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THEORETICAL FEASIBILITY OF COLD FUSION ACCORDING TO THE BSM - SUPERGRAVITATION UNIFIED THEORY

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Abstract: *Advances in the field of cold fusion or LENR in which the energy release cannot be explained by a chemical process, need a deeper understanding of the nuclear reactions and, more particularly, the possibility for modification of the Coulomb barrier. The treatise "Basic Structures of Matter – Supergravitation Unified Theory", suggests non spherical shapes of the protons and neutrons. Held by strong nuclear forces they form atomic nuclei as fractal three-dimensional structures. Such nuclear structures exhibit an excellent match to the pattern of Periodic Table, showing signatures of valences, Pauli exclusion principle and angular restrictions of the chemical bonds. The Coulomb barrier in these nuclear structures does not converge to a small size as in the case of the Bohr planetary model and it could be modified by some technical methods. Using the suggested atomic models, the analysis of some successful cold fusion experiments resulted in practical considerations for modification of the Coulomb barrier.*

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

1. Introduction

The scientific research on cold fusion was pioneered by High Flyn (1913-1997), an emeritus professor at the University of Rochester. Being an expert in ultrasonic waves, he advocated a method of cold fusion based on cavitation in liquid metals with injected hydrogen or deuterium and obtained a patent in 1982 [1]. At this time however, little attention was paid since cold fusion was thought to be theoretically impossible. Interest in cold fusion was raised after Fleischmann and Pons announced a successful cold fusion experiment in 1989 [2]. The lack of a theoretical explanation and difficulty in repeatability led to an official denial, but interest in this option for solving the energy crisis never disappeared. Due to opposition from mainly the hot fusion advocates, the field is more often referred to as Low Energy Nuclear Reaction (LENR). Many researchers and scientists around the world have reported successful experiments at a number of international conferences [3], and selected articles are collected in an on-line data base [4].

Recently, the interest in cold fusion as an alternative to nuclear energy was raised by the successful demonstration of the Andrea Rossi cold fusion reactor called E-cat. The Focardi-Rossi method of nuclear reaction Ni + H -> Cu [5] is based on the preliminary research pioneered by Piantelli in 1989 [6] that has been extended and supported by the local inter-university centers in Bologna [7] and later followed by Focardi-Rossi and colleagues [11]. After years of successful collaboration, and development Andrea Rossi gave in 2011 a number of public demonstration of the E-cat reactor prototype, capable of producing more than 10 kilowatts of heat power, while only consuming a fraction of that. At major public test on October 28, 2011 Rossi demonstration, a half of megawatt-hour thermal energy produced for about 5 hours [8].

According to current understanding of nuclear physics, fusion may occur only at superhigh temperatures in the order of a million degrees. The objections rely on the officially accepted theoretical understanding and, more particularly, on Quantum Mechanics, which is based on the Bohr planetary model of hydrogen extrapolated to all atomic nuclei. According to this model, the nucleus is extremely small in the order of 10^{-15} m, so the Coulomb barrier at such a distance is extremely strong and can be overcome only with a very high collision momentum achievable at a temperature of a million degrees.

The question why the chemical and physical properties of the elements in the Periodic Table do not follow strictly the row and column pattern has not been answered from the time of Mendeleyev. Could this be a signature of some three-dimensional composition of fractal structures from which the atomic nuclei are built?

2. A new theoretical approach

2.1 Brief introduction

The feasibility of cold fusion is theoretically explainable by the BSM-Supergravitation unified theory (BSM-SG) […] with an initial framework based on two indestructible fundamental particles, FP, with parameters associated with the Planck scale and a fundamental Law of Supergravitation (SG). This law is distinguished from Newton's law of gravity in that the SG forces, F_{SG}, in pure empty space are inversely proportional to the cube of the distance.

$$F_{SG} = G_0 \frac{m_{01} m_{02}}{r^3} \qquad \text{Supergravitation Law (SG)} \qquad (1)$$

where: G_0 – SG constant, m_{01} and m_{02} - SG masses (different than the Newtonian mass), r - distance

The two FP particles combine in hierarchical formations of 3D structures held by SG forces are building blocks of the elementary particles and underlying structure of space, often refered as space fabrics In far range propagation through the space-fabrics, the SG forces become gravitational forces of Newton's law of gravity. The suggested concept and derived physical models

allow explanation of all kinds of quantum mechanical interactions between elementary particles, using a classical approach and the unveiled structure of both the particles and the space-time fabric.

