

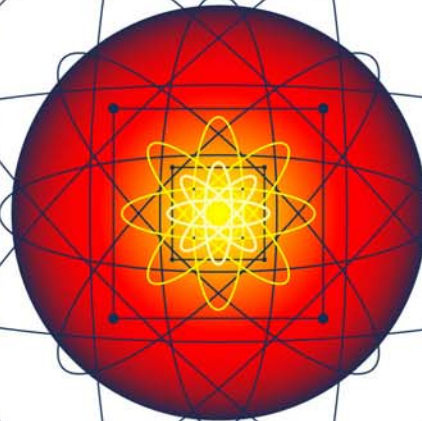
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PROGRAM
ABSTRACTS

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ABSTRACTS

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The conditions and realization of self similar Coulomb collapse of condensed target and low energy laboratory nucleosynthesis

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The problem of stability of condensed target in particular and stability of "usual" atomic form of matter in general in relation to the process of self-squeezing up to the collapse state is studied.

It was shown for the first time [1] that for a neutral atom compressed by external forces, a threshold electron density is shown to exist. If such a density is reached, a self-organizing process of "electron downfall to the nucleus" starts. This process is exoenergetic and leads to the formation of a supercompressed electron-nuclear cluster. The higher the charge of a nucleus, the lower the threshold of the external compression. The method of realization of such requirement was studied.

We considered peculiarities of the evolution of a region with sharp boundaries that is filled with a partially ionized plasma and is a part of the volume of a condensed target. The creation of such a region in the near-surface layer of the target can be related to the action of an external impulse symmetric ionizator or to the action of an intense small-extension shock wave on the target surface. We defined the conditions such that their fulfilment during the establishment of the equilibrium between the Coulomb attraction of electrons and ions with atom ionization multiplicity Z^*_1 and the kinetic pressure of electrons causes both the compression of this region and its ionization to the state with $Z^*_2 > Z^*_1$. The last leads to a further additional compression and ionization. Under these conditions, the spontaneous avalanche-like ionization of atoms of the target to the state of "bare" nuclei occurs synchronously with the avalanche-like metallization and the self-compression of the target. We showed that the avalanche-like ionization and the self-compression of the target happen in the case where the gas of degenerate electrons has drift momentum.

If the region with initial ionization has the form of thin spherical layer, the process of avalanche-like ionization and self-compression of the target in this region is accompanied by the accelerated movement of the plasma layer to the target center. One of the reasons for the accelerated movement is the surface tension in a bounded domain of the nonequilibrium plasma layer (degenerate electron gas neutralized by ions of the target). With increase in the velocity of movement of this layer to the target center, the additional self-compression of the system of electrons and nuclei to the state of degenerate electron gas occurs. At the leading edge of the running layer with extremely high electron density which is neutralized by nuclei of the target, the formation of a collapse of the electron-nucleus system proceeds, and the binding energy maximum for the electron-nucleus system shifts from $A \approx 60$ to $A \gg 60$. This result makes possible the fast synthesis of superheavy nuclei. The decay of the collapse state, a partial restoration of the target structure, its rapid cooling, and the condensation of a part of the products of nuclear reactions happen in the target volume at the trailing edge of the moving plasma layer. Upon such a scanning propagation of the wave with high electron and nucleus density, all the target substance is involved, step-by-step, to the process of nuclear transformations. At the target center, the moving plasma layer is squeezed with the formation of the state of quasistationary collapse under inertial confinement. Then the collapse state decays irreversibly.

It is assumed that only such mechanism of synthesis explains the creation of stable superheavy and other anomalous nuclei, the process of deactivation of any kinds of radioactivity in the collapse zone and creation of additional energy $Q = 10^2 \dots 10^5 Q_0$ (in relation to the energy of driver Q_0) observed in the experiments carried out at the Electrodynamics Laboratory "Proton-21".

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Progress in the study of isotopic composition in metallic thin films that have undergone electrochemical loading of hydrogen

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Research activity began some years ago in collaboration between the ENEA (Italy) and the SRI (USA), aimed at the identification of traces of matter left by nuclear reactions in condensed matter. This work also involved cross linked analysis in order to identify effects due to contaminants that could affect the isotopic shift estimate.

Nickel thin films have been sputtered on a polymeric substrate and loaded with hydrogen by electrolysis. Reference and active thin films have been prepared contemporaneously during the same sputtering to have on both the same deposition and the same impurities composition.

Secondary Mass Spectroscopy (SIMS) has been used to analyze the isotopic composition of the electrolyzed and blank substrates.

The results indicate that a reasonably reproducible apparent shift of the isotopic composition of the Cu element occurred in some of the electrolyzed films, with an increase of mass 65, while the natural value was always observed for all the blank samples. Cu was particularly suitable for use as a marker elements because of it has only two mass isotopes (63 and 65) that do not overlap with isotopes of other elements having the same masses. The possible contribution from double ionized elements was ruled out because 126 and 130 mass elements were absent. Furthermore, during the measurements the tuning of the instrumentation on the target masses was checked by moving the argon beam to the stainless steel samples support where the Cu isotopic composition was always the natural one. Depth profile analysis has also been performed, in order to reduce the possibility of organic species surface contamination and the effect of the polymeric substrate on the measurements: an increasing of the C signal due to the substrate was coupled with a decreasing signal of other species but without any change in the Cu isotopic ratio.

In addition mass spectrometric analysis of the electrolyte revealed no evidence of organic compounds above 10 ppb, that could produce C₅H₅⁺ fragments under ion bombardment.

Despite all the above mentioned results lead to exclude a contaminant effect on the 63/65 shift a research work is in progress in order to exclude that the revealed shift is traceable to an artifact.

Review of Recent Work at ENEA

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The recent research activity in the field of Condensed Matter Nuclear Science at ENEA is oriented toward material science and laser triggering in order to increase the reproducibility of excess of power production during loading of palladium with deuterium.

Isoperibolic calorimetry in gas phase, isoperibolic and flow calorimetry with electrochemical systems have been carried out.

Nuclear ash detection has been performed with a high resolution, high sensitivity mass spectrometer. Material science studies allowed us to obtain palladium showing high solubility for hydrogen isotopes and giving deuterium concentration at equilibrium larger than 0.95 (as D/Pd atomic fraction), with reproducibility above 90%.

Excess power production using the above mentioned material achieves a reproducibility up to 50% without triggering.

Laser irradiation with a proper polarization seems to have a significant role in further improving the reproducibility of excess power production. Heat bursts exhibit an integrated energy at least 10 times greater than the sum of all possible chemical reactions within a closed cell. The energy gain calculated at the end of the experiments is observed with deuterium but not with hydrogen.

Preliminary measurements give a ^4He signal in reasonable agreement with the expected values by assuming a $\text{D}+\text{D} = ^4\text{He} + \text{heat}$ (24 MeV for event) reaction.

Substances of Double Structure Cathode (“DS-cathode”) Present Essential Conditions Causing Solid-state Deuterium Nuclear Fusion (“Cold Fusion”)

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In electrolytical experiments with Double Structure Cathode (“DS-Cathode”), abundant reaction products (helium and excess energy) from deuterium nuclear fusion within solid (“cold fusion”) were exactly detected. Using D₂O or H₂O-liquids as electrolytes with Pd black, nano-particles or bulk metals as cathode materials, “cold-fusion” has been caused in both Pd black and nano-particles under pure D₂O-electrolyses, but never for bulk metals, and for all these cathode materials under pure H₂O-electrolyses.

To confirm exact requirements for “cold fusion” in cathode bodies, the following conditions are necessary;

1) Cathode bodies must be clean: Cathode body should be kept generally in high vacuum for a long period ($\approx 150^{\circ}\text{C}$, $\approx 50\text{hrs}$, $\approx 10^{-7}\text{torr}$) before experiments.

2) As a nuclear fuel, pure deuterium with higher density than host atoms of the clean cathode body are necessary. The best condition to cause “cold fusion” is to generate “Pycnodeuterium” (ultra high density deuterium) which is dispersed innumably inside sample solids.

3) To clarify the reaction events (reaction products, excess energy), experiments should be continued at least over 1000hrs. When the experiment period is several hundreds hrs, sometime misjudgments will be caused.

4) , It is well known that He never escape from metal and cannot penetrate metal from outside at room temperature. When the sample solid is metal in which helium (He) is produced, after the experiment the sample metal should be heated above 1000°C . In this process, if He exists inside the sample metal, He is certainly released from the metal to outside and is clearly detected using QMS.

We performed exactly the above four items using DS-cathode, and “deuterated sample solids” (metal/peculiar metal oxide) kept in DS-cathode were heated at $1000\text{-}1300^{\circ}\text{C}$. As a result, abundant He was released into QMS with residual deuterium in a high vacuum (10^{-7} Torr) at high temperature (just 1300°C).

Do Conjectures of Schwinger, Turner, Chubb, and R. Bush Resolve the Chief Challenge to Cold Fusion Theory?

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It is now widely acknowledged [cf. McKubre, Storms, *et al*] that the principal reaction in the F&P effect has been demonstrated to consist of fusion of deuterons to alpha particles in $Pd.D_{1.0}$. And those most experienced in researching the Randell Mills effect (e.g. M. Swartz) believe that the source of excess enthalpy in electrolysis of ordinary water with Ni cathodes is the exothermic fusion of protons to create deuterons.

So an intelligent layman (or scientist specialized in other fields) when confronted with the claim that heavy water but *not* ordinary water works in the presence of Pd , whereas with Ni the *opposite* situation is empirical reality, might take an initial, simplified, overview that there are Four Pairs of Lattice-Host and Embedded-Particle combinations: $\{ (Pd | D), (Pd | H), (Ni | D), (Ni | H) \}$ and that the question of suitability for CF is a “binary event” choice of YES/NO for each of the four pairs. Because the hosts and particles are unrelated, these binary events are similar to coin-flips in probability theory, with an *a priori* 50:50 chance of being correct in any one of the four instances, and so there is a $1 - (1/2)^4 = 1 - (1/16) = 1 - 0.0625 = 0.9375$ or 94% probability that any theory which discriminates correctly in ALL FOUR CASES is not correct merely by coincidence.

