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Coordinatore Prof. Belobrzeckaja Costa Larisa

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Belobrzeckaja Costa Larisa Nikolaevna,  
 PhD in Industrial Chemistry (Milan State University); Master in Chemistry (Saint Petersburg State University)  
 Prof. of the Department of Chemical Engineering and Process "G. B Bonino",  
 Faculty of Engineering, Genoa State University, Via Opera Pia, 15, 16145 – Genova (Italy).

Project: Award "Göde Prize for Gravity Research"

In the last decades of the end of the 20th and at the beginning of 21st centuries the high technological devices, such as mini nuclear reactors and/or atomic weapons, were produced in the field of pacific application of the transformation of electrochemical energy, via nuclear reactions, in clean electrical energy facilities and/or in military devices<sup>1,2</sup>.

a) *Chemistry and Nuclear nature of Low Energy Nuclear Reactions (LERN).*

A simple cell containing anode and cathode was constructed in our laboratory. The solid materials of the electrodes, as an example of good matrix, to capture Deuterium isotopes, were studied in D<sub>2</sub>O medium. A large amount of heat was observed and there was nuclear reaction at room-temperature (the temperature of beginning of the reaction) obtained stably and with good reproducibility. The excess heat was signaled by the extremely high temperature of the reaction explained by the nuclear fusion nature of the process.<sup>3</sup> The observation of a sizeable transmutation of Deuterium into Helium ( $2D \rightarrow 4He + 23,8 \text{ MeV}$ ) confirmed that LERN, so called 'cold fusion' was performed as result of the electrolysis of heavy water.<sup>4</sup> The electrochemical cell 1 (device) is shown on the Figure 1.

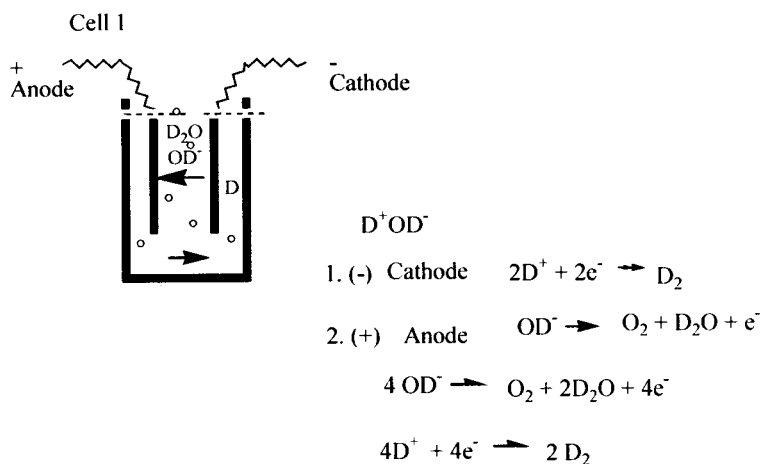
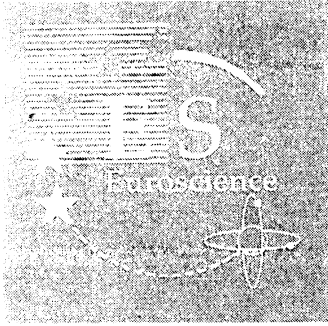


Figure 1. Electrochemical cell 1. (Fe-anode and cathode were using for a cell 1).

It's the first step for experimental investigation of LERN. In according to the electrochemical process a lot of Deuterium gas could be produced. Deuterium could be captured by metal structure. In this kind of LERN neutron (n) is the important source of radioactive particles that overcoming the Coulomb forces (barrier) without difficulties. It's known that the positive charges of nuclei is the principle responsible for the electrostatic Coulomb interaction. The



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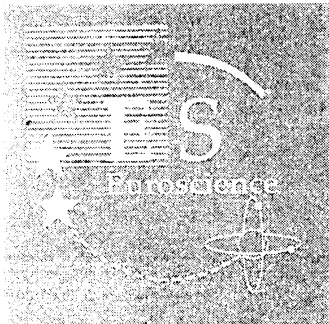
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positive charge (proton presents) in atomic nuclei, in general, are generated the high Coulomb barrier that increasing with growing of the number of charges on particules. In the case of the neutron production the Coulomb barrier is absent, because of no charges on particules. ( $^2\text{D}+^2\text{D}=\text{He} + \text{n} + 3,3 \text{ MeV}$ ;  $^2\text{D}+^2\text{D}=\text{T} + ^1\text{H} (\text{p}) + 4,0 \text{ MeV}$ ;  $^1_0\text{n} \rightarrow ^1_1\text{p} + ^0_{-1}\text{e} + \gamma$  and so on ). A detailed investigation of the impact of D/Fe (steel) plasmas (at ionization level of matrix) could be obtained that the Coulomb barrier must be much more smaller in vacuum according the reference<sup>4</sup>.