The SG forces are not only behind the nuclear forces at a close distance between nucleons, but they also define the electrical field of charged particles. Since the elementary particles appear to have a 3D non-spherical structure and shape, the atomic nuclei also possess non-spherical 3D geometrical structures that define the row and column pattern of the Periodic Table. In this sense, one of the major results of the BSM-SG theory is a new vision of the 3D structure of protons and neutrons and their spatial arrangements in atomic nuclei. This is presented in the Atlas of Atomic Nuclear Structures (ANS) that was archived in the National Library of Canada [13] and published elsewhere (viXra:1107.0031).

2.2. Non-spherical shape of protons and neutrons and their spatial arrangement in atomic nuclei according to BSM-SG theory

In Quantum Mechanics (QM) and Particle Physics all particles are assumed to be spherical, so QM deals only with energy. The assumption of the spherical shape is initially adopted in the planetary model of Hydrogen suggested by Bohr and later for the QM models of all atoms. Based on scattering experiments in which only a spherical shape is assumed, the nucleus is considered extremely small in the order of 10^{-15} m. However, the scattering experiments have only angular, and not transverse, resolution. Then if the nucleus is assumed to be non-spherical, such as a torus, a twisted torus, or a folded torus with much larger toroidal radius but thinner, the scattering data by positrons will be one and the same. Also, the positrons as well as the electrons are found to have rotational speed, so the momentum of this will affect the interpretation of the scattering data.

According to the derived physical models of BSM-SG theory, the proton has the shape of a twisted torus in the form of the figure 8, while the neutron is a double folded torus. At the same time they possess one and the same sub-elementary structure of helical structures. The validation of this conclusion involved extensive analysis of the Particle Physics data, and matching of the derived models with the theoretical developments of Quantum Mechanics, chemistry and experimental data from different fields of physics.

Figure 1 illustrates the revealed shape and the spatial arrangement of the protons and neutrons in the atomic nuclei of the elements Hydrogen, Deuteron and Helium according to the BSM-SG theory.

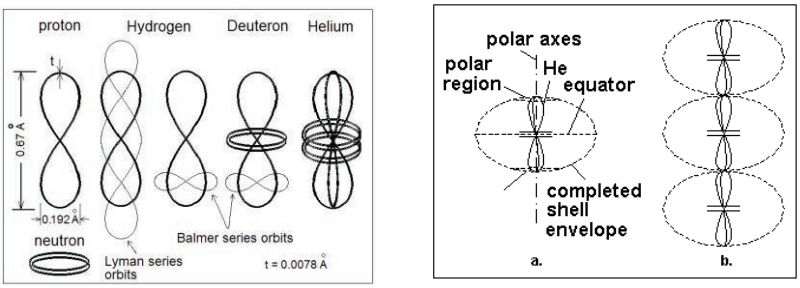


Fig. 1. Left side: shape of the proton and neutron and nuclear configuration of H, D and He atoms according to the BSM-SG theory, right side a.- completed shell of Argon (the envelope is shown), b. – a chain structure in heavier elements.

2.3. BSM-SG models of atomic nuclear structures

Among the major derivatives of the BSM-SG theory is the Atlas of Atomic Nuclear structures[13]. The derived BSM-SG atomic models match perfectly to the pattern of the Periodic Table, while showing the valences and many other features including the Hnds rule and Pauli exclusion principle. Fig. 2. shows two views of a mockup of Argon atom.