After publishing a review of some 371 published CF theory-papers, Mario Rabinowitz told me that the ability to discriminate correctly even among the first two pairs was a challenge that no CF theory of which he was aware could meet by citing explicit analytical formulae [not merely generalized formulae which “implicitly” solve all problems if they could be solved numerically, which is not practicable]. Therefore in a discussion with a sophisticated theoretician who has followed this field closely for 14 years I ventured the opinion that “to pass the Rabinowitz Acid Test” is the chief challenge to CF theory at the bedrock level. To the contrary, he opined, “This is not the biggest question. I put it to you that factors related to electronic structure, loading, and related factors, and their role in the phenomena must be addressed.” While agreeing that, of course, the anticipated, eventually complete CF theory must include numerous complications, I argue that for a first cut at the CF enigma, the chief challenge is that specified.

Furthermore, from June 1991 (in a Patent Application and internet postings and widely-distributed e-mail) I have been taking the position that this Chief Challenge was already solved in 1990 by the late Nobel Laureate, Julian Schwinger, when at ICCF1 he conjectured that the ratio $\sigma = L/\Lambda$, “contains within this single number a summary of all of the forces at work in the lattice,” where L = lattice period length, and Λ = the rms amplitude of the Zero Point Fluctuations (ZPF) of the bound particles in the embedded lattice at absolute zero temperature. Notice that L is independent of the choice of embedded particle, and that although Λ does depend in part on L , it also depends upon the mass of the particle, which is quite independent of the choice of host lattice. Therefore for any given choice of {host | particle} pair, the ratio σ is a strictly empirical number. Furthermore, in [1]-[2] I claim to have “proved” the validity of the Schwinger Conjecture, in the hypothetical case of 100% loading [*i.e.* $Pd.D_{1.0}$] as follows:

(i) In a simplified/idealized 1-D or linear lattice, using point-particle assumptions, I have developed a closed-form *periodic* Coulomb/Madelung/Fermi-Thomas/Mott potential $V(r) \equiv V(r + 2.L)$ which is sufficiently realistic to correctly PREDICT the strictly empirical ratio σ in the first of the above 4 cases to an accuracy of 99.7% of measured reality, where according to Turner and to S. Chubb, by *Bloch* the PERIODICITY of V is all-important;

(ii) following Turner in using standard QM (as in Bohm's classic book) I proved that the above YES/NO answer is equivalent to whether or not σ/π is closer to an ODD integer than to an EVEN one, whose physical interpretation is whether a de Broglie wave for an excited particle fits into the potential well between two adjacent bound particles.;

(iii) Bush's conjectured spectrum of resonant transparency of the Coulomb Barrier on either side of said excited particle is a function of basic constants of physics & mathematics, and of NOTHING ELSE but Schwinger's ratio σ ;

(iv) using empirical data from Chubb & Chubb, I successfully applied the preceding σ/π test not only to the above 4 pairs, but to 3 new pairs which had not been published in 1991, thereby showing [1] the presciently predictive power of Schwinger's Conjecture, with a Confidence Limit of $100.(1 - (1/2)^7) = 99.2\%$ that this is NOT a coincidence!

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Calorimetric & neutron diagnostic of liquids during laser irradiation

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Experiments with laser irradiation were performed on different liquids in special working cell. A red semiconductor laser ($\lambda=655 \pm 25$ nm) & power output \sim mW was used. Every time before, during and after laser irradiation calorimetric & neutron diagnostics were performed. For calorimetric diagnostics, a semiconductor thermo resistor (sensitivity $\sim 0,05^\circ$) was used. For neutron diagnostics, gas (BF_3 & He^3) neutron counters were used. All measured results are discussed.

Search for erzion nuclear catalysis chains from cosmic ray erzions stopping in organic scintillator

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In the framework of Erzion model, charged cosmic ray Erzions stopping in organic substance begin to create Erzion nuclear catalysis chains with frequency of ~ 100 MHz during ~ 10 - 100 ms. Using an organic substance (plastic) scintillator we can observe long & flat (10-100 ms) pulses of large amplitude (~ 100 MeV). No elementary particle can imitate such pulses. It is expected that such pulses in a plastic scintillator with mass of 100 kg will appear at the sea level every week. Such pulses can be observed every day with the Spectrometric Scintillation Super-Telescope (SSTIS) built at IZMIRAN for cosmic rays monitoring.

Room-temperature nuclear fusion materials for producing high energy effect in heavy water by electrolysis

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A simple cell containing an anode and a cathode is constructed. The solid material of the electrodes are studied in D₂O medium, to determine whether it is a good matrix for the capture of deuterium isotopes. A large amount of heat is observed, and a nuclear reaction at room temperature (which is the reaction initiation temperature) can be obtained with stability and good reproducibility. The excess heat is signalled by the temperature of the reaction rising extremely high, and can be explained by the nuclear fusion nature of the process.

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Experiments on spontaneous molecular-nuclear transitions $6\text{LiD} \rightarrow 8\text{Be}$

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In the general case, coupling between molecular and nuclear states in few-atomic systems is negligibly weak due to Coulomb repulsion and the short-range character of nuclear forces. Recently, in works of V. Belyaev and co-workers^(1,2) cases of significant amplification of this coupling were considered. A necessary condition for this effect consists in coincidence of energy of nuclear resonance states with a threshold for their decay via two- or three-body channels. Earlier experiments were carried out with the water molecule⁽³⁾. Spontaneous molecular-nuclear transition (SMNT) $\text{H}_2\text{O}^*(1^-) \rightarrow 18\text{Ne}^*(1^-; 4.522)$ has been searched for with a result of upper limit for water molecular systems: $T_{1/2} \geq 10^{19}$ y. Another promising case of SMNT is $6\text{LiD} \rightarrow 8\text{Be}^*$, where 8Be is expected in highly excited state (2^+ ; 22.28 MeV), coincident in energy with a 6LiD molecular state. The case presents a good opportunity for high sensitivity measurements, because the finite nuclei arise in a state decaying by double α -decay with each α -particle energy $E_\alpha \approx 11.2$ MeV. Two series of experiments were carried out with the use of two and three planar semiconductor detectors. Preliminary data obtained with two-detector technique were reported in⁽⁴⁾. These results showed presence of background double coincidences at a rate of few events per day, due, as it seemed, to secondary cosmic particles bombarding detectors (products of nuclear fragmentation). In new series of measurements, to eliminate these events, an additional charged particle detector, operating in "veto" mode for products of nuclear fragmentation, was included. The new data on considered case of SMNT demonstrates a prospect of this direction of studying exotic spontaneous nuclear fusion reactions. Also, future, much more efficient experiments with $\text{H}_2\text{O}^* \rightarrow 18\text{Ne}^*$ and $6\text{LiD} \rightarrow 8\text{Be}^*$ systems are discussed.

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Energy-Efficient Calorimetry in Glow Discharges

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This work aims to develop a low-powered calorimetric glow discharge process similar to that reported by Dardik, et.al. at ICCF-10, and to use this process to test a wide range of cathode materials, electrode coatings, gas types, gas pressures, and power input levels. The strategy is to use a large number of very similar units so that the calorimetric response does not vary significantly for a given power level. The design is metal or sealed glass cylindrical tubes, charged with 0.4 to 50 Torr mixtures of deuterium, hydrogen, argon, and helium gases. The tubes have small mass (<400 grams) to enhance their sensitivity to excess heat, and they are designed to allow visual observation of the discharge, on-line spectroscopic analysis of the gas to follow any changes in composition, and replication of the geometry and thermal mass during numerous changes in electrode composition. The discharges are presently powered by energy-efficient 40 khz, 3500 volt AC output – 12 volt DC input power supplies. Calibration is by heat from resistors with known power input from regulated power supplies. Electrodes use nickel, copper, palladium and a variety of nanoscopic materials.

The glow discharge has distinct advantages over the electrochemical approach because it can be operated at much reduced input power and can operate over a much wider range of temperature. Hence, if excess heat is produced, the heat will be more widely useful. Also a wide range of elements can be applied at either of the two electrodes without regard to their compatibility with a water-based electrolyte. Finally, we have made substantial effort to reduce energy input so that excess energy signal will be more distinct.

Preliminary data will be presented.

Excess heat production in an electrolytic cell using a polymer as a solid state electrolyte

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A novel gas phase electrochemical method has been used to load palladium. In this design, we use a palladium foil as a cathode, and two palladium foils as anodes. The cathode is sandwiched between the anodes, separated by a PEO (Poly Ethylene Oxide) based solid state proton conductor electrolyte. The system is placed in an all metal cell in which deuterium gas is introduced. The anodes are in contact on one side with the gas, and load very quickly up to a D/Pd ratio of 0.575. The other one being in contact with the POE based electrolyte. Then slowly the deuterium gas diffuses through the POE layers and reaches the cathode that gets loaded. When an equilibrium is reached, a voltage is applied between anodes and cathode, and more deuterium are pushed inside the cathode. We report loadings of up to 1.2 using Violante's cathodes that have been cold worked and heat treated. Loadings are calculated by the pressure drop in the chamber.

Experiments are conducted in a temperature controlled environment. Typical runs are done at 80°C. Our calorimetry allows us measurements of 1mW of power. We have applied DC as well as AC and DC+AC Voltages. We will report the first excess heat results.

Towards a robust model of nuclear interactions in deuteron bands

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The ion band theory of deuteron fusion due to Chubb is reworked in terms amenable to mathematical analysis and further refinement using standard methods of solid-state and statistical physics. Using realistic generic models of various metallic deuterides, each of the preconditions for radiation-less deuteron fusion is investigated and shown to be plausible. In particular, the effective annulment of the Coulomb barrier between degenerate states is shown to be the natural corollary of the local density approximation. The direct relationship between nuclear metastability and coherence length is quantified and the relaxation times of phonon-mediated decay modes estimated. The impact of Bose-Einstein statistics on the onset of appreciable fusion probability is highlighted and quantified.

Photon and particle emission, heat production and surface transformation in Ni-H system

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Results obtained in many experiments are presented, with a particular focus on the experiments in progress. Photon emission during the preliminary phases of activation and $^1\text{H}_1$ isotope absorption are shown; their correlation with the kind of surfaces (Ni and its alloy) and with neutron and other particle emission in the excitation progress and in large heat production (up to 70 W produced for some months) is also presented. Finally the SEM-EDAX analysis of the sample surfaces after some months of heat production is shown; new elements (not present in the initial analysis) appeared. The high concentrations of these elements with atomic number between Zn and C, is compared to the unmodified parts of same samples that remained inside the cell, outside of the activated region.

The Role of Surface Plasmons in Triggering Low Energy Nuclear Reactions

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This study deals with both the theoretical and experimental aspects of Surface Plasmons (SP) excitations. Surface plasmons (polaritons) are quanta of plasma oscillations created by the collective oscillation of electrons on a solid surface.

