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The Fusion-Transmutation Battery

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Abstract. Nuclear reactions such as transmutation, fusion or fission may occur in special nano-structures arrangements with a specific excitation that creates a nuclear active environment.
All the parameters of mass distribution, quantum states and field excitation contribute to the process that involves more than two bodies that are not smashed together through their Coulomb barrier, as is the normal nuclear practice. New concepts in physics such as quantum nonlocality and potential formation of nuclear molecules come into play when considering high quantum energy reactions triggered by low energy excitation of special quantum states. Several nuclear or sub-nuclear entities in various positions may entangle putting the nuclear mass in special communion that may react and end in totally different structures than for normally encountered combinations.
In the past 20 years of experiments, some observations of reactions producing heat only, reactions exhibiting strong bursts of neutrons, gammas and X-rays, some explosions, and over 40 accidents give strong support for new physics ideas in the world.

Keywords: Fusion, LENR, Direct Energy Conversion, Entanglement, Quantum Nonlocality, Battery, R&D, Power Source, Transmutation.

I. INTRODUCTION

Novel nano-structures under certain conditions might facilitate non-local nuclear reactions, such as fusion, or transmutation [1] of fission that follows all the laws of physics known today [2]. Non-local fusion is a novel process that appears in very particular conditions [3], seen today due to technological advancements. The materials, their local structures, and conditions are out of the ordinary, but with modern technology they can be successfully reproduced to make the process repeatable, delivering power on demand, running on command, and running under control [4].

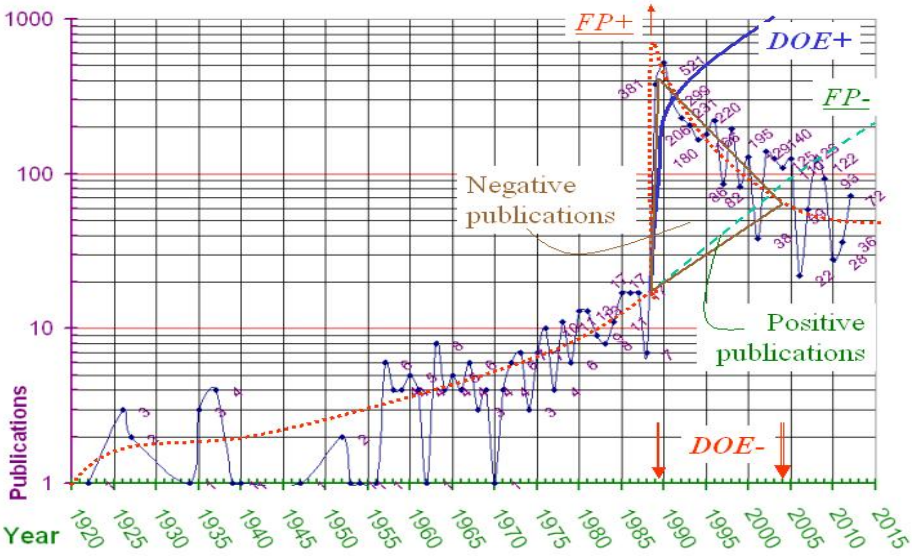

Fig. 1 – The history of the publications on anomalous nuclear reactions made using data from the lenr-canr.org library

While these nuclear reactions in condensed matter processes have long been a part of nature, they were first reported as anomalies in the 1920s [5]. In 1933, J. Frank [6] observed them, and then, one year later Herzfeld and Gopert-Mayer [7] studied them. In 1989, electrochemists Martin Fleischman and Stanley Pons, released a report [8, 9] on the anomalous behavior of hydrogen isotopes during electrolysis. This report received a much wider media attention than all the other publications since 1930s, creating a controversy known now as the FP effect, a subject under active debate, as Fig.1 shows, and has stimulated the understanding of the complex correlations existing in a multi-dimensional space-time, matter-energy, and other fundamental parameters [10]. As an example, a proton and a neutron seem to be two facets or manifestations of the same entity, a neutron being 3 electrons heavier than a hydrogen atom and may flip from n to p in $T_{½}$ =887 s, being bound or unbound to a certain state as shown in Fig. 2. Entanglement and tunneling are already accepted notions, with many applications, but inside a deformed space these notions may have special meaning and the particles involved may have different properties. In multi-dimensional space it is possible that the known elements in our 3D space could be consistent with other invisible dimensions, but may not span over all dimensions. They may also exist in subspaces that might intersect and influence each other. For example, a particle from another dimension that does not have a body – a mass effect – in our 3D space may exist as a force or potential field, or may not be felt at all and considered dark matter or dark energy. Rather, it could occupy space and have limit movement (v<c) or freedom degrees. This is what we now call dark mass, dark energy, antimatter, etc.