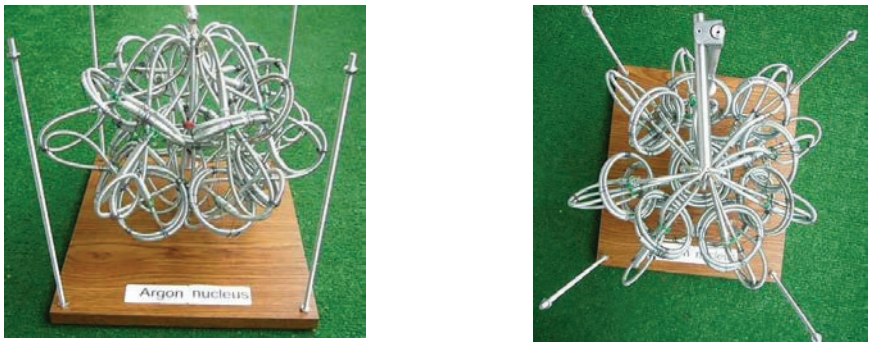


Fig. 2 Views of a mockup of Argon atom.

2.4 Coulomb barrier of the proton

According to BSM-SG theory, the SG forces are not only behind the nuclear forces. They also define the field lines of the electrical charge in closed proximity to the proton core. Therefore the SG field also defines the so-called Coulomb barrier that is one of the most controversial issues in nuclear fusion. Fig. 3 illustrates the distribution of the electrical field (E-field) in close proximity to the proton's high-density core and the locked E-field around the neutron's high-density core.

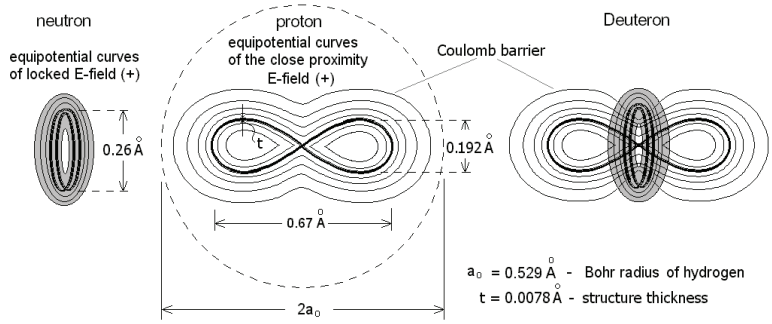


Fig. 3. Coulomb barriers of the near E-field of the proton and the locked E-field of neutron.

Both, the proton and neutron create the E-field as a modulation of the physical vacuum (CL space) by the superfine dense helical structure of their cores. The E-field of the neutron, however, is locked in proximity from the strong SG field.

The electrical charge in closed proximity to the proton is distributed around its shape, but this is in a microscopic range. Outside of the Bohr radius, the E-field lines appear as coming from a point charge. The spatial configuration of the proton's Coulomb barrier illustrated in Fig. 3 is significantly different from the Coulomb barrier of the Bohr model of hydrogen. Furthermore it could be modified to some extent due to its dependence on the SG forces, and there are some technical methods for invoking such an modification.

It is well known that a single neutron is not stable and converts to a proton with a lifetime of 12 min. The instability, according to BSM-SG is caused by the weak balance between the repulsive Coulomb forces in the locked E-field and the attractive SG forces that keep its shape of a double folded torus. However, when the neutron is over the proton saddle (central section) it is stable, forming in such way the stable element Deuteron. The stability is a result of a stronger balance between the repulsive E-fields (+) of the proton and the locked, but accessible at such a distance, E-field (+) of the neutron. The neutron can only rotate or vibrate, and the latter is behind a physical phenomenon known as the Giant Resonance. This phenomenon, discovered by Baldwin and Klaiber in 1947, was later confirmed by many and interpreted by Goldhaber and Teller (Phys. Rev. 74, 1046, (1948). The suggested explanation was that the protons move in one direction while the neutrons move in the opposite direction.

From the graphical model of the Coulomb barriers in Fig. 3 it is evident that a nuclear reaction p + d -> D would take place if the neutron and protons are properly oriented and the proton's Coulomb barrier is slightly modified.

2.5. General Relativity (GR) from the point of view of BSM-SG theory and a hypothesis of GR field micro-curvature around atomic nuclei.

According to General Relativity (GR), a massive object creates a field curvature (the space is shrunk). The radial dependence of this shrinkage is asymptotically smooth, but we may consider two spherical zones and denote them as near and far zones. The common etalon for unit distance must be a characteristic parameter available in both zones. Since the Compton wavelength is directly related to the Plank constant *h* by the expression $E = hc/\lambda$, it could be considered as a unit length etalon for measuring the energy of the emitted photon that passes between the two zones.