Surface plasmons may be generated by mechanisms able to produce charge separation between Fermi level electrons and a background of positive charges (i.e. lattice atoms):

1. Electron beam
2. Laser stimulation
3. Lattice vibrations = Phonons
4. Charged particles impinging on a surface

The change in zero-point energy of the surface plasmon oscillator system precisely corresponds to the classical image potential energy. External point charge induces a polarization charge density in a metal that is identical to the distribution induced by a set of surface plasmons. The existence of plasmons has been revealed at the Gas/Metal and Electrolyte/Metal Interfaces

A strong electric field enhancement arises during surface plasmons excitation. This phenomenon could be explained both with classical or quantum mechanical considerations.

As a surface phenomenon, SP excitation is strictly dependent on the physical and morphological properties of the interface between metal and non-metal media: while bulk plasmons frequency ω_p is a constant typical of the considered material, the SP one, ω_{sp} , is also a function of boundary conditions, i.e. non-metal dielectric constant and metal surface roughness^[4]. The latter condition is quite interesting when using a laser beam incident on metal surface to excite SP. To obtain SP excitation in this way one has to fulfill the matching condition between laser wave vector and SP vector's real component; such an excitation is theoretically not allowed on a smooth interface, because both energy and momentum conservation could not be respected: Sp's dispersion law lies on the right of light line of laser radiation. An interfacial corrugation could act as a diffraction lattice, increasing incident radiation wave vector, thus satisfying the requested matching condition: If roughness has a sinusoidal profile with period a , wave vector is increased of a quantity $2\pi n/a$, where n is an integer. As mentioned before, external charges act as a set of SP: an external triggering, such as laser beam, could force the electrolytic system to realize the same conditions causing the rise of events perhaps proving the occurrence of LENR.

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Innovative procedure to measure, in situ, resistive thermal coefficient of H(D)/Pd during electrolysis and cross-comparison of new elements detected in Th-Hg-Pd-D(H) electrolytic cells.

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In the framework of Cold Fusion studies devoted to detect excess heat, one of the most important parameters is the Deuterium (D) over Palladium (Pd) ratio.

It is well known that the value of such a parameter is related to the normalised resistivity (R/R₀) of D-Pd system: e.g. its maximum value, 2.0, is equivalent (at room temperature) to a D/Pd ratio of about 0.75. By further increasing the D/Pd the (R/R₀) starts to decrease. When at high D/Pd ratios, (that is at low R/R₀ values) there is some excess heat, the Pd temperature increases and, as a consequence, the apparent R/R₀ value increases, which is the same result as if a degassing (decrease of D/Pd ratio) occurred, giving raise to ambiguous data interpretation.

In order to solve such a problem we developed an innovative experimental set-up and a procedure allowing for the measurement of the Resistive Temperature Coefficient (affected *only* by real D/Pd ratio), in situ, during the electrolysis. We will show data both on Hydrogen and Deuterium loaded thin (50 micron), and long (60 cm) Pd wires, immersed in a solution of C₂H₅OD (or C₂H₅OH) and D₂O (or H₂O), with addition of Thorium (Th) and Mercury (Hg) salts at micromolar concentrations.

Another important result of Cold Fusion studies is the experimental evidence of a sort of “transmutation” of some of the elements present on the cathode surface, along with the Pd itself: Th and/or Hg in our specific experiments (before, instead of Th we used Strontium and Barium).

The experiments were performed using both Hydrogen and Deuterium based electrolytic solutions. Unexpected elements have been detected by high resolution ICP-MS analysis. Some of these elements have also an isotopic composition different from natural one.

Framework for Understanding LENR Processes, Using Conventional Condensed Matter Physics

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Two important sources of confusion in theoretical descriptions of low energy nuclear reactions (LENR's) have been: 1. Over-simplification, and 2. the language about the underlying electrodynamics (ED), and its role in coherent effects. In particular, as I emphasized previously[1,2,3], mainstream ideas about the treatment of ED, and its quantum mechanical generalization, QED, as it applies in systems at room temperature (the field of many-body physics, in condensed matter systems) have been largely ignored. A key point is that through wave-like effects that can occur in condensed matter systems, it is possible for large amounts of momentum to be transferred instantly to distant locations, without requiring that any particular particle (or particles) acquire high velocity. In [1,2], I provided a context for explaining how this can occur through a combination of structural effects (related to crystalline order) and dynamical changes (resulting from momentum fluxes of charged particles) at the boundaries of ordered regions, and through a phenomenon (Broken Gauge Symmetry), in which many particles coherently move, at once. In [1], I explicitly identified features associated with the electronic structure of fully-loaded Palladium (Pd) Deuteride (PdD_x , $x \rightarrow 1$) that explain how this can occur. In particular, the electronic states in PdD, in the immediate vicinity of the Fermi Level, are delocalized and have small overlap with the octahedral site region locations of the D-nuclei (deuterons d's). Because of this fact, in finite PdD crystals, outside forces are always needed in order to sustain high loading, and slight variations in loading are required to induce long-range coupling, through vibrational modes that have conventionally been thought to involve acoustical phonons. In fact, in the limit of small variations in loading, these vibrations, are not *conventional* phonons because the associated coupling does not conserve the number of d's that are present in the crystal. Instead, in the extreme low-temperature limit, a more appropriate starting point is the Ion Band State picture[4] in which each d effectively occupies a delocalized state, similar to the delocalized (Energy Band) states that electrons occupy in ordered solids. In [2,3], I use a generalization of a well-known procedure (Multiple Scattering Theory) in order to explain how the initial Ion Band State picture[4] is related to a more complete description of the nuclear physics problem and to situations in which disorder is present. In [1], I generalize these results to finite size crystals, with real boundaries. In fact, the essential physics of these papers[1-3], which involves identifying relative time-scales associated with particular transient, resonant processes, is really quite general: it can be re-expressed using standard many-body physics techniques (for example, conventional R-Matrix Theory[5]). Within this context, it is possible to identify relationships between particular theoretical approaches (Unified Phonon-Coupled SU(N) Model/Resonant Group Method[6], and Li's resonant tunneling semi-phenomenological model[7], for example) that involve resonant processes and the Ion Band State[1,4] model. In the paper, I examine this relationship and the importance of certain features (for example, boundaries) that can be included within the more general approach[1-3] that are not included in [6] and [7]. Although Generalized Multiple Scattering Theory (GMST) is based on a rigorous, formal solution, of the many-body problem, because it is expressed in terms of momentum fluxes at various boundaries, it is possible to calculate the rates of reaction associated with particular processes, using approximate numerical calculations of wave functions in particular regions of space. For this reason, through GMST, in principle, it is possible to use detailed computations to monitor the accuracy and limits of the particular model assumptions about the dominant processes that are involved in a specific LENR.

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Potential Role of Magnetism in Laser-Induced Excess Heat and Other LENR Phenomena

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Cravens and Letts¹ (CL) and Letts and Cravens² (LC) presented possibly the most important sets of results at ICCF10, and in the subsequent Proceedings papers. In particular, in LC, a particular protocol was presented and identified for triggering Excess Heat, In both the LC and CL papers, an applied (DC) magnetic field was used with a specific orientation, relative to an applied Laser field. A potentially important point is that although in their papers, CL and LC provided different information, an important common theme was used (associated with the orientation of the linearly polarized laser) and the plausible idea that electromagnetic (E.M.) coupling involving magnetic effects could be important. Subsequently, triggering, based on a similar form of Laser stimulation was reproduced, and the associated efforts were reported by Ed Storms and Mike McKubre during ICCF10. In fact, it is possible to provide a reasonable hypothesis that can be used as a starting point for understanding these results that is consistent with a conjecture associated with the importance of the magnetic effect, suggested in both LC and CL. Specifically, particular, novel features associated with the nature of the underlying microscopic physics suggest a somewhat counter-intuitive phenomenon : that the magnetic effect could be associated with the requirement that a preferential path, direction or configuration be established in which the combined spin of potentially interacting deuterons (d's) coherently approach vanishing value. In particular, because the matrix elements associated with conventional $d+d \rightarrow {}^4\text{He} + \gamma$ involve coupling to the E.M. interaction at distances that are far from the reaction and require that the final state has vanishing spin (since the lowest energy forms of coupling lead to a final state involving ${}^4\text{He}$), the reaction occurs only when the d's are oriented so that asymptotically far (on the length scale of nuclear reaction) from the reaction, they also have vanishing spin. When it is assumed that these states are also prepared in such a way that the overlap of ionic ${}^4\text{He}$ (for example in Ion Band States) with electrons be suppressed except in regions and along directions that favor a release of ${}^4\text{He}$ to regions outside the solid, a plausible case can be made that the magnetic effect observed by CL and LC is related to triggering. The associated hypothesis is consistent with a particular idea (associated with the requirement of eliminating helium-4 from the crystal) that Talbot Chubb and I made many years ago. Because magnetism has not played a direct role in most (if at all) LENR processes, it was not included in the earlier formulations of our theory^{3,4}. However, indirectly (as in the LC and CL work), it is conceivable that in a number of situations, it could help to trigger coherent effects. Besides discussing the potential role of magnetism in triggering Excess Heat in the CL/LC work^{1,2}, in the presentation, I also discuss a generalization of the ICCF10 paper³ that can be used to study the effects of magnetism in other LENR processes.

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Bloch Ions

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Wave function coherence plus a partitioning of nuclear charge appear to be a requirement for LENR, including Fleischmann and Pons cold fusion. Bloch ion wave functions¹ have the required characteristics. The D+Bloch ion is compared with the D₂ molecule, which has independent deuterons sharing a common potential well. Drawings compare a D₂ molecule trapped in a harmonic well with a 2-D+Bloch wave function trapped in multiple potential wells furnished by a metal lattice. The center of the D₂ molecule is distributed as a Gaussian within the harmonic well. The 2-D+Bloch wave function resembles the spin-paired 2-electron orbital that neutralizes the He nucleus and plays a role in chemistry. Both paired particles are subject to coordinate exchange symmetry, but differ in that the 2-D+Bloch ion density has local maxima in multiple potential wells, whereas the spin-paired 2-electron density has a single maximum in a single potential well. The 2-D+Bloch wave function resembles Bloch-state electrons in a metal in that both are characterized by coherent partitioning over multiple potential wells. Their wave function phases are ordered with respect to position and can only change in concert. The partitioned coherence of Bloch electrons gives the metal its high conductivity. Both types of Bloch particles are described by periodic symmetry formed in response to the periodic order of a hosting atom lattice.