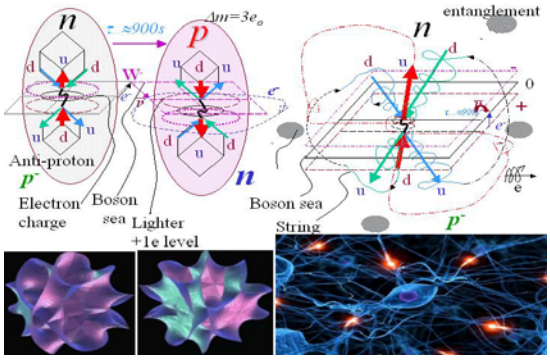

Fig. 2- 10-D representation of a neutron and a proton based on string theory concepts.

In quantum assemblies formed in nano-nuclear active environments, all parameters, from mass distribution to state of excitation fields, can contribute to the process. These processes involve more than two bodies, as is the case in presently accepted nuclear knowledge. The requirement to penetrate the Coulombian barrier fades due to the process's non-locality, and potential formation of quantum assemblies resembling nuclear molecules. This process is similar to an entanglement of several nuclear or sub-nuclear entities that are in various positions in space-time, but with the nuclear mass in a special communion, possibly in a sub-space or other dimension, that may end in totally different structures than previously entered into, as a function of a more complex set of selection rules. The stress to vacuum by something we call energy, brings balanced mass out of nothing, as for example the electron-positron creation by a gamma quanta with energy greater than 1.022 MeV when it is interacting on a space-energy structure. Recently have been predicted or discovered other "strange" effects such as Casimir's effect[11], Aharonov-Bohm effect [12], the string theory, etc. Recently Higgs boson [13, 14] have been discovered, while the 1982 etherons theory [15], is on stand-by. Other process, that are taking place in the absence of radiation, but under specific kinetic energy, like those in material fracture or cavitations [16] that make the most stable nucleus fission, and occupy the hole left in the "vacuum" [16], are in direct contradiction with the nuclear binding energy in its present common understanding, leaving room for other entities acting on "space" or "vacuum" to be discovered.

The actual technological approach to application of these effects, and a clear process understanding must happen concurrently in order to successfully create an operable power source. Required achievements are:

- the ability to control the nano-structure in such a manner that it always drives towards the same, stable nuclear reaction, and

- the ability to immediately harvest the particle's kinetic energy in the same structure, organized as a super-capacitor, and extracted as electricity to prevent the structure's heating.

In order for this structure to operate for long times, it has to self-recover from the structural damage inflicted by the previous energetic reaction [17] and its byproducts.

It is predicted that the fusion battery might have exceptional performance, maximal power density (1 MW/cc), and that there might be many byproducts that may be obtained and that similar performance might be obtained through transmutation or fission. Construction and safety of a fusion battery requires a new understanding of quantum and nuclear physics, driving to a new, superior understanding of matter and associated fields.

II. THE FUSION BATTERY OPERATION MODE

Fig. 3a shows a ternary nuclear reaction where two ^{2}H (Deuterium) nuclei called "fuel" and a nucleus belonging to the "burner's" nano-structure make, via entanglement, a unitary compound nucleus entangled in the lattice.

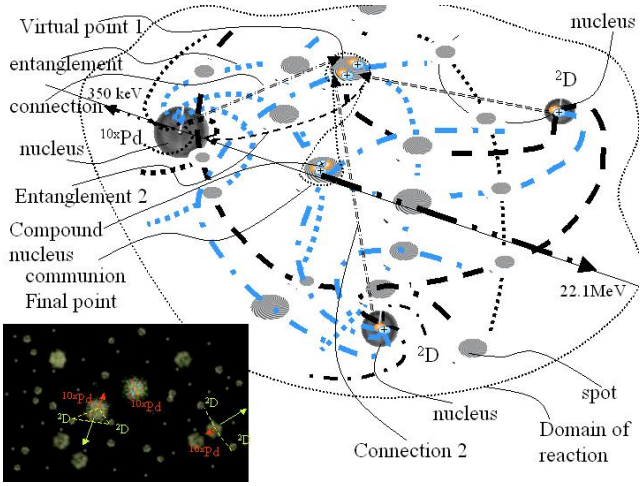

Fig. 3a – A possible explanation on the multi-body quantum reaction among Pd and D atoms in synergistically stimulated lattices.