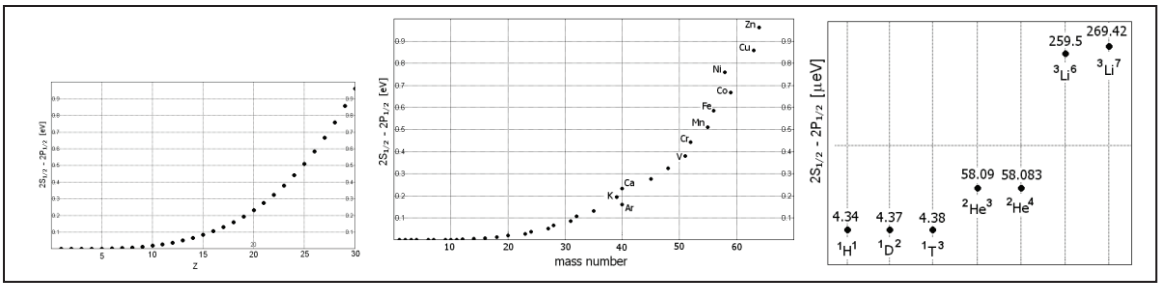
In the near zone the Compton wavelength etalon will be shorter than in the far zone. Then the wavelength of the photon emitted in the near zone but detected in the far zone will be gradually expanded, so it will exhibit a red shift. The wavelength expansion will be valid for the entire EM spectrum range since the photon wavelength is a whole number of Compton wavelengths. This

explains the gravitational red shift of the photons generated near the Sun and observed at the Earth. From this explanation we may formulate one important conclusion: **The field curvature of space has a property of energy conservation.**

If the GR effect of field curvature does not have a limit, we may assume that such an effect may exist also in the microscale range due to accumulation of the superdense structures of the elementary particles in the atomic nuclei. In fact, the experimentally measured Lamb shift corresponding to the transition $2S_{1/2}– 2P_{1/2}$ is a detectable signature of the field curvature in close proximity to atomic nuclei. The Lamb shift, first discovered for hydrogen by Lamb and Rutherford in 1947, was further investigated for elements with Z>2, which are ions with only one electron. According to the Coulomb law, if the single electron is in such a strong field, the potential should increase linearly with Z-number. The observations, however, show that the Lamb shift dependence on Z-number is steeper than Z^3.

The plots shown in Fig. 4 and discussed in details in [14], leads to the following conclusions: (1) The quantum orbits are bound to the individual protons, (2) The neutron is over the proton saddle. Their accumulation also reduces somewhat the strong Coulomb field near the polar regions, (3) the SG field of the protons and neutrons contribute to the energy levels by making the space non-linear.

Consequently, we may suggest that in close proximity to a nucleus, a field micro-curvature exists as a GR effect in a microscale range.



a. b. c.

Fig. 4. a.- Lamb shift as a function of Z-number, b. - Lamb shift as a function of mass number, c. – Lamb shift for the first few elements. Courtesy of Glen W. Erickson [32] recommended by NIST.

2.6. Hidden energy of the physical vacuum - a primary source of the nuclear energy

Using the reveled structure of the electron [11] and the derived parameters of the structure of the physical vacuum called Cosmic Lattice it is found that the space contains enormous amount of hidden energy of not EM type, that is directly related to the mass according to the Einstein equation $E = mc^2$. The estimated value of this energy for 1 cm^3 is:

$$E_S = 1.3736 \times 10^{20} \quad \left[J/cm^3 \right] \equiv 3.18 \times 10^{13} \quad [KWH] \qquad (2)$$

2.6.1. Access to the hidden space energy by nuclear reaction – an explanation by a General Relativistic effect in the microscale range

The BSM-SG revealed that all stable elementary particles possess sub-elementary helical structures defining a volume impenetrable to the Cosmic Lattice. On this base a mass equation was derived for the electron for which all dimensions were revealed. The mass equation was extended for all stable particles, which are built by similar helical structures:

$$m = \frac{g^2 ch(1-\alpha^2)}{\pi\alpha^2 \lambda_C^{\ 4}} \frac{pm_p + nm_n}{m_e} \quad (kg) \tag{20}$$

where: m_p and m_n – the mass of the proton and neutron respectively, p – number of protons, n – number of neutrons.

