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ELEMENTARY PARTICLES, ATOMIC NUCLEI AND MOLECULES ACCORDING TO THE BSM – SUPERGRAVITATION UNIFIED THEORY

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Abstract: *The Basic Structures of Matter – Supergravitation Unified Theory (BSM-SG) is based on alternative concept of the physical vacuum. At small distance below 1 angstrom the Supergravitational forces appear as strong nuclear forces, while at larger distance they converge to the Newtonian gravity. Amongst the major outcomes from BSM-SG theory are derived material structures of the stable elementary particles forming the material structure of atomic nuclei. The protons and neutrons are not spherical but having a shape of twisted and folded torus, respectively. They are thin but with much larger size than the size of the atomic nuclei according to the QM models, so the Coulomb field is not converged to a size in the order of 10E-15 m but is distributed over much larger size of the proton. The BSM-SG models of nuclear structures exhibit an excellent match to the pattern of Periodic Table, showing signatures of valences, Pauli Exclusion Principle and Hunds rule. They also define the angular restrictions of the chemical bonds.*

Key words: *unified theory, supergravitation, particle substructure*

1. Introduction

James Clerk Maxwell developed Classical Electrodynamics with the assumption of a material Ether (see section "A medium is necessary ", p. 493 [1]). After the inconclusive Michelson-Morley experiment, Einstein formulated in 1905 his postulate of Relativity that led to overthrowing the idea of the Ether. After development of General Relativity in 1920, Einstein partly reversed his opinion in favor of the Ether. In his book "Sidelights of Relativity he says "Without Ether the General Theory is unthinkable" [2]. Although, Einstein disagrees with Maxwell's vision about Ether, he did not provide a proof that the material Ether is impossible.

2. Basic Structure of Matter – Supergravitation Unified Theory (BSM-SG)

BSM-SG unveils the relation between the forces in Nature by adopting the following framework [3,4,5,6]:

- **There are two spherical superdense indestructible fundamental particles (FPs)** of two different substances of intrinsic matter with a radius ratio of 2:3 and different densities. The bell-shape curve radial dependence of their density permits vibration of the mass center at super-high proper frequency with an average value (for both types of FPs) associated with the Planck's frequency, F_{PL}:

$$F_{PL} = [(2\pi c^5)/(Gh)]^{1/2} = 1.855 \times 10^{43}\ (Hz) \quad (1)$$

- There is a fundamental **law of Super Gravitation (SG),** according to which FPs interact by a force inversely proportional to the cube of distance. This force in empty space is given by

$$F_{SG} = G_O \frac{m_{01} m_{02}}{r^3} \quad (2)$$

where: F_{SG} is the SG force, m_{01}, m_{02} are intrinsic matter mass, r is distance; G_O is a SG constant, which is different for each matter substance and may change sign for the case of imbalanced geometrical formations made from both FPs.

- **Vibrational energy and SG law:** FPs preserve a limited freedom of vibration in geometrical formations made from the same type of substance. In a complex 3D structure, FPs vibrate within a saturation limit – an energy well of the structure. The SG law is associated with the necessary energy for filling the energy well. The SG constant has a frequency dependence on the density of the structural formations and may change sign, which mean that SG forces could be attractive or repulsive.
- **Signature of SG forces –** Casimir Forces – attractive and repulsive - and some Vander Walls forces.

An enormous quantity of the two FPs interacting by SG forces and possessing energy above some critical level leads to formation of self-organized hierarchical levels. A unique crystallization process leads deterministically to creation of space with quantum properties – a physical vacuum and elementary particles forming the observable matter of an individual galaxy.

Fig. 1 shows three consecutive types of 3D formations at the lowest order of the crystallization process. They are denoted as Tetrahedron (TH), Quasipentagon (QP) and Quasiball (QB).