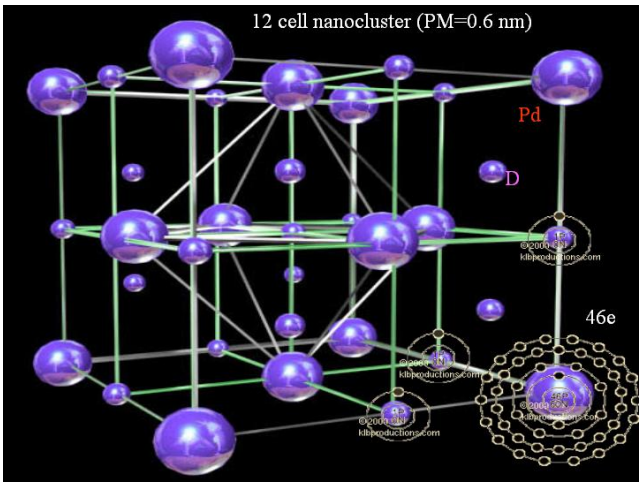

Fig. 3b – PdD schematic lattice cell

To better understand, here is an illustration showing 3 nuclei that are interacting in a compound nucleus, without "touching" each other in the classical sense of ion beam interactions that require energy to penetrate through the Coulombian barrier, in what we believed are the boundaries of the nucleus. Understanding that a compound nucleus is not a sum of the protons and neutrons present there, but a wrap or loom of quarks, floating in the "meson sea", with all quantum states surrounding it, having more than 3 dimensions is important.

Neutron and proton are two manifestations of the same entity that exhibits one quark for each dimension of our 3D space, and has a possibility to flip, resembling a set of 3 magnets. The neutron (ddu quarks =n), has lower stability than proton (uud=p), and has a life time $T_{½}$ = 887s until it flips back via a virtual boson w^{-} and an anti-neutrino ν_e^{-}, what is called neutron's beta decay [18]. The nuclear exchange is made at this level of strong interaction units in the case of fusion, transmutation, and fission, there being no difference between them from a nuclear reaction point of view. This neutron decay is a process that is the inverse of e-capture, and in our universe the proton-electron coupling in H atom is more stable than in a neutron. That is why the proton does not capture its electron to become a neutron under normal conditions [19].

This loom of quarks, once entered into entanglement, starts the exchange in order to recombine in a more advantageous manner from the point of view of nuclear stability and exhausting the surplus of energy as kinetic energy from the newly resulting particles. It is probable that the initial ternary entanglement produces a new binary entanglement, following the conservation laws in the new entanglement positions, based on the center of mass, from where the surplus energy or defect of mass, is released, conserving the energy, impulse, spin, parity, etc., as kinetic energy of the particles and excitation energy of the particles, that is released later by various nuclear decay modes.

In this respect: $^{105}Pd + 2\ ^{2}D \rightarrow {}^{105}Pd + {}^{4}He + 22.4$ MeV (1)

or may drive to: $^{105}Pd + 2\ ^{2}D \rightarrow {}^{107}Ag + {}^{2}D + 0.02$ MeV (2)

In the first reaction (1) that releases 22.4 MeV , Pd gets about 0.3 MeV recoil kinetic energy producing about 200,000 dislocations (dpa-s) in the lattice while He gets about 22.1 MeV traveling about 50 microns in the lattice.

This high energy, 22.1 MeV makes the particle travel a long distance of about 50 microns making possible the direct conversion of the particle's energy into electricity. The structure used resembles a super-capacitor because it relies of the difference of the ionization energy deposited by radiation in different materials that drives to knock-on electrons inducing electron showers that may be collected on electrodes and conducted to the output terminals.

Quantum model for non-local nuclear interaction

From the point of view of the model, the new approach does not invalidate any physics law known and proven up to now. In Fig. 3b is shown, in schematic view, the PdD lattice where the Pd is connected to the Deuterium or Hydrogen through an s-d bound. As previously shown, the Deuterium nuclei are moved further by 0.2A in PdD lattice than they were in D_2 gas phase, the lattice having a dimension of about 2 A =0.2 nm (A=Angstrom), and no fusion, based on classical concepts and spontaneous tunneling, is possible.

