

Common Mechanism of Superconductivity, Superfluidity, Integer and Fractional Hall Effects, and Cold Fusion

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1. Introduction

The experimental existence of low energy nuclear reactions (LENR) is well established and obtained results have been published in over 3000 scientific papers. Nevertheless there is no widely accepted theoretical mechanism for LENR.

We [1, 2] have discussed the cooperative resonance synchronization enhancement mechanisms of LENR. Some of the low energy external fields can be used as triggers for starting and enhancing of exothermic LENR. It is natural to expect that in the case of beta-decay (capture) the external electron flux with high density, or the laser of high intensity, or any suitable external fields should play this role. Any external field shortening distances between protons in nuclei and electrons in atoms should enhance beta-decay (capture) or double-beta decay (capture). We proposed a new mechanism of LENR: cooperative processes in whole system —nuclei+atoms+condensed matter+gaseous+plasma medium — can occur at smaller threshold then corresponding ones on free constituents. The cooperative processes can be induced and enhanced by low energy external fields. The excess heat is the emission of internal energy, and transmutations are the result of redistribution inner energy of whole system.

The investigation of LENR requires knowledge of different branches of science: nuclear and atomic physics, chemistry, and electrochemistry, condensed matter and solid state physics. This means that the problem of LENR is an interdisciplinary one. Yet the differentiation of science in the beginning of the 20th century may have brought about a situation in which the necessary interdisciplinary unification of different science branches has been lost.

We established a detailed mutually-simple correspondence between the properties of hydrogen atom states and other physical systems. We successfully applied the Bohr method to analyze different systems using the established isomorphism of hydrogen atom properties and system being investigated.

The definition of isomorphism from Wikipedia, the free encyclopedia (<http://en.wikipedia.org/wiki/Isomorphism>) is:

Informally, an isomorphism is a kind of mapping between objects, which shows a relationship between two properties or operations. If there exists an isomorphism between two structures, we call the two structures ISOMORPHIC. In a certain sense, isomorphic structures are STRUCTURALLY IDENTICAL, if you choose to ignore finer-grained differences that may arise from how they are defined.

According to Douglas Hofstadter:

"The word 'isomorphism' applies when two complex structures can be mapped onto each other, in a such way that to each part of one structure there is a corresponding part in the other structure, where 'corresponding' means that the two parts play similar roles in their respective structures" (Godel, Escher, Bach, p. 49).

PURPOSE: Isomorphism is studied in mathematics in order to extend insights from one phenomenon to others: if two objects are isomorphic, then any property which is preserved by an isomorphism and which true of one of objects are also true of the other. If isomorphism can be found a relatively unknown part of mathematics into some well studied division of mathematics, where many theorems are already proved, and any methods are already available to find answers, then the function can be used to map whole problems out of unfamiliar territory over to "solid grounds" where the problem is easier to understand and work with.

We will discuss isomorphism phenomena as between microscopic systems as between micro and macro systems.

2. The Quantum Hall effect

The Hall effect was discovered in 1879 by Edwin Hall. The resistance R_H (called now as the Hall resistance) depends linearly on the strength B of the magnetic field.

2.1. The Integer Quantum Hall Effect

Klaus von Klitzing [3] in 1980 observed that in a low-temperature liquid He ($\approx 4K$) in a very high magnetic field ($\approx 10T$) a step-wise dependence of the Hall resistance R_H on magnetic field, rather than Edwin Hall's linear relationship. The value of R_H at the position of the plateaus of the steps is quantized:

$$R_H = \frac{h}{\nu e^2}, \nu = 1, 2, 3, \dots \quad (1)$$

and the magneto resistance have a deep minima (is equal practically to zero in the plateau). This is the integer quantum Hall effect, where ν takes on integer values ($\nu = 1, 2, 3, \dots$).

⊗ Interpretation [3]: *the integer Hall quantization is the magnetic flux quantization h/e and the quantization of the charge into elementary charge e .*

$$R_H = \frac{h}{ve^2} = \frac{h}{e} \frac{1}{ve} = \frac{\phi_0}{ve}, \quad (2)$$

where $\phi_0 = \frac{h}{e}$ is the magnetic flux quanta. This interpretation is accepted now as standard one.