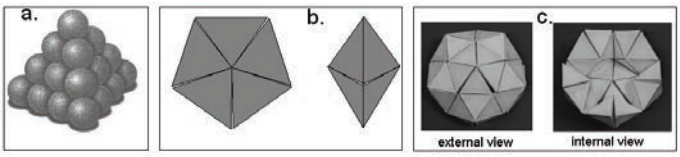

Fig. 1. Structures of lowest level. a. Tetrahedron (TH), b – Quasipentagon, c. – Quasiball (QB)

The FPs embedded in TH causes common mode spatial oscillations with properties defined by the TH geometry. Eq. 3 providing an accurate value for fine structure constant is based on the assumption that it is defined by the ratio between the frequency of common mode oscillations of TH and the Planck frequency of FP. (Derived in §12.A.5.3 [6]).

$$\alpha = 2/[(n^2 + 2\pi^2)^{1/2} + n] = 7.29735194 \times 10^{-3} \quad (3)$$

$\alpha = 7.297352533$ according to CODATA 98 (4)

The vibrational SG modes in QP exhibit an axial anisotropy due to its geometrical shape. The gaps between the THs in QP are combined in a common gap of $7.355^{0,}$ which is preserved in QB. This allows a left or right hand twisting of the QB - a **lowest level memory carrying the cirality (handedness)**. The next higher order contains the same type of formations, while the TH is formed by QBs of the previous order. For all orders the following relation for quantity of embedded FPs is valid: 1 QB = 12 QP = 60 TH

The frequency of common mode vibrations decreases from TH to QP to QB and for subsequent orders. Consequently, the well-defined hierarchical level of structural formations serves as an accurate divider of the fundamental Planck frequency.

The sectional view of QB shows that this formation encloses an internal empty space. The same is true for the upper hierarchical orders of QBs. Consequently if such QBs are compressed in a shell they will be molded into hexagonal prisms with internal structure carrying left and right handed twisting. The two types of prisms are respectively made from the two types of FPs.

Fig. 2. illustrates the hypothetical evolution phases of the primordial matter from both FPs leading to formation of internally twisted prisms followed by their crystallization into helical structures from which elementary particles are built [6].

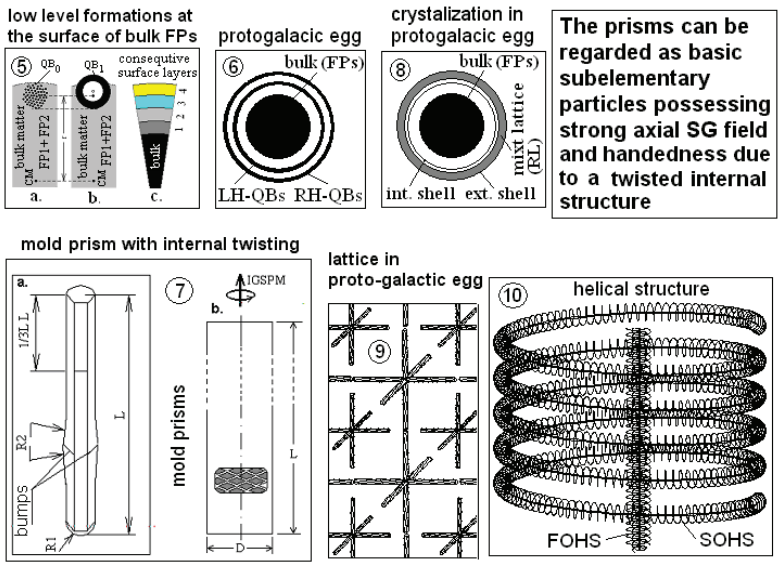

Fig. 2. Evolution phases of primordial matter and structures

The crystallization process occurs in a hidden phase of evolution of an individual galaxy. The remnant of the enormous abundance of FPs is in the center of the galaxy, now identified as a supermassive black hole. The galaxies have a cycle comprised of a hidden phase of particle crystallization, an observable active life, and a collapse with particle recycling. Globular clusters are remnants from a past galaxy life. The birth and collapse of an individual galaxy with an average active life of 12 billions years has a detectable signature – a Gamma Ray Burst. The galactic red shift is not of Doppler type but due to small differences in the shape of molded prisms. The universe is stationary and everlasting. These conclusions agree with the accumulated observations discussed by the Alternative Cosmology Group [7].