The morphology characteristics of cathode products (for example, the transmutation of particules including the catalyst isotope formation which take place in LERN) could be determined in normal, in low or micro gravity environment using the scanning and transmission electron microscopy. It's the second step of the additional studies of the gravity technique. In this case correlation between geometrical characteristic of condensed phase of LERN products and pressure (under high pressure) should be performed according the reference<sup>5</sup> described the effect of gravity level on the condensed products formation.

### b) Gravity effect at LENR under conditions of Zero-point-fluctuation induced force of particle motion.

We must understand how the 'gravitational field' influences the local behavior of point-particle's mass (energy). /Aerodynamics, magnetism and electricity forces are excluded for simplify the analysis of gravity effect (force) at LENR/. Prof. Andrei Sakharov view of gravitation is rather complicated research of elementary particle physics; and elasticity is the research of chemical (atomic) physics. Sakharov proposed that gravity is an elasticity of space that arises from elementary particle physics. It's known that elementary particles do not form a really starting point if we want to describe the nature (matter); elementary particles correspond to a first – order correction of vacuum physics. Vacuum, called 'empty space', is a basic Zero-order state of nature (matter), including huge densities of real photons, existing positive-negative (symmetric) pairs, wormholes (cold-holes) and so on. "Small distances" of vacuum physics studies that means the scale of studies  $\sim(10^{-33} \text{ cm})$ , "large distance" of atomic physics that means  $(10^{-11} \text{ cm})$  reinforce each other in continue process. The energy of an elastic deformation is nothing in confront to energy put into the bonds (binding) between atom and atom by the deformation. The energy that it takes to curve space is nothing in confront to perturbation in the vacuum energy fields added elementary particles (energy) produced by that curvature , according to Sakharov's opinion <sup>6</sup>. In consequence of the discovery of the positive electron (Anderson , 1933) and of many others new particles and radiations it's confirmed that idea of 'empty space' was failed and vacuum represents the great variety and richness of elementary particles. The number of particles is limited because our knowledge of science is limited. There are hundred of distinct bonds all of which contribute to the description of space and elastic constants. Some of binding (bridges and induced) produce by Van der Waal's forces (for example, in the case of LENR in heavy water medium there is described by reaction  $n\text{D}_2\text{O} \rightarrow (\text{D}_2\text{O})_n \rightarrow \text{poly}(\text{dipole})$  of positive-negative charges or in solid of cathode structure as no 'empty space' (vacuum) interactions of Metal  $\rightarrow$  Deuterium  $\rightarrow$  elementary particles  $\rightarrow$  mass/density energies), some from ionic coupling , some from homopolar linkage and so on. It's a system of positively and negatively charged masses moving in accordance with the Law of quantum mechanics. We are concretized our investigation on

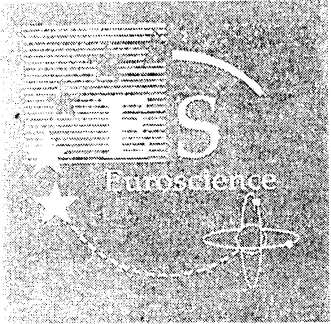


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positive-charged point particles only. Prof. A. Sakharov proposed that attractive gravitational force is similar to the induced Van der Waals (perhaps, we can add “unfrozen” permanent and induced Van der Waals forces) and Casimir forces than to the fundamental Coulomb force. In the case of vacuum application gravity constant  $G$  (Newtonian Gravitational constant) is the finite (small) value in relation with the high (going to infinite) value of high-frequency cutoff of Zero-point fluctuation (ZPF), in which matter presents under the form of (point) particles /partons/ (elementary particles smaller than a proton). Matter is the sum of electromagnetic fields/radiations based on point particle motions that interacts with Zero-point fluctuation (ZPF)-induced particle (electromagnetic) motions. Mass is described by kinetic energy of motion associated with the broad-spectrum ZPF radiation fields produced by ZPF motion of vacuum electromagnetic field. Matter is correspondent to a collection of charged point-mass particles, energy of matter is an assembly (sum) of random electromagnetic forces of particles. Charged and neutral matter take part equally in the gravitational interaction arising from charged point-particle interactions. The vacuum is described as zero-point electromagnetic radiation (mass/energy of motions) according to Fourier energy spectrum based on QED (“transverse self-energy”). The kinetic energy of parton ZPF motion is correspondent to finite value depends of the finite value of ZPF cutoff frequency. ZPF motion of particle is the interior (induced) particle energy including rest (residue)-mass-energy of particle associated with vacuum motion. The internal energy of particles (partons) based on kinetic energy of their motions (of a system motion= of a system contribution motion) to the effective mass (energy) of a system at ZPF of the vacuum. Fields produced the ZPF-induced fields associated to ZPF, Zitterbewegung interior motion of particles (fields). In this case ZPF motions generate the electromagnetic field distribution (fields), mass of system is proportional to frequency times mass squared of electric and magnetic nature of charged point-particles (based on motion). Boyer has suggested that Van der Waals forces act at all distances between a pair of polarizable particles (based on knocked moment of particles associated of the motions, charged distribution on particles, density of charge (mass/energy) in general, and at ZPF of vacuum in particular. The gravity interaction is based on a unipolar charged (positive) kinetic energy of particles and added mass/energy of ZPF (“quantum noise”, introduced interior particle/ electromagnetic mass/energy). The complicated equation (including radiation and induction field is characterized the retarded (enfrozen) Van der Waals interactions (forces) at all distances based on binding (force) at nuclear level under the long-range gravitational interactions and the short-range induction field. In conclusion the gravity is the induced effect associated to ZPF of the vacuum and it’s similar to Van der Waals forces. The formula of (moment of rotation)= (intrinsic (interior) curvature of space/matter/field, that included the huge number of linear vector angular rotations) + (extrinsic (exterior) curvature of space/matter/field) = (density of mass/energy based on exiting motion of particles and fields) is characterized the matter at ZPF of vacuum application. Gravitational mass/energy at LENR must be associated to introduced ZPF motion (particle/radiation) effect and at LENR model for gravity (resulting interests of radiation fields only (the summarizing of fields), binding and radiation-damping forces neglected) could be possible to verify (tested) at