2.2. The Fractional Quantum Hall Effect

The fractional quantum Hall effect was experimentally discovered by Daniel Tsui, Horst Stormer and Arthur Gossard, in which ν can occur as a fractions

$$\nu = \nu_0 \frac{2}{3}, \nu_0 \frac{1}{3}, \nu_0 \frac{2}{5}, \nu_0 \frac{3}{5}, \nu_0 \frac{5}{2}, \dots \quad (3)$$

⊗ Interpretation [3]: *By analogy, the fractional quantum Hall effect is interpreted on the basis of elementary excitations of quasiparticle with a fractional charge*

$$e^* = \frac{e}{3}, \frac{e}{5}, \frac{e}{7}, \dots \quad (4)$$

This interpretation is a very strange one. Horst Stormer wrote [4]:

The fractional quantum Hall effect is a very counterintuitive physical phenomenon. It implies, that many electrons, acting in correct, can create new particles having a charge SMALLER than the charge of any individual electron. This is not the way things are supposed to be. A collection of objects may assemble to form a BIGGER object, or the parts may remain their size, but they don't create anything SMALLER. Not only are they smaller than the charge of any constituent electron, but they are exactly 1/3 or 1/5 or 1/7, etc. of an electronic charge, depending on the conditions under which they have been prepared. And yet we know with certainty, that none of these electrons has split up into pieces.

Fractional charge is the most puzzling of the observation, but there are others. Quantum numbers – usually integers or half-integers – turn out to be also fractional, such as 2/5, 4/9, and 11/7, or even 5/25.

The quantization of Hall resistance (1) and (2) is incredibly precise. The Hall conductance has been found to be integer or fractional numbers of e^2/h to one part in a billion which are now called "exact quantization". The high precision measurements of the quantized Hall resistance are used as a resistance standard or for a determination of h/e^2 (a determination of the inverse fine structure constant α^{-1}) which are important for all areas in physics connected with the fine structure constant.

Therefore, the Hall conductance (the inverse Hall resistance (1)) obeys the "exact quantization" conditions

$$V_H = v \frac{e^2}{\hbar} \equiv v v_e, v = 1, 2, 3, \dots \text{ or } v = \frac{n_1}{n_2}, n_i = 1, 2, 3, \dots \quad (5)$$

where v_e is the electron velocity in the hydrogen ground state

$$v_e = \frac{e^2}{\hbar}. \quad (6)$$

$$P_H = v p_e, \lambda_e = v \lambda_H. \quad (7)$$

- We come to the conclusion [5] that the integer and fractional Hall effects demonstrate only the commensurability ratios between velocities, impulses and the de Broglie wave lengths of electrons in ground state hydrogen atom and corresponding ones for two-dimensional electron gas. So there is no room for interpretation of the fractional Hall effect in terms of the fractional charge. Nobody has observed a fractional charge in nature. Our interpretation of the integer and fractional Hall effects is simple and unique, physically grounded, and does not require a violation of the fundamental laws of Nature.

We know that the interaction between the elementary particles guided by some strong conservation laws. One of the conservation laws requires that the total electrical charge be preserved at any interactions. So, if this law is true then the total electrical charge in the aggregate electrons should always be an integer.

The mystery of fractional quantum numbers in discussing the effect get a very simple explanation: they demonstrated the commensurability relations for velocities, impulses and the de Broglie wave lengths of electrons in hydrogen atom and in two-dimensional experimental device. The hydrogen atom in ground state represents a superconducting dipole. Therefore the two-dimensional experimental device becomes a superconductor at the quantum Hall effect.

3. Superfluidity

P. L. Kapitza in 1937 discovered that the viscosity of the liquid helium at temperature below 2.19 K becomes zero. It was established that the motion of liquid helium obeys to the conditions

$$vr = N \frac{\hbar}{m_{He}}, N = 1, 2, 3, \dots$$

This means that sectorial velocities of liquid helium are quantized, therefore the phenomenon of superfluidity is a consequence of quantum mechanics on a macroscopic scale. Superfluids can flow through narrow channels without viscosity. The motion of the

superfluids through narrow channels submits to the same quantum conditions as electron motion in hydrogen atom do.

Remember the Bohr quantization conditions for hydrogen atom:

$$vr = N \frac{\hbar}{m}, N = 1, 2, 3, \dots$$

The condition of full transparency for waves (see below) coincides with the Bohr quantization condition.