The experiments prove that this kind of nuclear reaction takes place and the process is even more complicated, driving to various by products in different experiments. The nano-cluster in Fig. 3b shows the complexity of the quantum model that has to be used to describe the states of the system, even for the smallest structure a voxel magnitude of 0.6 nm that has 12 elementary cells. Such structure is difficult to obtain in practice; the minimum size reported for Pd nano-clusters has 3-7 nm.

In order to develop quantum calculations it is necessary to reduce the structure as much as possible, and the minimum quantum system that considers all the states has more than 200 parameters, from which some may be approximated with continuous functions and further reduced as shown in Fig. 3a, where two deuterium atoms and 1 Palladium is shown.

The quantum state function: $$\Psi = \sum_{atom}\sum_{element}\sum_{j} C_j\left[R_j\right]\left[S_j\right]\left[T_j\right] \quad (3)$$

where C_j is a coefficient that may be calculated using Clebsch-Gordon techniques for nuclear matter, and

R, S, and T are the spatial, spin and iso-spin pats of the nuclear and atomic parts. This function may be perturbed by the application of electric and magnetic fields and phonon excitation modes as border conditions.

The molecular dynamics formula are performing a good description of the atomic oscillation modes, while the internal nuclear matter behaves like three insulated entities inside the nucleus of the 3 atoms.

A typical example of a nuclear wave function constructed using Racah's method would be:

$$\Psi(j^n,\alpha,I,J) = \sum_{\alpha_1,I_1,J_1}\left[j^{n-1}(\alpha_1,I_1,J_1),j,I,J\right]\left[j^n,\alpha,T,J\right]\Psi\left[j^{n-1}(\alpha_1,T_1,J_1),j^n,T,J\right] \quad (4)$$

where: [$j^{n-1}(\alpha_1,I_1,J_1),j,I,J$] are the coefficients of a fractional part and $\Psi\left[j^{n-1}(\alpha_1,T_1,J_1),j^n,T,J\right]$ is the result of coupling asymmetric n-1 particle wave function to the n^{th} particle.

The Hamiltonian of such a system will be written as the sum of all energy of nuclear masses, nuclei binding energy, electron mass, electron binding energy, electric and magnetic field energy, phonons, or kinetic and potential energy, and that will be represented as a very complex equation, that treats the actual classical cases where this process of non-local nuclear reaction is not possible.

In a formal model based on many-particle Dirac Hamiltonians for the electrons and nucleons:

$$\hat{H} = \left[\sum_j \alpha_j\cdot c\hat{p}_j + \beta_j M_j c^2 + \sum_{j<k} V_{jk}^{nm}\left(r_k - r_j\right)\right]_{nucleons} + \left[\sum_j \alpha_j\cdot c\hat{p}_j + \beta_j m_e c^2 + \sum_{j<k} V_{jk}^{ee}\left(r_k - r_j\right)\right]_{electrons} + \sum_{j,k} V_{j,k}^{en}\left(r_k - r_j\right) \quad (5)$$

The first term in brackets is for a relativistic nucleon, Hamiltonian is including mass, velocity, and potential terms (including strong force interactions as well as electromagnetic interactions).

One may use any nuclear potential, but for simplicity Woods-Saxon potential is used here, and may be written as: $$U(r) = \frac{U_0}{1+e^{\frac{r-R}{a}}} \quad (6),$$ where, for each atomic nucleus where R may be the radius of Palladium or Deuterium, while r is measured from the center of mass of those nuclei.

If we consider the center of the system somewhere in space the total nuclear part Hamiltonian may be written as: $$\boldsymbol{H_t = H_{Pd} + H_{D1} + H_{D2} + H_{Interaction}} \quad (7).$$

That will drive to :

$$H_t = -\frac{h\nabla_{Pd}^2}{2\pi M_{Pd}} + U\left(r - r_{Pd}\delta\right) - \frac{h\nabla_{D1}^2}{2\pi M_{D1}} + U\left(r - r_{D1}\delta\right) - \frac{h\nabla_{D2}^2}{2\pi M_{D2}} + U\left(r - r_{D2}\delta\right) + H_{rest} \quad (8)$$

The only modification we have to introduce in the system in order to allow the nuclear reaction to take place is a "worm-hole operator" δ_{WH} that, when a set of quantum conditions are met and the nuclei are placed in the right positions as $\boldsymbol{r_{Pd\text{-}WH}}$, $\boldsymbol{r_{Pd\text{-}WH}}$, $\boldsymbol{r_{Pd\text{-}WH}}$, the associated term become 0 (zero), bringing the nuclear mass in the same position, all together. $$\delta_{WH} = \delta\left(r_X - r_X^{WH}\delta_{quantumstates}\right) \quad (9)$$

where X := Pd, D1, D2 and a space short-cut appears making the communion between the nuclear mass.