In a similar way as in the classical GR effect we may consider two zones in the field curvature around the atomic nucleus: near and far zones. All our instruments detect the nuclear mass in the far zone. The common parameter that could serve as a scale etalon in Eq. (20) is the Compton wavelength, λ_C, and it is at a power of four. Consequently, the nuclear mass m detected in the far zone will be strongly affected by the change of λ_C.

Using the derived factor for SG gravitation C_{SG} = 5.265E-33 by analysis of H_2 and D_2 molecules (BSM-SG Chapter 9, section 9.7), the theoretical binding energy between the proton and neutron for Deuteron is estimated by approximate method as 2.145E6 eV that differs from experimentally known one only by 3.6% (BSM-SG, Chapter 5, section 6.4.1)

Conclusions: (1) The source of nuclear binding energy is the Static energy of the physical vacuum; (2) The mass deficiency is a result of a GR effect of field micro-curvature around the atomic nucleus; (3) The nuclear energy released in the fusion and fission reactions is a result of sudden changes of the GR space micro-curvature, a process in which the hidden energy E_S is accessed.

2.7. Protons and neutrons in atomic nucleus according to BSM-SG models

The spatial arrangement of protons and neutrons defines the pattern of Periodic Table (PT), valences and angular restrictions on the chemical bonds. Fig. 5 illustrates two rows of PT.

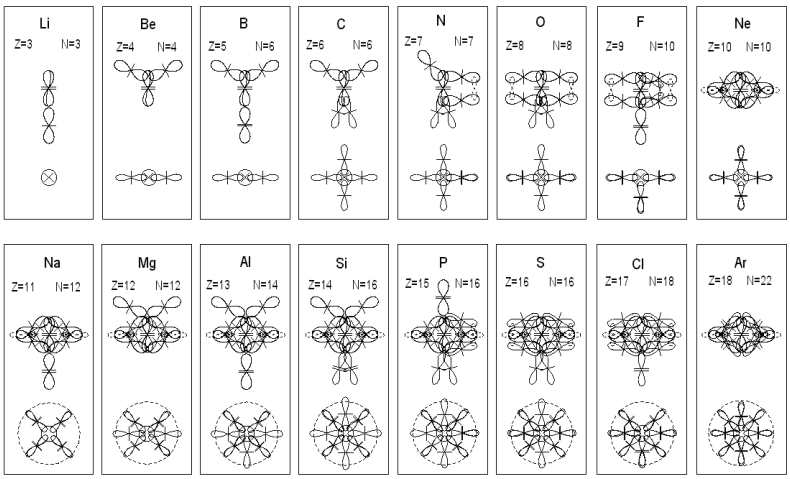


Fig. 5. Two rows of the Periodic Table using the BSM-SG atomic models [13].