What quantity is vr ? It is a double sectorial velocity of the body having periodical motion. So, we see that the quantization of sectorial velocities of liquid helium (macro system) is isomorphic to the quantization of the Bohr orbit in hydrogen atoms (micro system).

Let us briefly consider the quantization of planet and satellite sectorial velocities. There are some arguments that this phenomenon plays a fundamental role in the formation of stable dynamic systems similar to Solar system.

It was established [6] that quantization of sectorial velocities of Solar system elements is isomorphic to the quantization of the Bohr orbits in hydrogen atom. The same quantization for solar system [6]

$$VR = N \frac{\hbar_G}{m_G}, N = 1, 2, 3, \dots$$

Here is a quotation from a Nobel Lecture, December 8, 1998, by Robert B. Laughlin [8]:

Superfluidity, like the fractional quantum effect, is an emergent phenomenon – a low energy collective effect of huge numbers of particles that cannot be deduced from the microscopic equations of motion in a rigorous way and that disappears completely when the system is taken apart.... There are prototypes for superfluids,...., but these are all approximate and in the end not deductive at all, but fits to experiment...

...there is a regrettable tendency in solid-state physics to equate an understanding of nature with the ability to model, an attitude that sometimes leads to overlooking or misinterpreting the higher organizing principle actually responsible for an effect. In the case of the integral or fractional quantum Hall effects the essential thing is the ACCURACY of quantization. No amount of modeling done on any computer existing or contemplated will ever explain this accuracy by itself. Only thermodynamic principle does this.

4. The isomorphism of atom, molecule, crystal, ... structures

We have proved [5] the isomorphism and homology of atom, molecule (in living molecules too including DNA) and crystal structures. So interatomic distances in molecules, crystals and solid-state matter can be written in the following way:

$$d = \frac{n_1}{n_2} \lambda_e, \quad (8)$$

where $\lambda_e = 0.3324918\text{nm}$ is the de Broglie electron wavelength in a hydrogen atom in the ground state ($\lambda_e = \lambda_p$ in a hydrogen atom in the ground state) and $n_1(n_2) = 1, 2, 3, \dots$. So the de Broglie electron (proton) wavelength in a hydrogen atom in the ground state can be considered as a standard of dimensions for atoms and interatomic distances in molecules, crystals and living cells [5]. There are huge examples of commensurable ratios between the interatomic distances and λ_e in superconductors, nanomaterials, DNA, protein, and living molecules [5]. The parameter-free formula for interatomic distances in biomolecules, superconductors and size of nanostructures has been obtained. This establishes some bridge between the structures of different phenomena (conductivity, superconductivity, insulator-metal transmission, quantum Hall effect, superfluidity, quantization of nanostructure cluster size, size of biomolecules). This connection can be considered as indication of existence of some physical phenomena in the structures of the superconducting and living systems.

We have shown below only a small part of our calculations by formula (8) and the corresponding comparison with experimental data [7] for interatomic distances in some molecules. One can see surprising by high accuracy description of existing experimental data.

Table 1.

Interatomic semi-wave $\lambda_c / 2 = 0.1662nm$ distances d in molecules, $\Delta = |d(\text{exp}) - \lambda_c / 2|$.

Molecules	Distances	Δ
$[GdH]$	$d(Gd - H) = 0.1664$	0.0002
B_5H_9	$d(B - H) = 0.166$	0.000
$[UO_2]^{++}$	$d(U - O) = 0.167$	0.001
$C_6H_{18}O_3Si_3$	$d(Si - O) = 0.166$	0.001
$C_8H_{24}O_4Si_4$	$d(Si - O) = 0.166$	0.000
$C_8H_{24}O_6Si_5$	$d(Si - O) = 0.167$	0.001
GeF_4	$d(Ge - F) = 0.167$	0.001
$S_2F_{10}O_2$	$d(S - O) = 0.166$	0.001
RuO_4	$d(Ru - O) = 0.166$	0.000
OsO_4	$d(Os - O) = 0.166$	0.000
$CClN$	$d(C - Cl) = 0.167$	0.001
$C_2H_2Cl_2$	$d(C - Cl) = 0.167$	0.001
$C_2H_4N_2S_2$	$d(C - S) = 0.166$	0.001

Table 2.