The 2-D+Bloch double ion, like the D₂ molecule trapped in a harmonic well, has six degrees of freedom. It is best expressed in "center-of-mass, separation" coordinates $\{r, r_{12}\}$, where the r dependency describes a density distribution in the lattice and the r_{12} dependency describes an internal structure. The distinguishability of the two D+Bloch deuterons prior to coordinate exchange is formally expressed by starting with independent Bloch functions in configuration coordinates $\{r_1, r_2\}$. The coordinate transformation to $\{r, r_{12}\}$ results in a double Bloch symmetry in which both r and r_{12} dependencies are Bloch functions. The r_{12} dependency expresses an anticorrelation behavior in which the 2-particle wave function has reduced magnitude near $r_{12} = 0$ modulo R_{12ij} , where R_{12ij} is a lattice vector in r_{12} space. A decreasing degree of anticorrelation, described by cusps, reduces cusp amplitude and increases wave function overlap with increasing N_{well} , where N_{well} is the number of potential wells within which each ion is divided. For Singlet paired deuterons, there is no barrier to a coalescence type of fusion at sufficiently large N_{well} .²

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Bloch Nuclides, Iwamura Transmutations, and Oriani Showers

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The Iwamura et al. alpha addition transmutations¹ and the Oriani-Fisher energetic particle showers² demand an explanation. Fortunately, they are both understandable if one accepts a sufficiently simplistic interpretation of non-relativistic quantum mechanics. They both depend on the coherent partition of particle charge when the particle assumes a Bloch-like form and becomes distributed among a large number N_{well} of potential wells. When 2 such particles combine to form a common wave function, their 2-body wave function is characterized by Double Bloch symmetry, and the coherent sum over the total volume occupied reduces their effective self-interaction Coulomb energy by $1/N_{\text{well}}$. As a result the work required to bring the 2 "nuclei" into contact is reduced by factor $1/N_{\text{well}}$. If the 2 particles are a Singlet pairing of Bloch deuterons, the result is the Bloch deuterium reaction $2\text{-D}^+_{\text{Bloch}} \rightarrow {}^4\text{He}^{++}_{\text{Bloch}} + 23.8 \text{ MeV}$. If the 2 particles are Bloch alphas, the result is the Bloch alpha reaction $2\text{-}{}^4\text{He}^{++}_{\text{Bloch}} \rightarrow {}^8\text{Be}^{4+}_{\text{Bloch}} + E_{\text{nuc}}$, where heat of reaction E_{nuc} is a function of N_{well} . $E_{\text{nuc}}(N_{\text{well}})$ varies from $E_{\text{nuc}} = -0.046 \text{ MeV}$ when $N_{\text{well}} = 0$ (Ref. 3) to maybe $E_{\text{nuc}} = \sim 1 \text{ MeV}$ when $N_{\text{well}} \rightarrow \infty$. The increase in exothermicity is a result of the reduced Coulomb work required in forcing alpha particle separation to nuclear dimension.

The difference between Bloch deuterium fusion and Bloch alpha fusion reflects a difference in the type of fusion reaction involved. The Bloch alpha fusion is a liquid drop type nuclear coalescence reaction that leaves the internal nuclear-group configuration unchanged. In other words, ${}^8\text{Be}$ is identical to a coalesced form of 2-alpha in which the nuclear part of the reaction energy can be considered a result of nuclear-drop surface tension. Coalesced $2\text{-}{}^4\text{He}^{++}_{\text{Bloch}} \equiv {}^8\text{Be}^{4+}_{\text{Bloch}}$. In contrast, coalesced Singlet $2\text{-D}^+_{\text{Bloch}} \neq {}^4\text{He}^{++}_{\text{Bloch}}$, because the alpha involves a coupling of spin-paired protons merged by coordinate exchange to spin-paired neutrons merged by coordinate exchange, which is not the same as a Singlet pairing of deuterons merged by coordinate exchange. The reconfiguration creates a new particle, the alpha particle, that can be coherently partitioned without splitting the new nuclear group structure. The $2\text{-}{}^4\text{He}^{++}_{\text{Bloch}} \rightarrow {}^8\text{Be}^{4+}_{\text{Bloch}} + E_{\text{nuc}}(N_{\text{well}})$ reaction can be called a "Bloch-sensitive" nuclear reaction.

Bloch-sensitive reaction products lower their energy by expanding so as to occupy additional potential wells, such as occurs with Iwamura's ${}^8\text{Be}^{4+}_{\text{Bloch}}$. Also, successive Bloch-sensitive alpha reactions can create nuclear polymers, which can be called poly-Bloch nuclides. Poly-alpha nuclei, like ${}^8\text{Be}^{4+}_{\text{Bloch}}$, may be stable at large N_{well} . It may be that the Bloch-sensitive coalescence process can build up poly-alpha nuclides of large atomic weight. If such nuclides flake off their hosting metal substrate while retaining some of their Bloch periodicity, they become atom candidates for producing the nuclear showers observed by Oriani. The Bloch symmetry would likely degrade in time in response to entropy increasing recoils, causing transfer of energy from the environment to the atom flake, and leading to energetic particle emission when Bloch symmetry becomes too low.

Speculating further, it may be that the reaction, spin-paired $2\text{-H}^+_{\text{Bloch}} \rightarrow {}^2\text{He}^{++}_{\text{Bloch}}$ is a Bloch sensitive reaction with an exothermic product at large N_{well} . If so, poly- ${}^2\text{He}^{++}_{\text{Bloch}}$ may exist, in which case it would also be a candidate for Oriani-Fisher showers.

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Inhibited Diffusion Driven Surface Transmutations

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Iwamura et al.¹ have developed a LENR process that converts surface Cs atoms into surface Pr atoms using deuterium permeation through a specially structured, largely metal assembly. The assembly consists of a Pd substrate on which are deposited 4 layers of 2-nm CaO overcoated with 8-nm Pd, plus 1 CaO layer overcoated with a 40-nm Pd inflow layer. The Iwamura assembly is used as a permeable barrier between a D₂-pressurized volume and a vacuum volume.

I speculatively model the process as follows. At one or more of the CaO/Pd interfaces, deuterium is converted to a nuclearly reactive Bloch form.² The Bloch ions organize themselves into one or more many-body Bloch-ion subsystems. In these systems deuterium fusion creates Bloch helium ions that have relatively large energy relative to lattice energies, and spread out over all the CaO metal interfaces and over the interfaces between metal and gas, and metal and vacuum. Cs atoms protruding above the mean surface of the Pd metal are infiltrated by the Bloch helium. They combine with and absorb a Bloch-⁴He⁺⁺ pair, converting into Pr atoms. Both the formation of Bloch helium and the transmutation of surface Cs into Pr are exothermic processes.

The core question is: Why does Bloch deuterium form at the CaO,metal interfaces? My guess is that in the interface layer the Bloch deuterium configuration has lower free energy than such discrete particles as D⁺, D⁻, or adsorbed free-radical D atoms. This is not the case at the metal-gas and metal-vacuum interfaces, where electron-neutralized surface D⁺ ions must be in excited states to be of Bloch configuration.³ Bulk CaO is a face centered NaCl lattice with a large Gibbs free energy of -898 kJ/mol. One might imagine that the interface between CaO crystal and hydrided Pd lattice could host a fraction of a D⁺Bloch ion adjacent to each interface O⁻ ion and a D⁻Bloch ion adjacent to each interface Ca⁺⁺ ion. Each fractionally distributed D⁺Bloch ion and its fractionally distributed neutralizing electron(s) would be in Bloch function configuration. If the CaO lattice determines the Bloch periodicity, the D⁺ ion could be partitioned with a local maximum in density within each of a large number of non-self-trapping potential wells⁴. The essential step that transitions localized D⁺ into a delocalized Bloch configuration presumably occurs within these CaO-Pd interface layers. Bloch deuteron pairs then convert into wavelike ⁴He⁺⁺Bloch, which flows out to and "wets" the exterior metal surface.

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Experimental Studies of Glow Discharge in Light Water with Iron Electrodes

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Various elements have been observed on several different metallic cathodes after glow discharge in light water electrolysis. Some elements were found on the electrode surface and also in the residual particles at the bottom of the container. In the present studies, the iron electrodes were used in the cathode and graphite rod as anode in light water electrolysis. NaOH was used to promote the electrical conduction. The experiments were carried out around 98 deg. C in a beaker of 300 ml in volume of pure water. The voltage was increased to about 250 volts from zero. The experiment of discharge lasted about 10-15 minutes. Then the iron electrode was analyzed with a Quadrupole mass analysis system and EDS-ICP. Several different elements were found on the electrode as compared with the control sample. It is obvious that the product nuclei were a result of some transmutation reaction during the glow discharge process (ref. 1, 2 and 3). The detail results and experimental procedure will be presented at the conference and possible explanation will also be given. Comparison with similar experiments by others will be discussed.

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Transmutation of Nuclear Waste by Low Energy Nuclear Reactions.

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Since 1992 experimental tests at Texas A&M had shown the possibility to cause the transmutation (Low Energy Nuclear Reactions) of stable Elements (1), (2).

This possibility suggested the idea to cause the fission and fusion of unstable isotopes.

A series of experimental tests made from 1993 to 2003 proved the possibility to get rid of the nuclear waste (Thorium, Uranium, Radium) (2), (3).

In 2004 an industrial plant to destroy NORM (Naturally Occurring Radioactive Materials. Mainly Radium) was built by Monti America Corporation in Kamelooks (BC).

The first working operations have been performed in May 2004.

We report the experimental results to ICCF-11.

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Towards a Holistic Paradigm in Science

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The increasing body of experimental evidence for biologically or chemically assisted nuclear reactions requires a fundamentally new theory of physics, which is not only capable of explaining existing results, but may also help generate new ones. This is most clearly demonstrated by the need to hold the ICCF 11 Conference.

Penrose¹ clearly demonstrates that the Platonic realm of mathematics has a real existence; as real as the material objects in the world that we take for granted. This contention is generally considered to be impossible to prove, but Penrose shows that mathematical structures such as Mandelbrot sets are just too fantastic to be considered the mere creation of human minds. Mind and mathematical 'Ideas' are obviously connected in some way, as are also mathematics and the physical world. The 'Neo-Platonic' project of mathematical physics is built upon this. Yet the classical mathematical models that Descartes and Newton developed, and in turn the quantum and relativistic models that they spawned, paradoxically, have no room for the mind that perceives them. To deal with this Descartes invented dualism; Newton secretly turned to alchemy. Penrose has proposed that any future explanatory paradigm has to be inclusive of the non-material natures of 'Mind' and 'Platonic Ideas'.