The free prisms form a spatial structure called a Cosmic Lattice (CL), while the stable particles - protons, neutrons and electrons - initially form simple atoms, such as hydrogen, deuterium, tritium, helium and the first molecules. The newborn space has all the known properties of the physical vacuum, while the elementary particles interacting with the CL structure exhibit quantum mechanical features. The main properties of CL space are:

- The CL structure is formed of alternately arranged CL nodes made of 4 prisms of the same type aligned along the four apex axes of the tetrahedron they form. They have an intrinsically small inertia in a void space.
- The individual CL nodes are separated by gaps due to the specifics of the SG forces
- The SG field between the elementary particles in CL space is propagated by the ***abcd*** set of axes (see Fig. 3) of the CL nodes and appears as Newtonian gravitation

• The Electrical and Magnetic fields are types of CL space modulations, based on the dynamic properties of the CL nodes involving momentums along the ***xyz*** set of axes.
• The gaps between CL nodes and their proper frequency slightly depend on the mass of a material object, defining in this way the space properties according to General Relativity.
• Since the CL nodes are flexible, rarefied CL structure (with weaker internode forces) could pass through a denser one. This gives a new vision of the inertial frame suggested by Einstein.

Fig. 3 illustrates the CL node dynamics under SG forces.

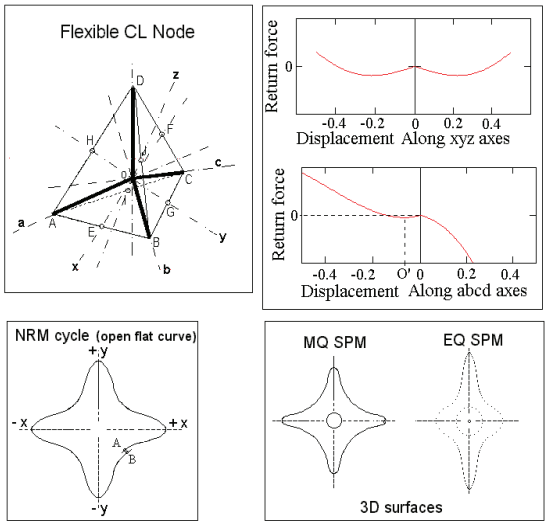

Fig. 3. CL node and its dynamics. MQ SPM has a central symmetry, EQ SPM is elongated

The dynamical behavior of the CL node is described by two vectors: Node resonance momentum (NRM) and Spatial Precession Momentum (SPM). The hodograph of NRM (cycle) is an open flat curve, as shown at the left bottom side of Fig. 3. A large number of NRM cycles forms a closed 3D surface of the SPM vector called a Quasisphere. It has 6 bumps (along the xyz axes) and 4 depressions (along the abcd axes). The magnetic field lines are formed by aligned quasipheres called MQ, while electrical lines – by aligned EQs. The MQs and EQs are synchronized with slightly different SPM frequencies. The photon is a specific wave in the CL space possessing a helical configuration from orthogonally arranged EQs and MQs with a boundary of MQs. The energy momentum from every CL node included in the photon wavetrain transfers to a neighboring one in one NRM cycle – this defines the velocity of light. The velocity of light (EM propagation) is additionally stabilized by the effect of self synchronization between the CL nodes, which is with the SPM (Compton's) frequency, and it is involved in the definition of the permeability and permittivity of the physical vacuum (Chapter 2 of BSM-SG).

The **Elementary particles** are built of prisms arranged in **helical structures** in a crystallization process preceding the birth of the galaxy.

The Electron is one coil of a First Order Helical Structure (FOHS) - an oscillating 3-body system with two proper frequencies [5]. The first one is the Compton frequency equal to the SPM frequency of the CL node. Fig. 4 shows the dimensions and structure of the electron and its modulation properties on CL nodes that define its electrical field.