Interatomic quarter-wave $3\lambda_c / 4 = 0.2494nm$ distances d in molecules, $\Delta = |d(\text{exp}) - 3\lambda_c / 4|$.

Molecules	Distances	Δ
$[CHO_2]^-$	$d(O - C - O) = 0.250$	0.001
C_3H_9BrSn	$d(Sn - Br) = 0.249$	0.000
$[C_2O_4]^-$	$d(O - C - O) = 0.250$	0.001
$C_4H_6O_4$	$d(O - C - O) = 0.250$	0.001
$C_4H_8O_4$	$d(O - C - O) = 0.250$	0.001
$C_4H_8N_8O_8$	$d(O - C - O) = 0.250$	0.001
$C_4H_9NO_3$	$d(O - C - O) = 0.249$	0.000
$C_4H_9N_3O_2$	$d(O - C - O) = 0.249$	0.000
$C_5H_{10}N_2O_3$	$d(O - C - O) = 0.249$	0.000
$C_6H_2O_4$	$d(O - C - O) = 0.250$	0.001
$[C_{14}H_{11}O_6]^-$	$d(O - C - O) = 0.249$	0.000
$C_{14}H_{29}ON$	$d(O - C - N) = 0.249$	0.000
$C_3H_5NO_4$	$d(O - N - O) = 0.249$	0.000
$C_3H_9AuBr_3P$	$d(P - Au) = 0.250$	0.001
$C_3H_9Cl_2Sb$	$d(Sb - Cl) = 0.249$	0.000
C_6H_6	$d(C - C + C - H) = 0.2495$	0.0001
$C_7H_{13}ClHgO$	$d(Hg - Cl) = 0.250$	0.001
$C_{12}H_{36}As_4Cu_4I_4$	$d(As - Cu) = 0.250$	0.001

- Note that the quantization conditions for the fractional Hall effect [5] are the same as (8). It means that the fractional Hall effect demonstrates only the commensurable velocities of electrons in hydrogen atoms and *GaAs*-type heterostructures (two-dimensional electron gas). So there is no room for interpretation of the fractional Hall effect in terms of the fractional charge. Nobody has observed a fractional charge in nature.

5. Electrical conductivity

Formula (8) gives the real method for increasing of the electrical conductivity.

Table 3. Geometrical parameters of metals, d is a parameter of cell or distances between nearest atoms,

$$\Delta = |d_{\text{exp}} - d_{\text{cal}}|.$$

	Conf	d_{exp}	d_{cal}	Δ	n_1 / n_2	σ	$T_c (K)$
<i>Cu</i>	$4s^1$	$d = 0.25562$	0.25860	0.00298	7 / 9	5.88	
<i>K</i>	$4s^1$	$d = 0.4628$	0.46549	0.00269	7 / 5	1.39	
<i>Cr</i>	$4s^1$	$a = 0.28845$	0.29093	0.00248	7 / 8	0.78	
		$d = 0.24980$	0.24937	0.00043	3 / 4		
<i>Ag</i>	$5s^1$	$d = 0.2889$	0.29093	0.00203	7 / 8	6.21	
<i>Rh</i>	$5s^1$	$a = 0.3803$	0.38791	0.00761	7 / 6	2.08	
<i>Rb</i>	$5s^1$	$d = 0.494$	0.49874	0.00474	3 / 2	0.8	
<i>Nb</i>	$5s^1$	$a = 0.3294$	0.33249	0.00309	1	0.69	9.20
<i>Au</i>	$5s^1$	$d = 0.28840$	0.29093	0.00253	7 / 8	4.55	
<i>Pt</i>	$5s^1$	$a = 0.392$	0.38791	0.00409	7 / 6	0.96	
<i>Al</i>	$3p^1$	$d = 0.28569$	0.29093	0.00424	7 / 8	3.65	1.180
<i>Ga</i>	$4p^1$	$a = 0.244$	0.24937	0.00537	3 / 4	0.67	1.091
<i>In</i>	$5p^1$	$c = 0.49467$	0.49874	0.00407	3 / 2	1.14	3.4035
^4He	$1s^2$	$c = 0.583$	0.58186	0.00114	7 / 4		2.17
<i>Be</i>	$2s^2$	$a = 0.25515$	0.24937	0.00478	3 / 4	3.08	
<i>V</i>	$4s^2$	$d = 0.2619$	0.25860	0.00330	7 / 9	0.50	5.38
<i>Ca</i>	$4s^2$	$d = 0.394$	0.38791	0.00609	7 / 6	2.78	
<i>Fe</i>	$4s^2$	$a = 0.286645$	0.29093	0.00329	7 / 8	1.02	
		$d = 0.248242$	0.24937	0.00113	3 / 4		
<i>Ti</i>	$4s^2$	$a = 0.2951$	0.29093	0.00417	7 / 8	0.23	0.39
		$c = 0.4697$	0.46549	0.00421	7 / 5		
<i>Zn</i>	$4s^2$	$c = 0.49468$	0.49874	0.00406	3 / 2	1.69	0.875
<i>Co</i>	$4s^2$	$a = 0.2505$	0.24937	0.00113	3 / 4	1.72	
<i>Ni</i>	$4s^2$	$d = 0.24917$	0.24937	0.00020	3 / 4	1.43	
<i>Pd</i>	$5s^0$	$a = 0.38902$	0.38791	0.00111	7 / 6	0.95	
<i>Cd</i>	$5s^2$	$a = 2979$	0.29093	0.00697	7 / 8	1.38	0.56
<i>Y</i>	$5s^2$	$c = 0.57306$	0.58186	0.00880	7 / 4	0.17	

