The problem of creating something which is new, but which is consistent with everything, which has been seen before, is one of extreme difficulty [1]. The vortex-fractal modeling isn't in contradiction to the known laws of nature. Vortex-ring models add same new imagination for future mathematical modeling and computer models.

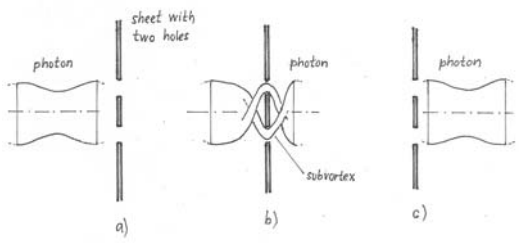

Fig. 13 Photon coming through the sheet with two holes [10].
a) The photon before the way through,
b) the photon vortex structure is split to two sub-vortex structures (e.g.: osmeron rays),
c) the photon behind the sheet

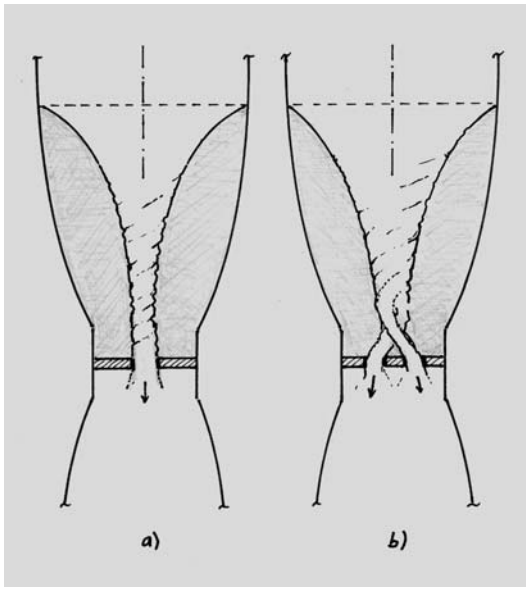

Fig. 14 A vortex structure in the PET-bottle experiment [9]:
a) with one hole
b) with two holes (to explain behavior of the photon in the Fig. 13)

The annular vortex structure of the hydrogen H could be imagined as the "smallest electric motor with a magnetic bearing" in Nature [11]. The proton creating rotary magnetic field is "a stator" and the rotating electron is "a rotor", which levitates in the electromagnetic field of the standing proton. The difference between the particle and the antiparticle is in the direction of the vortex rotation. The vortex-fractal structure of the electron ray is presented in Fig. 2 [11].

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