Kant, in his *Critique of [Aesthetic] Judgement*, argued that knowledge of the true 'Idea' of a thing is impossible. He explained how living organisms should be considered as an enfolded whole, that once analytically dissected cannot be put back together again. Complexity theory supports the empirical evidence that the outer form, or morphology, of an organism cannot be deduced by an analysis of its DNA. Einstein, Chew, Bohm, and Pribram² have all, either directly or indirectly, provided evidence that the universe is holistic in nature. Bortoft³, whilst working for Bohm on this very problem of wholeness in quantum physics, found in the scientific ideas of the turn of the 18th century German poet and dramatist Goethe, a practical way of 'seeing' enfolded meaning. Goethe considered his greatest achievement was to have developed a scientific method that transcends Kant's limits to knowledge. He showed how through phenomenological, 'intuitive thinking' (*Anschauung*) one is able to perceive Plato's 'Ideal Forms'. Therefore, ontology need not be relegated to philosophical metaphysics. The hermeneutic phenomenology of Heidegger and Gadamer² is thereby a way to realising a science of meaning that is complimentary to the conventional quantitative, formalist, and analytic, scientific approach.

Goethe recognised the wholeness of the polar relationship between matter and mind; substance and form; between the physical and the 'immaterial (spiritual)'; and between the forces of gravity and the counter-gravitational force(s) ('levity') most commonly observed in living organisms. Adams⁴, whilst investigating apparent counter-gravitational thermodynamic phenomena in electrochemistry, looked to Projective Geometry for solutions to his problems, based on help from Russell, and Whitehead. He received further advice from the scientist, interpreter of Goethe, and mystic, Steiner, who indicated that the obscure, but beautiful part of Projective Geometry, called by Whitehead, polar-Euclidean space, otherwise known as negative, or counterspace, is - due to its holistic nature - ideally suited to a study of organic forms. Work in this area has also been conducted by Locher-Ernst, Whicher, Edwards, and most recently, by Thomas^{5,6}. His thesis is that if both space and counterspace are real, then the resulting interplay between them must be significant. This concept has been applied to gravity, liquids, gases, heat, light, chemistry, and life. This has led to a new concept of time, and a new approach to relativity and quantum physics has started to emerge. This paradigm, though in its early stages of development, is uniquely suited to an understanding of biologically or chemically assisted nuclear reactions because of its holistic, dynamic nature.

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Electron Screening Constraints for the Cold Fusion

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The observation of an enhanced electron screening effect in the ${}^2\text{H}(\text{d,p}){}^3\text{H}$ reaction taking place in deuterized metallic targets [1] may be a breakthrough for explaining the phenomenon of cold fusion. Based on our experimental results, theoretical calculations of screening energies in five different target materials (C, Al, Zr, Pd, Ta) have been performed within an improved dielectric function theory [2]. The theory, including polarization of both quasi-free and bound electrons, describes the observed target material dependence of the screening energies, underestimates, however, the absolute values by about a factor of 2. Applying an effective screening energy approach and realistic stopping power values, the theoretical cross sections, thick target yields as well as nuclear reaction rates have been calculated down to the energies corresponding to the conditions of cold fusion experiments. This allows for a comparison of the experimental results at higher energies with those achieved in the heavy-water electrolysis experiments.

Constraints for the cold fusion reaction rates and the energy production arising from the experimental screening energies will be discussed. Possible reasons for the cold fusion branching ratios will be presented.

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On elements concentration changes in the high current electrolysis experiments

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A set of electrolysis experiments were performed. The electrolysis cell consisted of a 100 ml beaker containing 50 ml of electrolyte. A glass slab was used as a cap. The simple design, with cathodes hanging through the cap, without any adhesive, prevented both electrodes and electrolyte from getting in contact with possible contamination sources. Electrolyte was K_2CO_3 1 M in de-ionized water for all experiments.

First a control experiment was conducted, having a 0.43 mm diameter platinum wire 99.9% purity both as anode and as cathode. The drift current was 31 mA and the experiment lasted for 20 hours. The electrolyte after the control experiments was labeled as E1 and the unprocessed electrolyte as E0.

Then a low drift current electrolysis was performed, having the same 1 mm diameter nickel wire, 99.5% purity as cathode and 0.43 mm diameter platinum wire 99.9% purity as anode. The current was 149 mA and lasted for 46 hours, thus having the cathode charged with hydrogen. The electrolyte after this experiment was labeled as E2.

The third experiment had the same cathode, preloaded with hydrogen and a new 1 mm nickel wire, from the same batch, as anode. The voltage across the cell was 0.8 V before the experiment was started and this was taken as a proof that the cathode was preloaded. The current was initially 3 A and was decreased to 0.8 A, with an average of 1.4 A, and the voltage was 80 V; the experiment lasted for 12 minutes. Electrolyte after this experiment was labeled as E3. This last experiment was actually an electrolysis arc discharge.

The table with the Pb, Zr, Cd, Cu concentrations in electrolyte after each experiment is included in this abstract. The concentrations were measured using an atomic absorption spectrometer.

Element	Pb, mg/l	Zr, mg/l	Cd, mg/l	Cu, mg/l
E0	1.2	0.36	0.26	0.48
E1	1.2	0.30	0.25	0.50
E2	1.1	0.26	0.25	0.50
E3	0.7	0.12	0.13	0.29

The experiments presented in this abstract are preliminary experiments of an ongoing study. So far it was noticed that the discharge appeared only on the hydrogen preloaded nickel electrode. Another interesting thing that was found is that the Pb, Zr, Cd, Cu concentrations in electrolyte did not change significantly after the control experiment but were significantly decreased after the last experiment. This suggests an effective and low cost method for removing heavy metals like Pb, Zr, Cd, Cu from polluted water.

Transmutation of metal to low energy In confined plasma in the water Electrochemical Plasma Cell

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Elevated energetic fluxes (120/140 %) have been noticed inside an electrolytic cell working in alkaline surrounding, using tungsten electrodes to start the generation and the confinement of a plasma close to the cathode. Together, have been noticed energy generation, always close to the cathode, with the appearing of new chemical elements which where absent, at the beginning, in the experimental apparatus (Re, Os, Au, Tl, Tm, Hf, Yb, Er, Ca.). That is a tangible proof of some nuclear transmutations referred to the tungsten cathode. The results of this research, the theoretical frame of the phenomenon that plays a role on it have been, for the first time, showed-up at the 18th of April 2004, during the second Grottammare (Ap) ONNE meeting, in Italy.

Cold Fusion using Organic Acids

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Despite its problems, the electrolytic method for inducing thermal anomalies in deuterated metals has retained its popularity. But the use of aqueous solvents has problems:-

- 1) Most aqueous electrolytes boil close to 100 ° C. This makes it difficult to explore the generation of excess power at higher temperatures. Evaporation of hot aqueous electrolytes is a further complication for accurate calorimetry.
- 2) The excess power is modest compared to the electrical power required to dissociate the water into hydrogen and oxygen.
- 3) Uncertainty may be introduced by not knowing the extent of recombination of hydrogen and oxygen. This may be true even when a recombination catalyst is used because the efficiency of a catalyst is never 100% and it may change over time (as it may get clogged up with water).
- 4) Problems can occur if the electrolyte reacts with the catalyst or its support (such as H₂SO₄ with alumina).
- 5) Potential oxidation at the anode necessitates an inert electrode material such as platinum. This adds expense.
- 6) Alkaline electrolytes tend to dissolve glassware risking contaminants.
- 7) Protium impurities in the electrolyte tend to be preferentially discharged at the cathode (significant isotope effect for hydrogen ions),

In order to overcome these problems the use of formic acid was first considered. Formic acid can be electrolysed to produce hydrogen at both the anode and the cathode. Recombination is impossible. Unfortunately formic acid is volatile – it boils at 101 ° C (producing an acrid vapour) and consequently does not solve problem 1. It is also expensive to deuterate.

Oxalic acid in contrast is a solid. Like formic acid it is a strong non oxidizing acid. The dihydrate melts at 120 ° C. The anhydrous acid melts at around 180 ° C with decomposition. It can be deuterated simply by mixing with heavy water as both hydrogens readily dissociate.

Table 1.

1) H ₂ O (water)	= H ₂ + 0.5 O ₂	+ 280 kJ/mole
2) HCOOH (formic acid)	= H ₂ + CO ₂	+ 31 kJ/mole
3) (COOH) ₂ (oxalic acid)	= H ₂ + 2CO ₂	+ 36 kJ/mole

As Table 1 above shows the energy required to produce hydrogen from formic or oxalic acid is about 13% of that required from water. The possibilities for amplification input energy should be dramatic!

Modest research funds will be gratefully accepted to carry out these ideas into practice!

Advantages of the Oxalic Acid Electrolyte

- 1) As hydrogen is evolved at both anode and cathode, the same materials can be used for each. This reduces expense and the risk of introducing additional impurities into the system. Indeed it may be possible to use non-noble metal for both anode and cathode.
- 2) As recombination cannot occur in the cell, no catalyst is necessary and analysis of thermal behaviour is simplified.
- 3) Even at 125 ° C evaporation is expected to be negligible. (To be verified.)

Potential Problems

- 1) Modest currents decompose quite large masses of oxalic acid necessitating an increase in scale. It may be impractical to add solid anhydrous oxalic acid to a working cell. A compromise might be achieved by using a formic / oxalic acid solution.
- 2) Some electrode materials / over potential combinations may result in unexpected side effects such as the electrolytic reduction of oxalic acid. This would certainly complicate the calorimetry.

Conclusions

The system described if found to be functional could form the basis of a reliable low cost demonstration kit.

References:

Abhay Ambadkar and John Dash "Electrolysis of D₂O With A Palladium Cathode Compared With Electrolysis Of H₂O With A Platinum Electrode: Procedure And Experimental Details". (Private Communication - www.iscmns.org/meetings/Asti/Demo/Recipe.htm).