6. Superconductivity

It is well known in optics (and in quantum mechanics too) that the transition coefficient of light through the layer is equal to one if the following relations between the thickness R of the layer and wave length λ_e exist

$$R = \frac{n_1}{n_2} \lambda_e, n_1 = 1, 2, 3, \dots, n_2 = 2, 4. \quad (9)$$

It is interesting to note that: 1) the Bohr quantization conditions $\lambda_N = N\lambda_e$ for a hydrogen atom; 2) the quantization conditions $\lambda_N = N\lambda_{4He}$ for superfluid 4He coincide with (9); and 3) the Tomasch quantization conditions for tunneling are the same as (9).

We have carried out a systematic analysis of interatomic distances for a huge number of systems, using (9), in which $\lambda = \lambda_e$ is the electron wave length in the ground state of a hydrogen atom.

Table 4. Geometrical parameters of high temperature superconductor $YBa_2Cu_{3-y}O_{7-x}$ at temperature below

$$T_c, \Delta = |a_{exp} - a_{cal}|.$$

	d_{exp}	d_{cal}	Δ	n_1/n_2	$T(K)$	x
c	1.164028(13)	1.163710	0.000318	7/2	10	
c	1.16311(10)	1.16371	0.00060	7/2	8	0.04
b	0.388130(4)	0.387905	0.000125	7/6	10	
b	0.38786(3)	0.38791	0.00003	7/6	8	0.004
$Ba - O(1)$	0.28660(11)	0.29093	0.00333	7/8	10	
$Ba - O(1)$	0.2878(3)	0.29093	0.00313	7/8	8	0.04
$Ba - O(2)$	0.29806(14)	0.29093	0.00703	7/8	10	
$Ba - O(3)$	0.29573(17)	0.29093	0.00480	7/8	10	
$Ba - O(5)$	0.28892(11)	0.29093	0.00101	7/8	10	
$Cu(2) - O(4)$	0.23760(5)	0.23274	0.00486	7/10	10	
$Y - O(3)$	0.23760(5)	0.23274	0.00486	7/10	10	
$Cu(1) - O(1)$	0.19406(0)	0.19400	0.00006	7/12	10	
$Cu(1) - O(1)$	0.1939	0.19400	0.00010	7/12	8	0.04
$Cu(2) - O(2)$	0.19258(2)	0.19400	0.00142	7/12	10	
$Cu(2) - O(2)$	0.1939(1)	0.19400	0.00010	7/12	8	0.60
$Cu(2) - O(3)$	0.19599(3)	0.19400	0.00199	7/12	10	
$Cu(2) - O(3)$	0.1940(1)	0.19400	0.00000	7/12	8	0.04
$Cu(2) - O(3)$	0.1939(1)	0.19400	0.00010	7/12	8	0.60
$Cu(2) - O(4)$	0.1940(1)	0.19400	0.00000	7/12	8	0.04
$Cu(2) - O(4)$	0.1939(1)	0.19400	0.00000	7/12	8	0.60

Table 5. Critical temperature T_c as function a (in nm) for superconductor Nb_3Al , $\Delta = |a_{\text{exp}} - a_{\text{cal}}|$.