It is possible to reformulate the hypothesis with the wormhole function in an opposite manner: the wormholes are created by each particle as an intrinsic property and they exist distributed in space. Their density is reduced with distance and the presence of electric and magnetic fields, but may extend along outside in special conditions of excitation as the material cluster interfaces in synergistic excitation modes, that are specific to each structure.

It was observed in the fusion experiments that these reactions trend to take place on the surface or in material interfaces, being driven by the material dimensional grains. Prof. Arata showed that very good results are obtained in nano-powders, with emphasis on NiH systems.

A special type of reaction appears in inter-boundary interface and on nano-grain corner reaction, a kind of tip-effect. It reveals a novel kind of movement specific to high D loaded matrices where the D movement is made as a group movement, being practically a collective hopping movement. It is known from hydraulics principals, that with a sudden stop of a long column of moving flow, the inertial forces acting in the fluid column produce a compression wave that propagates forward and backward in the fluid at supersonic speeds as a soliton wave, frequently damaging the pipes and fittings. The same happens in the collective hopping movement, when two opposite movements collide on a PdD interface molecule. A surplus of D atoms is obtained under a strong compression wave that pushes these D atoms deep into Coulombian barrier, possibly penetrating it, or increasing the probability of meeting denser near nucleus passive wormholes and initiating the nuclear reaction.

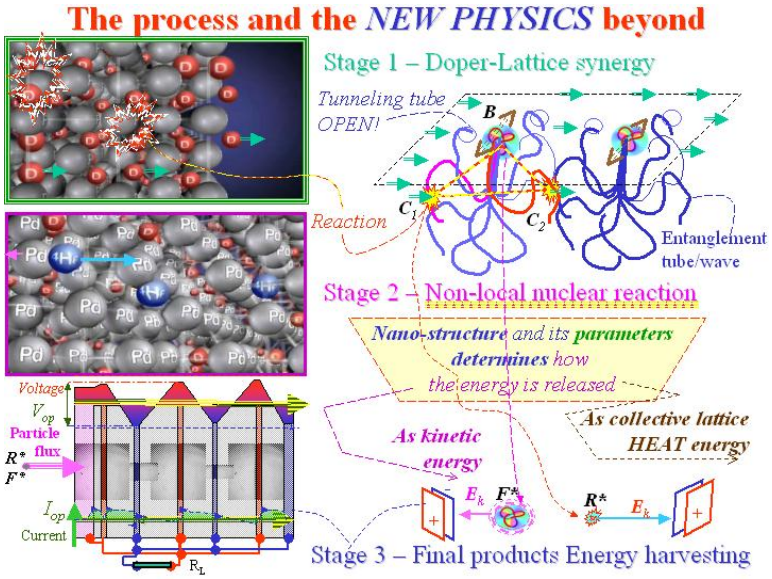

Fig.4–The operation principia of the battery nano-element

The phonon funneling effect is developed for non-parallel compression forces that decompose on the boundaries, creating a stronger evanescent waves that strongly compress the D atoms into the Pd until the passive wormholes activated by the resonant movements having terminals that start to hang outside the electric force-field, generically called Coulombian barrier or nucleus effective radius, where the nuclear potential compensates the electric potential, driving to a stable structure, and meeting with the D activated wormholes making the communion.

When the two structures touch each other, the reaction is initiated and the “nuclear matter communion” takes place as presented in the expanded view in upper-right side of Fig.4 where the Pd and D wormholes touch and react. The experiments of quantum entanglement and teleportation have shown that the entanglement wave decays in time and in natural systems there might be a continuous balance between the rate of newly created wormholes and their decay rate. These rates are controlled by the exceptional excitation conditions that are creating what Ed. Storms calls Nuclear Active Environment (NAE).