Excess Heat in Electrolysis Experiments at Energetics Technologies

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Using the electrolytic cells described in our ICCF-10 paper driven with Dardik's modified SuperWaves, significant amounts of excess heat were obtained in a number of experiments. The most successful of these experiments generated excess heat a couple of times: (1) Approximately 5 hours into the first loading of deuterium into the Pd cathode – giving an average power gain of ~2500% during 17 hours. The average current density was 7 mA/cm². (2) The same foil was deloaded after the excess heat generation stopped for no apparent reason and then loaded again. After 16 hours of loading excess heat was generated again at an average level of ~1500% for 80 hours. The average current density was 8.4 mA/cm². At the end of the two experiments the tritium concentration in the electrolyte was 270% of its pre-experiment level. The total amount of excess energy generated is approximately 1.1 MJ and 3.5 MJ in, respectively, the first and second experiments. This amount of excess energy corresponds to, respectively, ~4.8 KeV or ~15.3 KeV per Pd atom. The corresponding average specific power is 71 or 48 W per gram Pd. For comparison, the average specific power in commercial nuclear fission reactors is between 20 to 40 W per gram uranium.

The Pd cathode is a 50 μm thick foil that is 7 mm wide and 60 mm in effective length. It has been pre-treated by Dr. Vittorio Violante of ENEA in Frascati, Italy. The anodes are two 0.1 × 20 × 60 mm Pt foils. The electrolyte is 0.1M solution of LiOD in D₂O. After the experiments the cathode was investigated using a number of probing techniques, including AES, SEM-EDS, TEM and SIMS. Significant amount of low Z contaminants were found on its surface, extending to a depth of dozens of Angstrom. Their origin appears to be the lubricant used for rolling the foil in the pre-treatment process. Their presence prohibited detecting nuclear reaction products with acceptable certainty on and near the surface. No transmutation products were found at deeper layers. However, no measurement of He inventory was attempted.

The Super Waves Principle

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The results presented at ICCF10 of Glow Discharge experiments performed by Energetic Technologies (ET) researchers in Israel were described as “dramatic”. I expect that no less will be said of the Electrochemical Cell results to be presented at this conference. It is the purpose of this communication to describe the technical features of the ET results that distinguish them from prior cold fusion results, and the governing principle and theory that guide these new experiments. This information is offered to assist others to make progress in developing new energy technology.

Unique to the ET experiments is the use of a new understanding of wave modulation. Rather than dc, dc + ac, dc pulsed or bi-level perturbation, the waveforms being subjected (successfully) to test by ET employ waves fractally nested in a specific non-linear manner designed to stimulate intrinsic oscillatory processes across a wide range of scales. I call these SuperWaves©. When properly implemented SuperWaves have been demonstrated to influence strongly processes in the realms of physics, physical chemistry, metallurgy and also in physiology.

Early validations of the SuperWaves principle were obtained in physiological studies and from theoretical and applied studies of the melting, stirring and strengthening of metals. The current presentation will focus on the organizing principle of SuperWaves in the D/Pd both as a means to improve the rate and extent of (D) loading, and to provide the stimulus needed to produce cold fusion heat (and nuclear?) effects.

Search for optimum conditions to produce excess heat from the electrolysis of heavy water with a palladium cathode

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Results of experiments to optimize excess heat production will be presented. Variables explored include degree of cold work, current density, temperature, and surface topography.

Thermal analysis of calorimetric systems

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The aim of this paper is to take an overview of main calorimetric devices and show the pattern used in order to allow their optimal operation. Three different concepts of calorimetric systems have been studied:

- 1) Isoperibolic at high temperature (200 °C).
- 2) Isoperibolic at low temperature (30-50 °C).
- 3) Flow at low temperature (25-35 °C).

A classic model of heat transfer has been developed in the first case by including evolving boundary conditions where the typical fluctuation of the ambient temperature has been described by means of Fourier series approximation. The finite element method was applied to calculate the temperature field for a 3D transient model.

The finite element method has also been used for both low temperature calorimetric systems: isoperibolic and flow at steady state. The accordance between the calculated results and the experimental value is satisfactory. An effective tool to simulate the behavior, to estimate the sensitivity and to optimize the studied systems turns out. The theoretical calculations allowed to identify the response level of the designed calorimetric apparatus in terms of efficiency and of excess of power signal.

About Reifenschweiler Effect

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In the year 1994, O. Reifenschweiler described an apparent decrease of the radioactivity of tritium absorbed by thin films of titanium. Is this effect really linked to a variation of the lambda factor of the tritium? Some authors have tried to explain the strange behaviour of the hydrogen isotopes in hydride-forming metals as the consequence of a quantic condensation of hydrogen isotope nuclei in the lattice. (Bose-Einstein Condensate) Are these hypothesis able to explain the apparent loss of radioactivity of the tritium?

A simple calorimetric method to avoid artifact in a controversial field : the ice calorimeter

Jacques Dufour¹, Xavier Dufour, Denis Murat, Jacques Foos

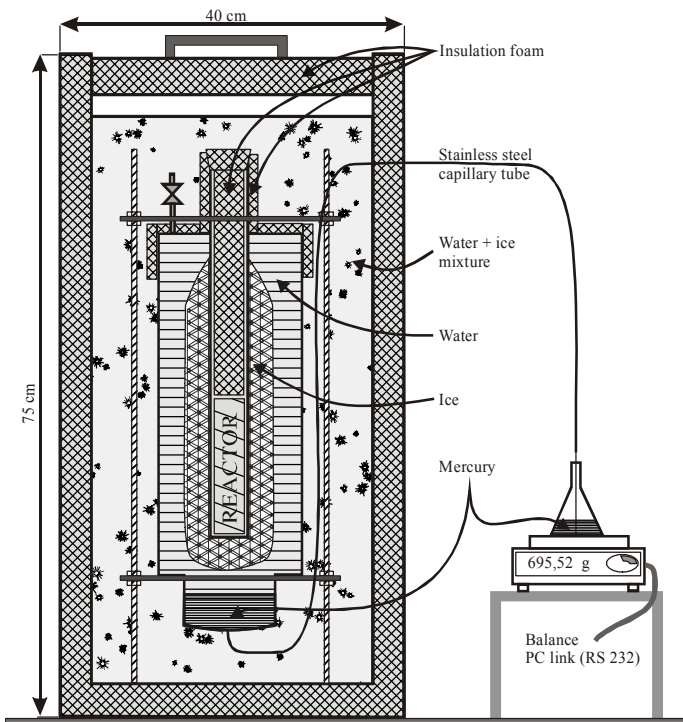
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The idea of the ice calorimeter is rather old. Antoine Lavoisier (1743-1794) developed in 1783 a calorimetric method based on the measurement of the mass of the ice that melts when heated. Robert Bunsen (1811-1899) improved this method in 1870 and designed a calorimeter based on the measurement of the volume rather than the mass of ice melted. 1 g of ice occupies 1.0908 cm³, 1 g of water 1.0001 cm³. Thus, when 1 g of ice melts it shrinks by $\Delta V = 0.0907 \text{ cm}^3$. The measured reduction in volume of the melted ice indicates the number of grams which have melted. Nowadays this method is still used [1] because it is simple, accurate, sensitive and most of all rather insensible to interferences which is a key point in order to have convincing experiment in a controversial field. Moreover, an ice calorimeter is adiabatic and isotherm (0°C) thus suppressing the problem of heat transfer in wires and tubing connecting the experiment to the outside of the calorimeter.

To measure the volume of ice melted, we design an automatic reading unit by weighting a reserve of the indicator liquid (mercury). The mercury density at 0°C is $(d_{\text{Hg}})_{0^\circ\text{C}} = 13.595 \text{ g/cm}^3$. The latent enthalpy of fusion of the ice is $\Delta H_w = 6.01 \text{ kJ} \cdot \text{mol}^{-1} = 333.7 \text{ J} \cdot \text{g}^{-1}$. Thus, the heat

$$H = \left(\Delta H_w \cdot \frac{m}{(d_{\text{Hg}})_{0^\circ\text{C}} \cdot \Delta V} \right) \cdot \chi$$

measured by the calorimeter is where m is the weight of mercury which is transferred from the reserve tank during the experiment and χ a correction factor due to the buoyant force on the capillary tube (see Figure 1). χ was measured to be 0.998



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Figure 1 : The ice calorimeter

Use of an ice melting calorimeter to perform experiments in a novel working hypothesis (strong gravity in LENR). Comparison with Seebeck and mass flow calorimeters

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Using precise and reliable calorimeters has always been a major issue in the field of nuclear reactions in solids. The apparition of an exothermal effect seems to be the more convincing signature that something abnormal occurs (the radiations and reaction products are difficult to distinguish from background). To improve the measurement of this very weak thermal effect (a few % of the energy input), an ice melting calorimeter has been built and its results compared to those of commonly used calorimeters (Seebeck and mass flow calorimeters).

The response of these 3 calorimeters has been tested using a very simple experiment, the Joule effect produced by DC flowing through a resistor.

All calorimeters have been installed in a temperature regulated room (with variations of + or - 0,4°C round the set point). The resistor is a small metallic wire (2 to 6 cm long, 60 to 200 μ in diameter), heated by a DC generator regulated at constant power.

The Seebeck calorimeter is 4x4x8 cm and made from Seebeck modules (Melcor CP1,4-127-045L). The calorimeter itself is placed in a box immersed in a cryothermostat at a fixed regulated temperature (+ or - 0,05 °C).

The mass flow calorimeter uses pure distilled water as calorific fluid (typically 10 M Ω cm), kept at this high level of purity by passing on ion exchange resins). The mass flow of water is weighted (SRI type system, sampling two thirds of the time). The temperatures are measured by PT 1000 sensors, periodically calibrated against a reference. The temperature of the water entering the calorimeter is kept constant (+ or - 0,05°C) by a cryothermostat.

The volume of the stainless-steel ice calorimeter is 3 liters. The experiment is placed in its inside tube (30x4 cm), filled with a water/methanol mixture. The calorimeter is filled with bi-distillated water and prior to an experiment a cylinder of ice is formed by passing, in a tubing, a cooling fluid. The whole assembly is placed in an insulated cylinder, filled with an ice/water mixture. All wires and tubing to the outside are in this mixture on some 40 cm.

The main conclusions of the comparison are the following :

-the Seebeck calorimeter is very sensitive to the temperature fluctuations of its background. The required calibration depends very much upon the intensity of the current used to heat the calibrating resistor (influence of the wires).

-the mass flow calorimeter is very sensitive to the position of the temperature sensors at the inlet and outlet of the water collecting the heat. A calibration is thus necessary, which can introduce uncontrolled errors.

-the ice melting calorimeter recovers 98 +/- 1% of the energy input. No calibration is required. The wires and tubing do not exchange heat with the outside.