T_c	a_{exp}	a_{cal}	Δ	n_1/n_2
18.6	0.5183(1)	0.5172	0.0011	14/9
17.6	0.5185(1)	0.5172	0.0013	14/9
13.6	0.5191(1)	0.5172	0.0019	14/9
9.6	0.5172(1)	0.5172	0.0023	14/9
<1.4	0.5200(1)	0.5172	0.0028	14/9

We come to the conclusion that superconductivity can be explained by the following assumption: channel motions in systems like that of electron motion in the ground state of a hydrogen atom are exactly synchronous. Therefore, superconductivity systems represent a coherent synchronized state — a complex of coupled resonators with the commensurable frequencies.

- This means that we have in principle found out the possibility to achieve superconductivity at room temperature (Gareev 2000).

The parameter-free formula for interatomic distances in biomolecules, superconductors, and size of nanostructures has been obtained [5]. This establishes some bridge between the structures of different phenomena (conductivity, superconductivity, insulator-metal transmission, quantum Hall effect, superfluidity, quantization of nanostructure cluster size, size of biomolecules). This connection can be considered as an indication of the existence of some physical phenomena in the structures of the superconducting and living systems.

We have shown [25] only a small part of our calculations by formula (9) and the corresponding comparison with experimental data for interatomic distances in some molecules. One can be surprised by a high accuracy description of the existing experimental data.

Understanding of the origin and evolution of the genetic code must be the basis for a detailed knowledge of the relationship between the basic building blocks of DNA and environment. As is widely accepted today, essentially all the DNA in an eukaryotic nucleus are formed of histones and different chromatin structures folded hierarchically. At least five orders of DNA and chromatin organization and folding (nucleotide, helix, nucleosome, solenoid and chromatin fibre loop) have been described in the literature. A DNA chain is a long unbranched polymer composed of only four types of subunits. These are nucleotides containing the basis adenin (A), cytozine (C), guanin (G), and thymine (T). These nucleotides form complementary flat pairs and the distances between these plains are equal to λ_e .

- This means that the structures, formed in DNA molecules by nucleotides, produce the two- and three-dimensional superconductors (wave guides).

All proteins look like dimers in which the two copies of the recognition helix are separated by exactly one turn of the DNA helix:

$$3.4\text{nm} \Leftrightarrow 10\lambda_e = 3.325\text{nm} .$$

DNA is packaged with histones into regularly repeating nucleosomes that are packed into 30 nm (diameter) fibers:

$$30 \Leftrightarrow 90\lambda_e = 29.92\text{nm} ,$$

it is also elaborated, folded and organized by other proteins into a series of subdomains of distinct character. This higher-order packing is the most fascinating and also most poorly understood aspect of chromatin.

Molecules of DNA, amino acids, proteins, ... contain tetrahedral blocks $H_3C - C$ with the angles $\angle HCH = \angle HCH = 109.47^\circ$, with the bond length

$$3d(H - C) = \lambda_e = 0.3325\text{nm} \text{ and } 3d(H - C) + d(C - C) = 3/2\lambda_e = 0.4987\text{nm}$$

Note that these molecules of amino acids and DNA have planar blocks $H_2N - C$, whose bond length is equal to

$$2d(H - N) + d(N - C) = \lambda_e = 0.332\text{nm} .$$

Pentagonal rings in adenin and guanin have the bond length equal to 0.668 and 0.666 nm, respectively, which is close to $2\lambda_e = 0.665$ nm.

- Many distances in living molecules are commensurable with the de Broglie wave length λ_e of an electron (proton) in the ground state of a hydrogen atom. This means that λ_e play the role of the standard distance in molecules, especially in living molecules. Hence, the electron and proton motions in a hydrogen atom and in living molecules are synchronized and self-consistent. A hydrogen atom represents radiating and accepting antennas swapping the information with the surrounding substance. Atoms, molecules represent wave antennas.