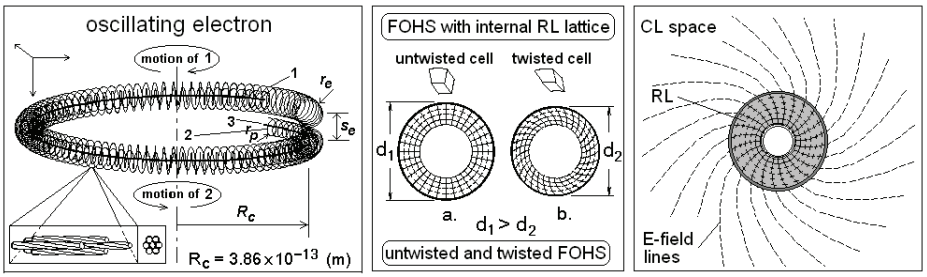

Fig. 4. Electron and its internal lattice modulating CL space. Calculated dimensions: $R_C = 3.86\times10^{-13}$ (m) ; $r_e = 8.8428\times10^{-15}$ (m)

The fine structure constant is embedded in the helical step s_e given by the expression:

$$s_e = (\alpha c/\nu_c)(1-\alpha^2)^{1/2} = 2r_e = 1.7706\times10^{-14}\ (m) \quad (5)$$

The **denser internal lattice of FOHS** modulates the CL space, creating aligned EQ SPM, which define the **electrical field lines.** When moving and rotating, the modulation causes formations of loops of phase synchronized MQs – **magnetic lines**.

Confined motion: The screw-like motion of the rotating and oscillating electron and its interaction with the SPM frequency of the CL nodes causes a confined motion with preferred velocities, corresponding to (13.6/n) eV, where ***n*** matches the principal quantum number of the Bohr atomic model. In a closed loop motion, ***n*** defines the real length of the quantum orbit, because the loop length contains a whole number of quantum magnetic lines (See §7.7.1, Chapter 7 of BSM-SG).

Using the structure and oscillating properties of the electron, the following physical parameters of the CL space are derived:

Static CL pressure, P_S: defines the Newtonian mass of an elementary particle (Equation 7) as a pressure exercised on the volume of its impenetrable internal lattice divided by the square of the speed of light

$$P_S = \frac{m_e}{V_e}c^2 = \frac{g_e h\nu_c^{\ 4}(1-\alpha^2)}{\pi\alpha^2 c^3} = 1.3735\times10^{26}\ (\mathrm{N/m^2}) \quad (6)$$

$$m = (P_S/c^2)V_H\ (\mathrm{kg}) \quad (7)$$

where: V_e – volume of denser internal lattice of the electron, V_H- a similar volume of a stable elementary particle

Partial CL pressure, P_P: related to the inertial properties of the elementary particles in CL space at their confined motion

$$P_P = P_S\alpha\upsilon/c \quad (\mathrm{N/m^2}) \quad \text{where: } \upsilon \text{ - is velocity} \quad (8)$$

Dynamical CL pressure, P_D: - exercised on atoms and molecules by ZPE waves responsible for equalization of the CL space background energy.

$$P_D = \frac{h\nu_c}{cS_e} = \frac{g_e h\nu_c^{\ 3}(1-\alpha^2)}{\pi\alpha c^3} = 2.0258\times10^3 \quad (\frac{N}{m^2 Hz}) \quad (9)$$

The signature of P_D is the observed Cosmic Microwave Background (CMB). Therefore, **the estimated temperature of 2.72K** (by fitting of CMB to a blackbody curve) **in fact is a CL space background parameter.** The derived theoretical expression (Chapter 5 of BSM-SG) is:

$$T = \frac{N_A^{\,2}}{S_W}\frac{h\nu_c (R_C + r_p)^3 L_{PC}^{\,2}}{2cR_C r_e R_{ig}}\frac{\mu_e}{\mu_n} = 2.6758K \qquad (10)$$

where *Lp*, shown in Fig. 5 is estimated by analysis in §6.12.2, Chapter 6 of BSM-SG [6].

Other identified CL space parameters:

CL node distance (at xyz axes) ~ 1.0975×10^{-20} (m),

NRM (resonance) frequency: 1.0926×10^{29} (Hz)

SPM frequency = Compton frequency (known): 1.2356×10^{20} (Hz)

The CL space contains two types of energy – dynamic and static. The dynamic one is envision by Quantum Mechanics. According to BSM-SG its signature is the background temperature of 2.72K given by Eq. 10 which corresponds to the CMB radiation. The static type of energy is the energy of connection between CL nodes. Its estimation given by (11) is possible by application of Eq. (6) by using the revealed structure of electron (Chapter 5 of BSM-SG). The Static energy is many orders larger than the dynamic one and directly related to the mass.