The response of these 3 calorimeters will be compared in details. The possibility of using the ice melting calorimeter to perform experiments in the frame of a novel working hypothesis (possible role of strong gravity in the field of LENR), will be discussed.

Neutrino-Driven Nuclear Reactions of Cold Fusion and Transmutation

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The term “neutrino-driven nuclear reactions” they usually attribute to some reactions of direct or reverse β -decay having, as a rule, extremely small interaction cross section and applied for detection of neutrino (antineutrino). The author considers, contrary, that a great majority of intense reactions of β -decay, nuclear fission and partly of fusion, formerly described without participation of neutrinos as an input, are neutrino-driven ones.

The facts listed below demonstrate that the reactions of direct and reverse β -decay, including nuclear fission and partly nuclear fusion, are driven from the outside.

Significance of a radioactive decay rate variation and its correlation with the solar activity variation is demonstrated after some decades long observations.

Variation of decay rate after variation of crystalline and chemical environment was observed since the 40th years of the XX-th century.

Variation of nuclear transmutation rates is even more significant after low energy non-nuclear actions on media (cold fusion and transmutation of nuclei).

It was also stated that the Chernobyl accident produced radioisotopes (in particular, ^{137}Cs) for some years after their fallout had reduced half-life periods (3.5 and 17 years for 1988 and 1992 years' samples, correspondingly), hereinafter asymptotically incremental up to the conventional values (30.6 years).

And, last but not least: there are some data on an opportunity of radioisotopes decay and other nuclear transformations initiating by means of so-called torsion radiation (scalar fields, non-hertzian energy and so on).

We suggest the hypothesis of neutrino-driven nuclear reactions for explication of abnormally fast nuclear reactions surveyed above and conformities to natural laws observed under the noted reactions proceeding.

The not-high energy neutrino (NNN) is abundant in Nature, which is a solid fact. The author suggest that correct interpretation of many other authors' experimental data allow the conclusion that NNN is not an inert particle but can be focused (concentrated) and then captured by condensed matter, absorbed or desorbed in any physical, chemical and biological process accompanied by the entropy change (reversible or irreversible ones) and, perhaps, generated artificially using appropriate devices.

Suggested mechanism of the not-high energy neutrino (NNN) interaction with matter is, first of all, an electron-neutrino couple ($e\nu$) formation in atom that causes a series of secondary effects at nuclear, atomic and molecular levels of matter.

The hypothesis provides explication to conformities to natural laws of radioactive and "stable" nuclides transmutation rate variation by low energy non-nuclear actions on nuclei and can be testified experimentally.

Effects of atomic electrons on nuclear stability and radioactive decay

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Despite the energy-space-time scale of nuclear processes considerably differs from that of atomic ones, a lot of experimental evidences for a strong effect of atomic electrons on nuclear processes is documented. In the present paper we analyze how the change of atomic electronic states may influence the rate of nuclear decay and the condition of nuclear stability, and how it may redistribute the channels of nuclear decay. The changes of atomic electronic states may be caused by application of a strong magnetic field.

It is known that under full ionization of the atom the bound-state β -decay (i.e. when β -electron doesn't escape from the atom and occupies the bound atomic state) appears to be energetically preferable in contrast to the case of β -decay of the neutral atom. Our analysis of the database of nuclear masses gives the following conclusion: a number of nuclei are found, which are stable in the neutral atom and should be unstable with respect to bound-state β -decay if the nucleus is bare (i.e. under full ionization of the atom): ^{163}Dy , ^{193}Ir , ^{205}Tl .

Under high degree of atom's ionization, the β -stability threshold moves towards larger values of Z , i.e. towards decreasing the neutron/proton ratio in the nucleus. We show that the clearance of electron atomic states in a certain number of atoms whose nucleus emits the delayed neutron may increase the fraction of delayed neutrons.

It is also shown, that while considering the nuclear processes – both known and novel ones – which proceed with participation of weak interactions, one has to take into account the mass of electron in spite of its smallness in comparison with the nuclear binding energy. Within the frame of the respectively enhanced accuracy, it is shown that the necessary and sufficient condition of nuclear stability with respect to β -decay and K-capture appears to be the minimum of the mass defect on isobars, that not always coincides with the widespread condition of the minimum of nuclear mass.

The major conclusion of the paper is that the potentiality of a hypothetical collective process of low-energy nuclear transformations is shown to be compatible with the known fundamental conservation laws. This claim is suggested by our successful attempt for a phenomenological description of such a process – first of all, by a number of successful qualitative predictions verified by the experiment.

Specifically, comparison of the results of our modeling with respective experimental data shows that the known fundamental conservation laws allow the existence of a hypothetical collective process of low-energy nuclear transformations, which may manifest itself in the following way.

This process may proceed at small input/output energies per participating atom, namely those of the scale of chemical energies.

The final ensembles of chemical elements with values of energy closest to that of the initial ensemble appear to consist of stable isotopes, if the initial ensemble consists of stable isotopes as well.

In other words, the success of the proposed phenomenological model may be considered as an indirect evidence for

probable collective nature of a hypothetical process of nuclear transformation and, probable importance of weak interactions in describing the above process (more precisely – the importance of proton-neutron transformations due to the known fundamental interactions, namely, weak interaction, or some unknown ones).

Elaboration of the proposed model, even without specification of the mechanism of transformation, will allow making a preliminary estimates of the expected production of elements from the given input elements, and what is even more important, estimating the relevant input elements to produce requested output elements.

On the possible magnetic mechanism of shortening the runaway of RBMK-1000 reactor at Chernobyl Nuclear Power Plant

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The official conclusion about the origin of the explosion at the Chernobyl Nuclear Power Plant (CNPP) does not seem to be satisfactory: First, many questions have not been answered and, second, the official conclusion is based on the numerical simulations whose results do not agree with the experimental facts and analytic estimations.

The official versions of the accident contradict the available facts and contemporary physics at the following points:

The dependence of the reactivity on coolant density is overestimated with respect to the designed data.

The increment of instability growth calculated analytically from equations analyzed, exceeds by far – even for the overestimated reactivity – the respective results of numerical simulation [3 – 6];

The claim of a strong inhomogeneity of neutron density is not compatible with the explosion; anyway, a strong inhomogeneity may result in an increase of the runaway time rather than its decrease.

The cause of the CNPP accident has not yet been convincingly explained and the contemporary state of science does not seem to be able to provide such an explanation.

To interpret such a high rate of the reactor runaway, we think one should assume the existence of a new physical phenomenon (or even a number of such phenomena).

We suggest a possible mechanism of the reactor runaway which does not contradict the above-mentioned facts. It is known that the bound-state β -decay (i.e., a decay in which the β -electron does not escape from the atom and is captured into an unoccupied bound state in the atom) may increase the phase volume of final states and, hence, may increase the probability of β -decay. We show that the appearance of an unoccupied electron state in an atom, capable of emitting a delayed neutron, leads to an increase of the fraction of delayed neutrons.

Thus, the following mechanism of the accident evolution is suggested:

The impact of a strong magnetic field upon the reactor core may result in the distortion of the electron shells around the nuclei emitting the delayed neutrons, with the production of unoccupied electron states closely to the atomic nucleus.

This makes possible the β -decay into bound states, which results in an increase of the decay constant, $\lambda \rightarrow \lambda + \delta\lambda$.

The respective relative increase of probability of neutron-releasing decays into excited nuclear states, $\delta\lambda_n/\lambda_n$, substantially exceeds the value $\delta\lambda\beta/\lambda\beta$ for decays without neutron release.

Hence, the fraction of delayed neutrons, β , is going up, that, in an active medium, leads to the runaway of reactor.

Thus, in contrast to the official version, it is not the reactivity that increases to the value 5β , but the value of β itself, i.e., the fraction of delayed neutrons, increases.

Quantum equation of tachyon

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As discussed in detail by Recami & Mignani [1], the existence of the tachyon (i.e. a superluminal particle) has no conflict with the theory of special relativity.

Here we suggest a new quantum equation which generalizes the Dirac relativistic equation. In contrast to Dirac equation, the suggested spinor equation is applicable to describing the superluminal electrically charged particles (tachyons):

$$\gamma_{\mu} \cdot \left[\partial_{\mu} - \frac{\mathbf{g}}{\hbar c} \mathbf{B}_{\mu} \cdot \gamma_5 \right] \psi + \frac{mc}{\hbar} \gamma_4 \psi = 0, \quad \left[-\partial_{\mu} \bar{\psi} \cdot \gamma_{\mu} - \bar{\psi} \cdot \gamma_{\mu} \frac{\mathbf{g}}{\hbar c} \mathbf{B}_{\mu} \cdot \gamma_5 \right] + \bar{\psi} \frac{mc}{\hbar} \gamma_4 = 0 \quad (1)$$

where γ_{μ} is Dirac matrices, $\mathbf{B}_{\mu} = (-i\vec{\mathbf{B}}; \chi)$ is the pseudopotential of electromagnetic field, operation $\bar{\psi} = \psi^+ \gamma_4$ corresponds to Dirac's conjugation. Equation (1) with allowance for the linear mass term obeys the gauge invariance introduced by G. Lochak [2]:

$$\psi \rightarrow \exp\left(i \frac{\mathbf{g}}{\hbar c} \gamma_5 \cdot \varphi\right) \cdot \psi, \quad \mathbf{B} \rightarrow \mathbf{B} + i\nabla \varphi \quad (2)$$

Therefore, the solutions of equation (1) obey the symmetry rules for the magnetic field, i.e. they, similarly to [2], describe magnetic monopoles. The latter agrees with the theory by Recami [1]. The description of electrically charged tachyon in classical approximation was shown [1] to be equivalent to description of a subluminal magnetic monopole.

Similarly to Lochak equations [2], each of equations (1) is split into two independent equations in the Weyl representation:

$$\psi = \frac{1}{\sqrt{2}} (\gamma_4 + \gamma_5) \cdot \begin{pmatrix} \xi \\ \zeta \end{pmatrix} \quad (3)$$

(here, in contrast to [2], we allow for the linear mass term). Such a splitting makes the suggested equation substantially different both from Dirac and Lochak equations. The equations derived in the Weyl representation obey conservation of respectively “left” and “right” currents:

$$\mathbf{X}_{\mu} = (-\xi^+ \vec{\sigma} \xi; i\xi^+ \xi), \quad \mathbf{Y}_{\mu} = (\zeta^+ \vec{\sigma} \zeta; i\zeta^+ \zeta), \quad (4)$$

where σ are the Pauli matrices.