7. Cold Fusion

It is well known in optics (and in quantum mechanics too) that the transition coefficient of light through a layer is equal to one if the following relations between the thickness R of the layer and wave length λ exist

$$R = \frac{n_1}{n_2} \lambda, n_1 = 1, 2, 3, \dots, n_2 = 2, 4$$

(10)

- In this case the light does not feel the layer: the layer does not exist for the light in such conditions. The layer is invisible and transparent.
- The same mechanism can be for cold fusion or LENR when cell sizes and corresponding wave lengths obey the conditions (10) — maximal effectiveness for nuclear processes.

8. Crystallographic Picture of Universe

- M. Gryzinski [9, 10, 11] has proved that atoms are the quasi-crystal structure with definite angles: 90° , 109° and 120° , which are the well-known angles in crystallography. It was assumed [12] that electrons on atomic orbital have the form of correct systems on the sphere (the Platon and Arximed bodies, ...). The system of the same particles is STABLE only in the cases when the particles are situated on the very top of isogon – polyhedron.
- From the point of view of academic science, the crystallographic structure in nuclei is not accepted due to the large kinetic energies of nucleons in nuclei. Nevertheless the crystallographic models of nuclei have been constructed with success [14, 15]. A. Dudek *et al.* [16] confirmed the existence of tetrahedral and octahedral forms of rare earth nuclei.
- D.D. Ivanenko and R.V. Galiulin [13] come to conclusion that the structures all states of matter (FROM THE ELEMENTARY PARTICLES to THE LARGE SCALE of THE UNIVERSE) can be describe by Delone sets in the spaces of constant curvature.

For example, V.F. Weisskopf [17] comes to conclusion that the maximum height H of mountains in terms of the Bohr radius a is equal to

$$\frac{H}{a} \approx 2.6 \cdot 10^{14},$$

and water waves lengths λ on the surface of a lake in terms of the Bohr radius is equal to

$$\frac{\lambda}{a} \approx 2\pi \cdot 10^7.$$

- *The greatness of mountains, the finger sized drop, the shiver of a lake, and the smallness of an atom are all related by simple laws of nature – Victor F. Weisskopf [17]. He considers the three spectroscopies (atomic, nuclear and subnuclear) to be on common ground [18].*
- We have proved the ISOMORPHISM of hydrogen atom, molecule, and crystal structures (Gareev 2000).
- We have proved the ISOMORPHISM of hydrogen atom and solar system structures (Gareev 1996).
- V. Krivitski [19] confirmed that the form of Earth is a triacontahedron with 5-fold symmetry.
- N. Yabuuchi and A. Takahashi [20] came to the conclusion *that nuclei exist in similar structures as structures of Pythagoras-Platonic polyhedrons in universe, molecules and atomic clusters. Furthermore, there exist in the universe the form of self-organization to arrange these materials (from large one to small one) into regular polyhedrons in realizing stars, molecules, atoms and elementary particles.*
- J. Kepler (1596) found *that each of five Platonic solids could be uniquely inscribed and circumscribed by spherical orbs; nesting these solids, each encased in a sphere, within one another would produce six layers, corresponding to the six known planets – Mercury, Venus, Earth, Mars, Jupiter, and Saturn. By ordering the solids correctly – octahedron, icosahedron, dodecahedron, tetrahedron, cube.* (Wikipedia)

So the resonance synchronization principle is substantiated at the micro and macro level as the consequence of the energy conservation law and resonance character of any interaction between wave systems. The commensurability and self-similarity result in the very unity of the world.

This means that our method can be used in different fields of fundamental research and also in applications: construction of new materials, say, high-temperature superconductors, new drugs in medicine, new methods in diagnostics of diseases, and new devices by analogy with biomolecules.

- It is interesting to note that there is SYMMETRY between the order of the spectra of the hydrogen atom and the electronic levels of different atoms [23]. This means that the homology and isomorphism of the hydrogen atom and many-electron atom structures exists.

In 1953 Schwartz [24] proposed considering the nuclear and the corresponding atomic transitions as a unified process. This process contains the β -decay which represents the transition of nucleon from state to state with emission of electron and antineutrino, and simultaneously the transition of atomic shell from the initial state to the final one. A complete and rigorous solution to this problem is still needed.

9. Conclusions

The structures of elementary particles, nuclei, atoms, molecules ... and the Universe are topologically the same.

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