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the effective Planck cutoff frequency of ZPF vacuum (mass/energy of motion) spectrum according to the proposal of Sakharov. <sup>10,7</sup>

Experimental part:

The device of electrochemical cell described in the a) section was prepared. LENR (reactions) were studied at the DiChep "G.B. Bonino", Genoa State University based on the results of private laboratory studies of Prof. Belobrveckaja-Costa L.N.

Low, Micro, Normal gravity effect at the LENR could be studied at the N.N. Semenov Chemical Physics Institute, RAS, Moscow (a. section)

The device could be proposed to study (to test) [Prof. Sakharov theory at LENR under Zero-Point Fluctuation of the Vacuum] at the Göde Institut Gravitationforschung (Moscow State University, Faculty of Physics, the group of Prof.D. Ivanenko/E. Fradkin) (b. section)

Appendix:

\* Sakharov example that Lagrange function of the gravitational field is generated by vacuum polarization effects due to fermions (Theor. Math. Phys. (1975))

Lagrange function  $\mathcal{L}$  of the variation principle for all fields and particles:  $I = \int \mathcal{L} d^4x = \text{extremum}$

$$G \text{ (Newtonian constant of Gravity)} = \frac{c^3}{16\pi B \hbar^2 \int k dk} \quad \text{where "cutoff" is formally divergent integral}$$

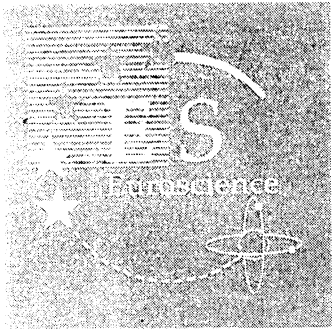
Planck length (value)  $\hbar c_{\text{cutoff}} \sim (c^3 / \hbar G)^{1/2} = 1/L^* = 1/1.6 \times 10^{-33} \text{ cm}$   
 where  $\hbar c_{\text{cutoff}} \sim 10^{28} \text{ eV}$  or  $10^{-5} \text{ g}$  or more, and  $\int k dk$  is cut off.

$$G = \frac{\pi}{2} \frac{c^5}{\hbar \int_0^{\omega_c} \omega d\omega}; \quad \omega_c = \left[ \frac{\pi c^5}{\hbar G} \right]^{1/2}, \quad \text{where } \omega_c \text{ is an effective Planck cutoff frequency of ZPF vacuum spectrum.}$$

$$\langle F \rangle_{\text{average force}} = -\frac{Gm^2}{R^2}; \quad F = -\frac{\hbar c \Gamma^2 \omega_c^2}{\pi R^2} + \dots; \quad \text{where } m = \frac{\Gamma c^3}{G}; \quad m = \frac{\langle E \rangle}{c^2} = \frac{\Gamma \hbar \omega_c^2}{\pi c^2}$$

$$\omega_0 = 0 \quad U = -\frac{9}{4} \frac{\hbar c^3 \Gamma^2}{\pi} \text{Re} \int_0^{\omega_c} \frac{e^{-2\omega R}}{R^2} \left[ 1 + \frac{2}{\omega R} + \frac{5}{(\omega R)^2} + \frac{6}{(\omega R)^3} + \frac{3}{(\omega R)^4} \right] d\omega$$

equation of Vander Waals forces at all distances



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