ZPE-S=1.373×10^{26} (J) (in one cubic meter of space) (11)

Using the particle data and the derived mass equation, the internal structure of the proton and neutron is identified, as shown in Fig 5. The outside helical structure is positive. Inside it are 3 helical structures - two pions (+) and (-) and a central kaon. All helical structures are stable because they are closed tori. If the external positive structure is broken (in particle colliders) the internal pions and kaon are cut and decay. More often they are cut in one place preserving the total mass so it is accurately estimated. The kaon has a different inertial property, so its estimated mass appears larger. The calculated dimensions are verified by analysis of atoms connected in molecules with experimentally known lengths of the chemical bonds.

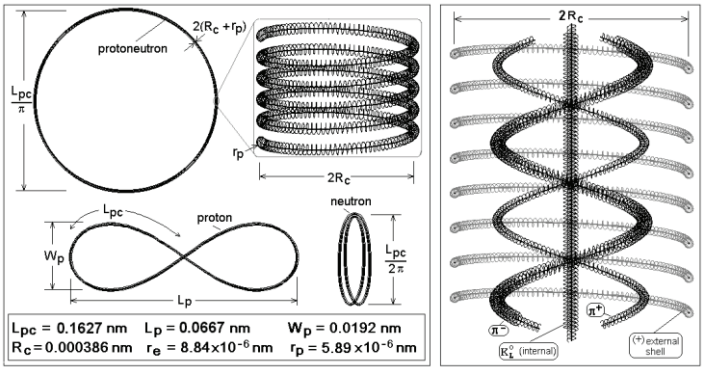

Fig. 5. Overal shape (left side) and internal structures of proton and neutron (right side).

The proton and neutron have one and a same structure but the proton is twisted in the shape of an 8, while the neutron is double folded.. The neutron is more stable when positioned over the proton, forming a deuterium nucleus, as shown in Fig. 6. The CL space modulation by the proton (CL node dynamics) appears as a charge, but for the neutron it is locked in the near field by the strong SG forces. In case of motion, however, the locked charge modulates dynamically the CL space creating a magnetic field. This defines the magnetic moment of the neutron that is unexplainable enigma in contemporary physics. The material structure of the "antiproton" obtained in particle coliders however is not the same as the proton, so it is unstable.

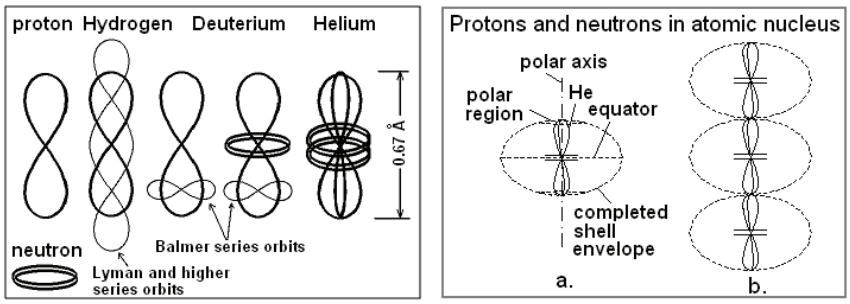

Fig. 6. Protons and neutrons arrangement in atomic nuclei

The left side of Fig. 6 shows the spatial arrangement of the protons and neutrons and the quantum orbits for H, D, and He. The right side shows the proton and neutron arrangement in the atomic nuclei according to BSM-SG.

The unveiled nuclear structures of stable elements are presented in the Atlas of Atomic Nuclear Structures – Appendix A of the BSM-SG book, by using suitable graphics symbols [8]. In a neutral atom each proton has its own bound electron, so the positions of the electron quantum orbits are completely defined by the nuclear structure. The atomic nuclei are slightly twisted along the polar axis due to the twisted 3D shape of the proton. This feature is in agreement with transmission Lauer patterns of elements (see §8.4.2.4 of BSM-SG, Chapter 8).