In fact, the “new physics” comes into play, by accepting the presence of the wormholes as a manifestation of the multidimensionality of the space, and the presence of the “communion” in a similar fashion as the church presents based on a special excitation and enlightenment.

These special excitation states are the big present mystery, and grace to systems like NiH or PdD where the anomalous behavior was strong, has been observed for 100 years, and has made us think that the Middle Age alchemists practice was brilliant intuition, developed by wishful thinking and performed well in advance the capabilities of doing and understanding the intimate structure of matter-energy and space.

This nuclear active environment is possible by using external energy to initiate the wormhole nuclear reaction, that may generate a fusion, transmutation or fission, control its cross sections or reaction rate and keep the nuclear

reaction channels under control. This research may drive to safe energy devices, but also to extraordinary knowledge and understanding of matter and space, realizing that all the elements of the big-bang, called creation, are homogenously spread in the galactic universe and that it is part of us, being hidden in the fine structure of the fabric of space we are made-of, making the link between micro and macro universes.

III. THE FUSION BATTERY DEVICE

The final goal is to build a functional power source with the burner in the middle, surrounded by direct energy conversion structures (DNECE modules), as shown in Fig. 5 as a block diagram, that are surrounded by cooling devices that use helium to take the heat from the structure and release it in a heat exchanger.

In order to have smooth operation, it has to be fueled with a combustible gas –nuclear burning is envisioned. In the construction configurations where the transmutation released energy is harvested, the burner is deteriorating, and has to be replaced periodically, while in the configurations generating transmutation, with less fusion, the burner has a longer life.

The system is computer controlled and has a system to recover fuel from the cooling agent.

The maximum temperature depends on the input to the burner and harvesting structure, and if it is high enough, it may provide excess thermal energy to electric conversion systems.

Fig. 5 shows a block diagram of the power source that relies on a nano-cluster controlled nuclear reaction. The power source is comprised of an external enclosure, containing the following modules:

- The central burner that contains a “CIci” nano-structure [1] that harvests the recoil energy of the atoms involved in a nuclear reaction. In the central burner the combustible fluid that can contain Deuterium, Hydrogen or Tritium is introduced and reacts with the Palladium, Platinum or Nickel atoms in nano-clusters. In this area, there are means to control the reaction rate by controlling the input parameters such as pressure, temperature, electric field, and input and output flows. The central burner is built on a “CIci” structure that converts the energy of the recoiled nuclei into electricity. An important fraction of this energy will be heat that will be removed from the structure by same liquid flow, carrying the heat outside through a heat exchanger.

- The conversion module that converts the energy produced by fusion into electricity. This module contains the high-energy customized “CIci” structure that converts the energy of alpha particles into electricity. It also uses Helium for cooling purposes. It may also use actinides in the structure to harvest the energy of neutrons emitted by fission and fission reactions.

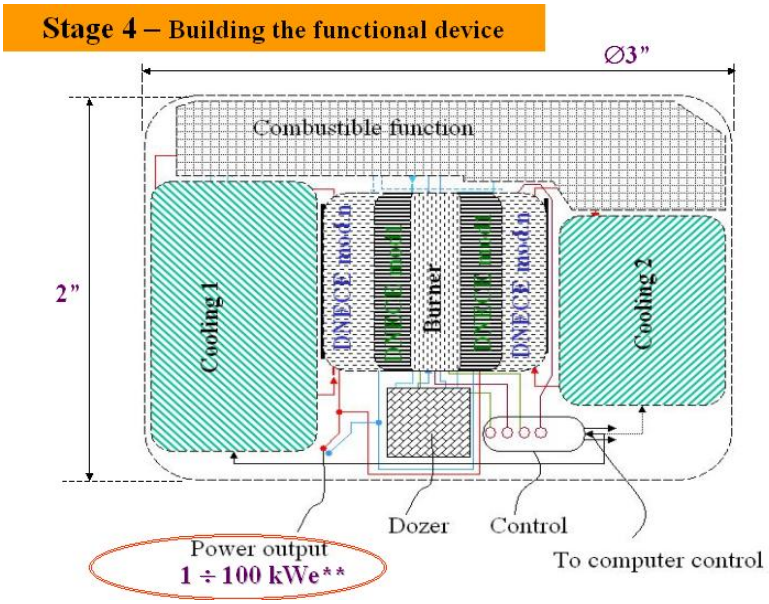

Fig. 5 – The block diagram of a fusion battery

The first charged particle energy conversion module may not contain actinides because it is very thin, compared with what is normally needed to harvest the neutron’s energy and amplify it in fission processes.