2.8. Graphical illustration for understanding LENR by using the BSM-SG atomic models.

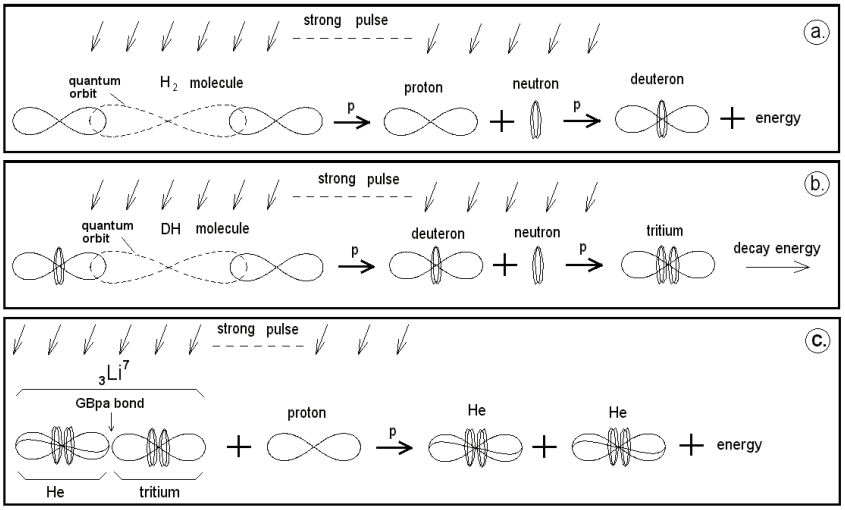


Fig. 6. Graphical explanation of some cold fusion reactions proposed by Flyn and reactions demonstrated by the group of Taleyarkham. Cold fusion by strong shock pulse in sono-fusion or EM pulse in plasma (a) H2 -> p + n -> D; (b) HD -> D + n -> T, (c) L + p -> 2 He . The $_3Li^7$ nucleus is comprised of He and T nuclei attached by GBpa bonds (§8.3.6, Chapter 8 of BSM-SG).

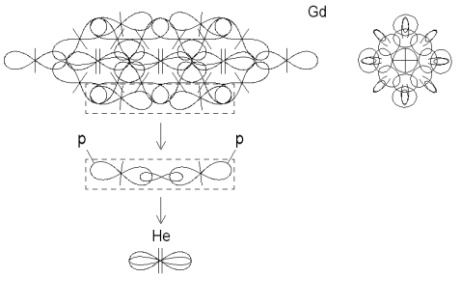


Fig. 7. Two neighboring protons in Gd nucleus fusing to alpha particle

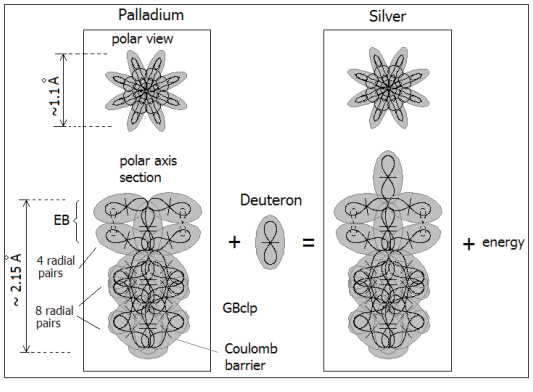


Fig. 8. Fusion reaction Pd + D -> Ag. The Coulomb field is shown in gray color

3. Graphical illustration of some experimentally proved LENR

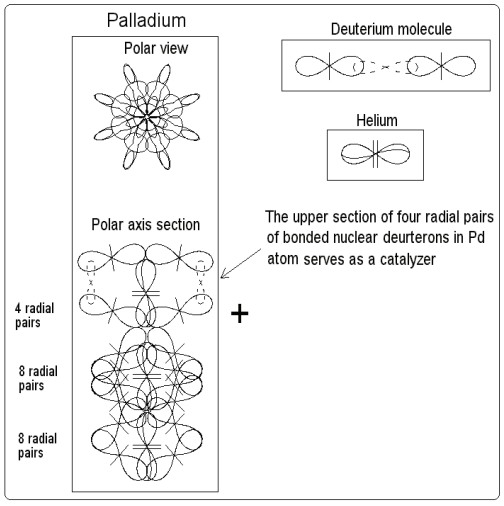


Fig. 9 He nuclei obtained from LENR of Pa as a catalyst in a deuterium atmosphere (first obtained by Dr. Case)

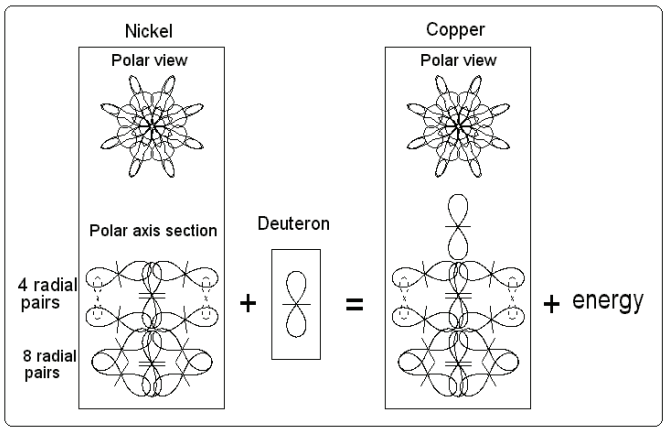


Fig. 10 LENR obtained by Piantelli, Focardi and Rossi: Ni + D -> Cu; Cu + H -> Zn