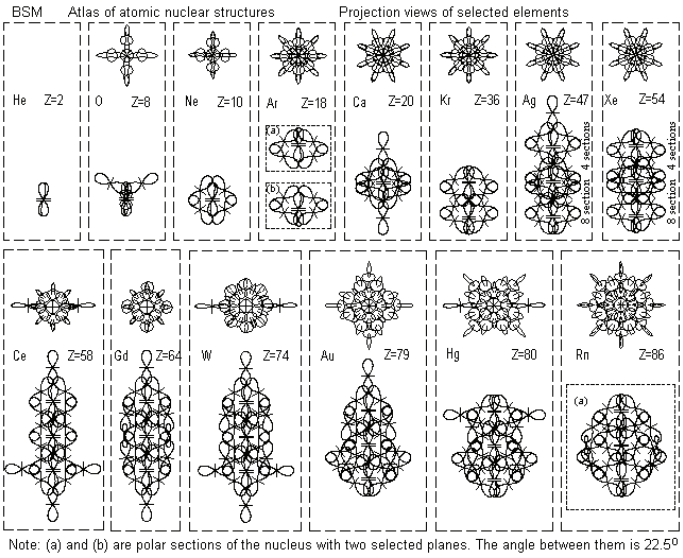

Fig. 7. Atomic nuclei of some elements

Fig. 8 shows the shape of the H_2 – ortho molecule and calculated vibrational levels compared to the measured ones.

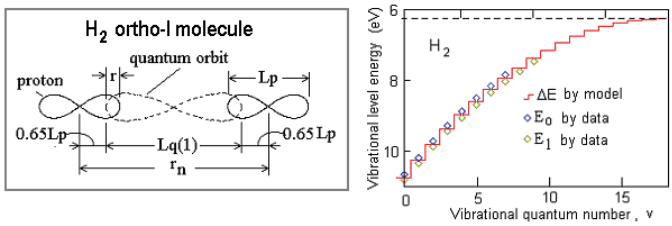

Fig. 8. A physical model of the H_2 – ortho molecule and calculated vibrational levels (step curve)

The parameters of the H_2 molecule (shown in Fig. 8) were obtained by analysis of the optical and photoelectron spectra. The value of one important factor of the SG law denoted as C_{SG} is obtained by fitting the vibrational levels (calculated by derived Eq. 9) to the QM vibrational levels (§9.7, Chapter 9 of BSM-SG).

$$E_V = \frac{C_{SG}}{q[[L_q(1)(1-\alpha^4\pi\Delta^2)]+0.6455L_p]^2} - \frac{2E_q}{q} - \frac{2E_k}{q} \tag{12}$$

$$C_{SG} = G_0 m_0^{\,2} = (2h\nu_c + h\nu_c\alpha^2)(L_q(1)+06455L_p)^2 = 5.2651\times10^{-33} \tag{13}$$

where: q –electron charge, $L_q(1)$ –quantum orbit length for electron velocity of 13.6 eV, L_p – proton length, Δ- vibration level, E_q = 511 KeV, E_k – electron kinetic energy, ν_c – Compton frequency, α - fine structure constant, G_{SG} – SG gravitational constant, m_0 – SG mass of the proton (also neutron).

The derived factor C_{SG} is additionally verified by calculating the binding energy between the proton and neutron in Deuterium (Chapter 6 of BSM-SG, p. 6-52).

The structural analysis of simple molecules indicates that the H_2 – ortho molecule is imbedded as a chemical bond system in molecules, having a vibrational rotational spectra. An equation similar to (12) was derived also for the D_2 molecule, which is a more common system in the chemical bonds. For a simple diatomic molecule, a universal expression (12) for internuclear distance r_n, is derived. In &9.75.D (Chapter 9 of BSM) it is shown that the vibrational range distance is negligible in comparison to the internuclear distance r_n, due to the involvement of the SG law (this is an unsolved problem in Quantum Mechanical models).

$$r_n = (A - p)[(2\alpha C_{SG})/(pB_{D2}(n))]^{1/2} \quad (14)$$

where: A - mass in atomic mass unit (per one atom), p – number of protons involved in the chemical bond (per one atom), n – subharmonic quantum number of the orbit, B_{D2} – energy of D_2 bonding system; α - fine structure constant.