The second stage of the direct energy converter that contains “CIci” structures that are customized to utilize slower moving particle energy and that will include robust terminal structures at the edges to prevent dislocation damage. These structures will be cooled by a Helium flow.

To prevent excessive damage the edges, they will have higher porosity and liquid or viscous material trapped in the pores that recover after the edge dislocation process. Another alternative solution is to use special cells that fail-safe and may be easily replaced when damaged.

The third energy conversion stage is placed outside the box because it has high volume, being about 1 ft thick nano-structure filled with actinides exhibiting high cross section, and driving to a sub-critical nuclear fission structure.

The burner converter stage uses a special unit to inject the fluid and re-circulate it for cooling. It uses the same combustible fluid for cooling because there is not much room to separate the circuits. The pressure is dynamically established by a differential pumping method.

- The main fuel system that provides the fuel to the burner system and re-circulates it, cooling and purifying it and preparing it to be reused. The system assumes no leaks of any material contained inside the system.

- The helium cooling system and helium recovery is a closed system attached to each energy converter structure. It cools the harvesting structure in the zone where it has the maximum conversion efficiency and prevents overheating. It, also, recovers the reaction-generated helium and prevents its accumulation in the structure where it may trigger damaging effects.

- The control system controls power extraction systems and power adjustment by integrating the feedback signals coming from all the modules, with those from the external control unit.

The final product, at maturity, will look like that presented in Fig. 6, with a case, containing the cooling system, and ready to be connected at its output terminals. With a size of about 1 cubic foot it may deliver up to 20 MW, a factor of a few million times more than a Li-Air battery. In general, the batteries are similar, they are fed with a gas (air or deuterium) and based on specific internal processes they deliver electric energy at their output terminals.

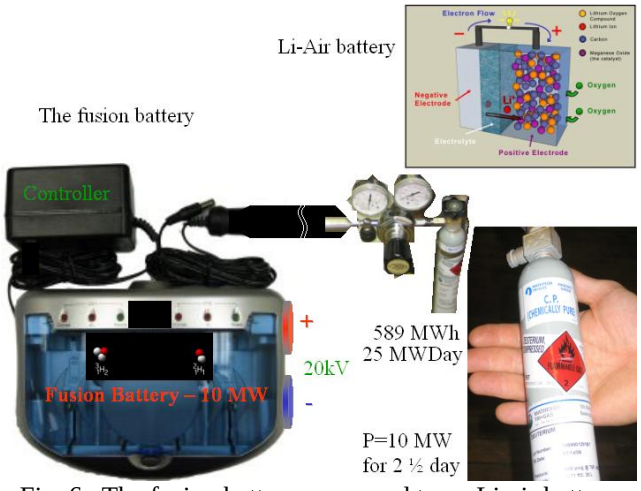

Fig. 6– The fusion battery compared to an Li-air battery

One bottle of 20 liters of Deuterium is all that is needed for an electric vehicle to run over 1 million miles. There are many other applications in space travel, and air, ground, underground and underwater transportation, which will not be mentioned here.

In spite all the knowledge accumulated, I have to state that the field is very broad, and even if a demonstration battery can be build in a relatively short period of time with the appropriate funding and infrastructure, a more extensive research program is needed.

VI. CONCLUSIONS

Power sources created with special material in nano-structures and specific low energy excitation in quantum active environment will enable mankind to have a new and friendlier relationship with nature. With enough energy all other resources may be had at will.

First reliable products may be deliverable in ten to fifteen years with application of serious effort.

Estimated performance of such devices might be:

Device's Specific Energy density:

- 3 GWDay/kg for D-D, D-6Li, H-7Li
- 1 GWDay/kg for H-11B, 3He,

- 50 MWDay/Kg – H-Ni, D-Ni, H-V

One advantage of such device is that it has no storage limitation and no criticality constraints.

The first structures used first may use as power sourceburner materials: Ni, V, Pd, Pt, Th, etc. with the following possible fuel: H,D,T,3He, B.

Energy conversion efficiency may be as high as 95% depending on the details of the design and manufacturing.

Power density depends of conversion efficiency, and heat extraction. The energy not extracted as electricity becomes heat, and has to be extracted as such. For a goal of 95% efficiency and heat extraction of 200 W/cc, the maximum power density is P_d^{Max}= 4 kW/cc, few times higher than the actual nuclear power sources may deliver.