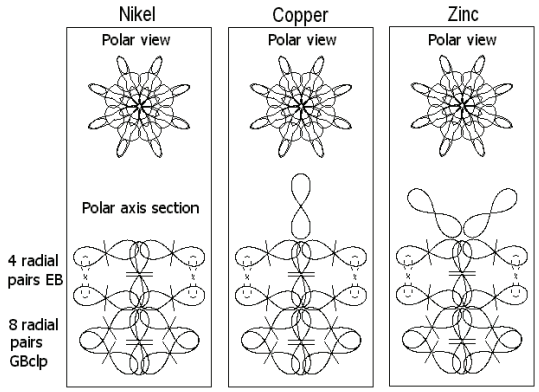


Fig. 10 LENR products of Cu and Zn obtained by Piantelli, Focardi and Rossi: Ni + D -> Cu; Ni + H -> Cu; Cu + H -> Zn

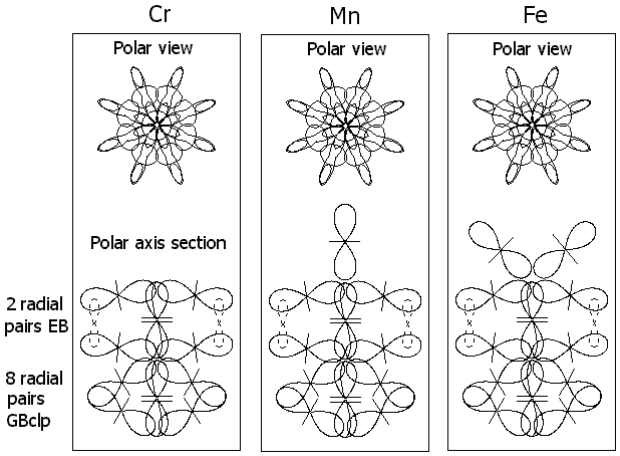


Fig. 11 LENR predicted by BSM-SG theory: Cr + D -> Mn; Mn + D -> Fe Cr + H -> Mn; Mn + H -> Fe

4. Consideration for successful Cold Fusion reactions with energy yield

1. The process of cold fusion is more probable between a heavier and a light nucleus with a proper neutron to proton ratio
2. The knowledge of the real 3D configuration of the nuclei helps to estimate the possibility for deeper penetration of the smaller nucleus into the heavier one. It also allows to find common structural features between elements that showed affinity to cold fusion reactions or transmutations in prior art experiments.
3. The heavier element must be in a solid state in a powder form in order to increase its active surface.

4. A proper temperature of the powder substance is required
5. A proper pressure of the light element gas is a prerequisite for the cold fusion process. The applied pressure must also be combined with a pressure pulsation.
6. Optional use of acoustic cavitation in a liquid phase.
7. Optional use of a plasma arc.
8. Optional use of a strong EM pulse

5. Conclusions

- QM models of atoms, based on the Bohr planetary model, are only mathematical. The scattering experiments cannot serve as a proof for the planetary model of the atoms, because they have only angular resolution and in data interpretation all particles are assumed spherical. However, particles with shapes of twisted and folded torus will give the same angular distribution.
- According to the BSM-SG atomic models, the Coulomb barrier is spread in much larger volume and it could be modified. The efficiency of LENR also depends on the mutual positions of nuclei and their exited state (nuclear spin).
- LENR does not involve severe refurbishment of atomic nuclei, so the radioactivity is missing or minimal.
- The radioactive waste provided by all nuclear plants on the Earth is about 12,000 metric tons per year. At year 2015 it will reach about 250,000 tons.
- A microgram of Plutonium penetrated in human body will lead to ill conditions with a life expectancy of 10 years (Los Alamos National Laboratory) (26): 78–79, (2000))
- LENR is a safer alternative to the presently used nuclear energy
-

Note: Detailed discussions and references to this article are published in [14].

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