3. Structure of the molecules

Using BSM atomic models and the length of possible quantum orbits a synthetic structural models of molecules could be built. The angular directions of their chemical bonds agree with the VSEPR models used in structural chemistry. This is demonstrated for the simple molecules O_2, O_3 (ozone), CO_2 and H_2O, as shown in Fig. 9. The bond lengths are calculated by the equations in Chapter 9 of BSM-SG [6] agree to experimentally known ones.

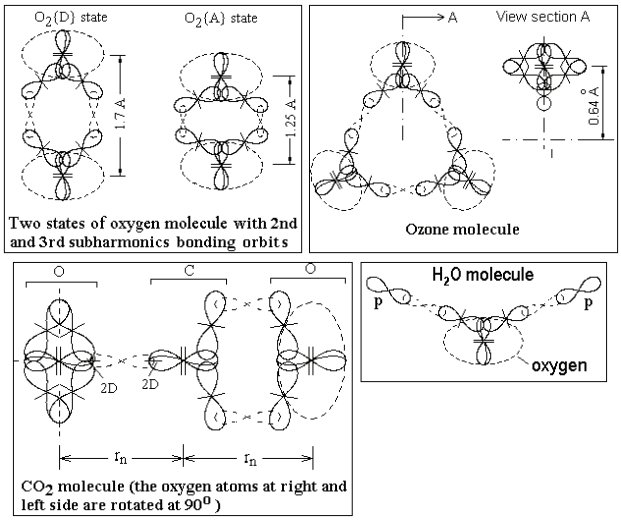

Fig. 9. Synthetic images of O_2, O_3, CO_2 and H_2O molecules

4. Atoms in metal lattices

Fig. 10 (left panel) shows the comparison between the image of the metal lattice of gold [9] and the synthetic model obtained by the BSM-SG atomic models [9].

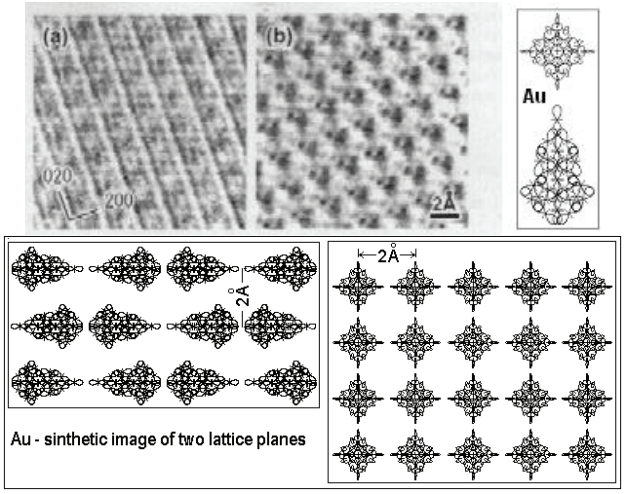

Fig. 10. Left panel: Images of two different planes of Au lattice by tunneling microscope, Courtesy of T. Kawasaki et al. [9]; middle panel – a structure of the atom of gold, right panel: - a synthetic model of metal lattice

5. Modeling in nanotechnology

The BSM-SG atomic models open an opportunity for synthetic modeling in nanotechnology and new materials by using 3D atomic models. The left panel in Fig 11 illustrates the carbon atom Its valences (participating in chemical bonds) are in pairs lying not in one but in two orthogonal planes with slightly displaced points of connection at the nucleus. Using this 3D shape, a synthetic 3D model of a carbon sheet (grapheme) is built and shown in Fig. 13. This 3D model shows that the neighboring carbon atoms lie in two parallel planes with a distance between them of about 0.05 nm. Such resolution is close to the limit of electron microscopy.