Fusion-Transmutation power source could replace chemical power source reducing the volume requirement by a factor of six orders of magnitude from cubic meter to cubic centimeter. Such power sources could replace actinide based nuclear fuel, obviating criticality hazard, radio-chemical contamination, irradiation hazards and transportation restrictions.

Direct conversion of quantum reaction energy into electricity makes possible to obtain high power density. The heat energy associated with cooling the device can be converted thermo-electrically to boost the overall efficiency of the device even higher, and provide safer, more reliable operation.

New physics insight will emerge from the study of these new reactions in nano structures in the general area of space, entanglement, teleportation, space and matter correlation, synergy of matter and energy.

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REFERENCES

1. Liviu Popa-Simil, *THE FUSION BATTERY, A Novel Type of Nuclear Battery and Potential Outcomes and Applications*. Nuclear Fusion, ed. L. LLC. Vol. Nuclear Fusion. 2012, Los Alamos: kindle e-books. 400.
2. Liviu Popa-Simil, *Meta-material based nuclear structure applications in beamed thrust and space energy harvesting.* 47th AIAA Joint Propulsion Conference and 9th International Energy Conversion Engineering Conference, August 1-3, San Diego, CA, 2011. **1**(1).
3. Edmund Storms, *An explanation of low energy nuclear reactions (cold fusion).* J. Condensed Matter Nuclear Science, 2012: p. 29.
4. Liviu Popa-Simil, *Advanced Space Nuclear Reactors from Fiction to Reality.* Physics Procedia, 2011. **20**(Space, Propulsion & Energy Sciences International Forum - 2011): p. 270–292.
5. J. Tandberg, *Kall fusion redan på 1920-talet.* Patent Application,, 1927. **Sweden**.
6. J. Franck, Goettinger. Ber. II,, 1933. **44**: p. 203.
7. KF Herzfeld, M.G.-M., Z. Phys. Chem., 1934. **26B**(203).
8. Fleischmann Martin; Pons Stanley, *Simple experiment' results in sustained n-fusion at room temperature for first time.* University of Utah., 1989.
9. Fleischmann Martin; Pons Stanley; Anderson Mark W., L.L.J.H.M., *Calorimetry of the palladium-deuterium-heavy water system.* Journal of Electroanalytical Chemistry, 1990. **287**(2): p. 293–348.
10. Liviu Popa-Simil, *The harmony between nuclear reactions and nuclear reactor structures and systems.* ANS-ICAPP12, 2012. **1**(12080): p. 12.
11. H.B.G. Casimir, Proc. Kon. Ned. Akad. Wetensch., 1948. **B51**: p. 793.
12. Yakir Aharonov, D.B., *Significance of Electromagnetic Potentials in the Quantum Theory.* Phys. Rev., 1959. **115**: p. 485.
13. CERN 2 teams, *CERN experiments observe particle consistent with long-sought Higgs boson.* CERN Press release, 2012. **web**.
14. Peter W. Higgs, *Broken Symmetries and the Masses of Gauge Bosons.* Phys. Rev. Lett., 1964. **13**: p. 508–509.
15. Ioan Iovitzu Popescu, *Ether and Etherons; Etheronics – A Possible Reappraisal of the Ether Concept.* Roumanian Academy journal of physics; Stud. Cercet. Fiz, 1982. **34**(1): p. 451-468.
16. Alberto Carpinteri, *Piezonuclear Fission Reactions in Rocks; Evidence from Microchemical Analysis, Neutron Emission and geological Transformation.* http://theatomunexplored.com/wp-content/docs/1carpinteri.pdf, 2012.
17. Liviu Popa-Simil, *Applied Nano-technologies Improves Nuclear Power Safety and Performances*. Nano-technologies in Nuclear Power, ed. L. LLC. 2012, Los Alamos: kindle e-book.
18. Gerhard Burau, J.B., C. Fuchs, A. Faßler, *The Quark Gluon String Model with Quark Recombination.* University of Tubingen, 2011.
19. V.Yu. Grishina, L.A.K., W. Cassing, A.B. Kaidalov, E. De Sanctis, P. Rossi,, *Deuteron photodisintegration within the Quark-Gluon Strings Model and QCD motivated nonlinear Regge trajectories.* http://arxiv.org/pdf/hep-ph/0101129v1.pdf, 2001.