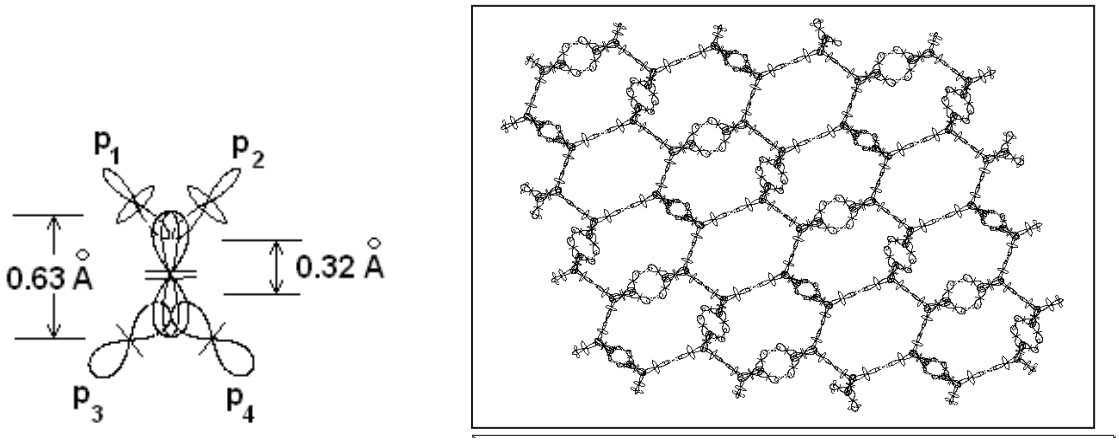

Fig. 11. Left panel: Carbon atom; Right panel: Synthetic model of Carbon sheet (graphene). Neighboring atoms lie in two parallel planes at distance smaller than 0.05 nm.

The existence of two displaced planes in the carbon sheet is apparent from the high resolution electron microscope image shown in Fig. 12. a. [10]. The brightness processed image shown in Fig. 12.b indicates the existence of two displaced planes. The 3D structure of Carbon nuclei is apparent also from the image of a carbon nanotube shown in Fig. 15 (see the left edge). The displaced parallel planes are not explainable by the adopted standard model based on the Bohr's planetary model of atoms.

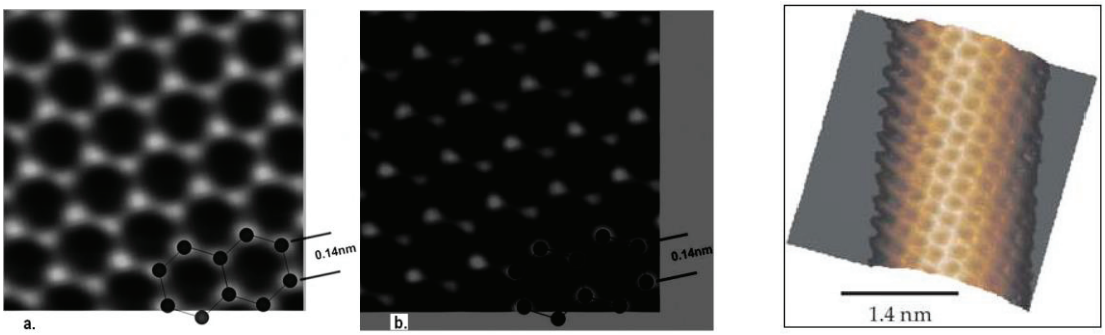

Fig. 14. a. Single wall Carbon sheet with TEAM microscope [10]; b. Processed image by brightness adjustment showing a signature of two displaced planes; right panel: - Single-wall nanotube (Courtesy of A. Javey et al. [11]

5. Conclusions and predictions

- A new vision about the microcosmos and the universe [4,6,12].
- The elementary particles possess material structure with complex 3D geometrical shapes
- The structure of elementary particles, permits reveling the structures of atomic nuclei that define the pattern of the Periodic Table, the primary and secondary valences, the bond directions of the atoms in molecules, the stability (radioactivity) and other chemical and physical properties of the elements.
- BSM atomic models could be used for modeling in nanotechnology and creation of materials with new properties
- Hidden energy of non EM type – a primary source of nuclear energy
- Mass is not equivalent to matter but it is a measurable parameter of the matter
- Gravitational forces on a material object could be modified by proper modulation of the CL space (physical vacuum)

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