Equation (1) obeys the conservation of the vector of the current $\mathbf{J}_{\mu} = i\bar{\psi} \gamma_{\mu} \psi = \mathbf{X}_{\mu} + \mathbf{Y}_{\mu}$ and the space-like pseudovector of “magnetic” current $\mathbf{\Sigma}_{\mu} = -i\bar{\psi} \gamma_{\mu} \gamma_5 \psi = \mathbf{Y}_{\mu} - \mathbf{X}_{\mu}$, which is present in the Maxwell equations for the electromagnetic field :

$$\partial_{\nu\nu}^2 \mathbf{B}_{\mu} = -i \frac{4\pi \cdot \mathbf{g}}{c} \cdot \mathbf{\Sigma}_{\mu} \quad (5)$$

Equation (5) agrees with Maxwell classical electrodynamics equations extended to allowance for the magnetic current [1 – 3].

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Neutron Isotope Reactions

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It is suggested that neutron clusters of sufficient size are bound and stable except for beta decay, and that these massive neutron isotopes can react with ordinary nuclei by transferring neutrons to them, accepting neutrons from them, or binding with them to form nuclear molecules. Implications of this extended scope of nuclear physics are explored, including reactions of neutron isotopes with oxygen, lithium, deuterium, and other ordinary nuclei that produce helium, hydrogen, tritium, and transmutations. This approach offers a natural explanation for a range of novel nuclear phenomena for which evidence has been accumulating over the past fifteen years. It provides a theoretical framework for guiding future research and for exploring potential applications to energy production and other nuclear processes.

Concerning the modelling of systems in terms of Quantum Electrodynamics, QED; an illustration drawn from the field of nucleation and phase growth and the special case of “Cold Fusion”

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A question we are asked repeatedly is ; “what are the causes of the opposition to your belief in the reality of “Cold Fusion?”. This question is normally asked in the context of the statement that Quantum Mechanics shows that this phenomenon is impossible (a view that we share). Our answer is always based on the statement “but what about the modelling of such systems in terms of QED?” which is always met by the insistence that Quantum Mechanics shows that Cold Fusion is impossible. We conclude that scientists do not understand QED or, if they have some understanding of this subject, then this must be subject to some major misconceptions.

This pointless dialogue (perhaps more correctly described as two monologues conducted in parallel) and the insistence on the primacy of Quantum Mechanics in the modelling of systems in the Natural Sciences is unfortunate because it obscures the outcome of the investigations in the more normal fields of the Natural Sciences (more normal than Cold Fusion). A brief outline of the work which has led to the formulation of the concept of coherence will therefore be given under the aegis of the revolutions in our understanding of the Natural Sciences which has taken place since the latter part of the 19th Century.

The main illustration of the way we can demonstrate the applicability of these concepts will be based on the study of nucleation and phase growth. The development of microelectrode substrates allows us to study the statistics of the formation of the first nucleus; it will be shown that these statistics are strictly in line with concepts developed from QED coherence. We conclude that QED coherence is not just a concept to be confined to sub-atomic physics, cosmology etc. but that it pervades the modelling of the whole of the Natural Sciences including that of “Cold Fusion!” Some of the major steps which have taken place in the development of this subject area will be illustrated.

Theoretical model of the probability of fusion between deuterons within deformed lattices with micro-cracks at room temperature

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In this work, we wish to demonstrate that a reaction path as the following, dislocations, deformations due to thermodynamic stress and, finally, micro-crack occurrence, can enhance the process of fusion of the deuterons introduced into the lattice by deuterium loading [1]. In fact, calculating the rate of deuteron-plasmon-deuteron fusion within a micro-crack, showed, together with an enhancement of the tunneling effect, an increase of at least 2-3 orders of magnitude compared to the probability of fusion on the no deformed lattice. In fact, strong electric fields can take place in the micro-crack and the deuterons are accelerated to the energy which are enough for the D-D tunneling [2,3]. These phenomena open the way to the theoretical hypothesis that a kind of chain reaction, catalyzed by the micro-cracks produced in the structure as a result of deuterium loading, can favor the process of deuteron-plasmon fusion [4].

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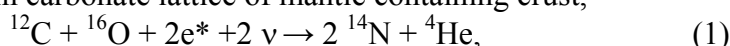
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Possible nuclear transmutation of nitrogen in the earth's atmosphere

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The details on the origin of nitrogen, which exists so abundantly in the Earth's atmosphere, are missing. In Archean era (3.8 to 2.5 billion years ago), the percentage of nitrogen gradually increased in inverse proportion to a parabolic decrease of carbon dioxide. The disappearance of carbon dioxide is associated with formation of carbonate rocks and mantles containing carbon dioxide due to weathering of igneous rocks. Thus, consumption of carbon dioxide, i.e., formation of carbonates, seems to correlate with formation of nitrogen. An attempt to give the possible answer to the question was interpreted to be the result of endothermic nuclear transmutation of carbon and oxygen atom pairs in carbonate lattice of mantle containing crust,



With help of combined effect (50% shrinkage) of screening of free electrons derived from the carbon and oxygen atoms under high pressure and the temperature enhancing on the reaction rate at deeper temperature and electropionic attraction effect thanks to the excited electron e^* capture and neutral pion catalysis derived from electron emission. The excited electrons were generated by rapid fracture or sliding of carbonate crystals due to volcanic earthquake, and plenty of neutrinos ν were derived from universe, mainly young sun. The cross section σ for the nuclear reaction are given by

$$\sigma = \frac{10^6}{E} \exp\left(\frac{-0.470}{E}\right). \quad (2)$$

The activated state product $^{12}\text{C}^{16}\text{O}$ immediately undergo fission to two ^{14}N nitrogen atoms, accompanied by liberation of four neutral pions. The formation of nitrogen would be continued for 1.3 billion years in Archean era, until the active volcanism or storm of neutrinos ceased. The possible nuclear transmutation rate of nitrogen atoms could be calculated as 2.3×10^6 atom/s.

Influence of excitation and ionization of the atoms on the velocity of nuclear processes at low energies

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The full review of Russian low energy nuclear reactors is represented. We have concluded that transmutation of nuclei at low energies is possible in the framework of the modern physical theory - excitation and ionization of atoms and universal resonance synchronization principle are responsible for it [1]. Investigation of this phenomenon requires knowledge of different branches of science: nuclear and atomic physics, chemistry and electrochemistry, condensed matter and solid state physics. The results of this research field can provide a new source of energy, substances and technologies.

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Cold Fusion and Nuclear Non-Proliferation

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The literature of “cold fusion,” low energy nuclear reactions (LENR), and new hydrogen energy are reviewed in a search for experimental observations and theories that, if confirmed, might impact nuclear non-proliferation. Some experimental observations and some theories suggest that this research might impact nuclear non-proliferation.

The International Sustainable Energy Organization ISEO and Novel Energy Systems

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In 2002 a motion for an international sustainable energy agency was launched by the Swiss National Council before the Johannesburg World Summit. Similar suggestions were also made in Germany and Austria, at the Geneva Clean Energy Conferences in 1991 and 2000, at the 9th session of the Commission on Sustainable Development in 2001 in New York and at the World Summit on Sustainable Development WSSD in Johannesburg in 2002, where ISEO was the first time presented to Ministers, NGOs and Academia.

It is explained why a world-wide organization for sustainable energy is needed to speed up the implementation of renewable energy and better efficiency and why there is an urgent need for benign novel energy systems to complement the limited renewable energy resources. There is the justified hope that modern physical chemistry can provide more clean, decentralized energy than all conventional systems combined with their detriments to natural landscapes.

The remaining finite mineral resources must be conserved for the organic chemistry and metallurgy. More pressing reasons for an accelerated transition to the clean, sustainable energy age are the pollution, endangering biospheres and health, and the fatal effects of climate change, causing record floodings, devastating storms, rising oceans, melting glaciers, ice caps and migrations.

ISEO is a hybrid organization like IUCN with private sector and government members, relevant NGOs, UN liaisons and strong ties to the academia. Details, news and events can be viewed on web portal www.uniseo.org.

To fulfill its task efficiently and speedily, ISEO is active in following areas:

A new section was launched for novel energy systems, supplementing ISEO's basic activities in the fields of international standardization, energy statistics, forecasting methods and systems analysis, allowing the external costing of harmful energies and the sustainable energy systems engineering and planning of hydro and wind power, biomass, geothermal heat and power, solar energy (PV, heat, drying), ocean energy (OTEC, waves, tidal), hydrogen and clean fuel production, storage and applications, heat pumps and co-generation, sustainable architecture, clean transport, muscle energy, energy efficiency (insulation, lighting, engines etc.), human behavior and awareness creation, better R&D and project financing, education and training, better environmental and energy legislation, and clean, sustainable energy policies.

ISEO promotes also the Global Energy Charter for Sustainable Development as an indispensable sustainable energy policy framework and renewable energy research and implementation guideline.

Update on Phonon-Coupled SU[n] Models

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We have continued our efforts on modeling anomalies in metal deuterides, and report progress along the lines discussed at previous conferences.

Anomalies within the model are associated with deuterium double occupancy in metal deuterides. Double occupation probabilities are estimated as a function of loading and temperature in PdD. The occupation probability is thought to increase near single-site host metal lattice defects.

Angular momentum transfer between the lattice and nuclei is proposed to take place through a Duschinsky mass change mechanism, both in the case of lattice-coupled d+d reactions and lattice-induced disintegrations of other nuclei.

Previous models focused on four-nucleon states and their associated dynamics in the presence of phonon exchange. In the latest version of the models, we require the presence of a second population to maximize the associated reaction rates. We propose that transitions to high angular momentum states of the host metal lattice nuclei can play such a role, and that the underlying coupling is very similar to that described previously.

The new models have many good properties, and appear to be able to account for many of the anomalies systematically from a unified point of view.

Low Energy Nuclear Reactions resulting as picometer interactions with similarity to K-shell electron capture

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It is a well known fact that there is a basic difference between the usual nuclear reactions in fm distance needing energies above MeV and between the fusion reaction of deuterium or tritium and other light nuclei where energies of few keV are necessary only and the reactions occur at fifty to hundred times larger distances. Despite the very detailed experimental knowledge of hot fusion, the very first consequent theory based on a Schrödinger potential with an imaginary part was not known before recently [1] where the input is given by only two natural numbers, the resonance energy and the resonance width. This reproduces the very accurately measured cross sections better than any artificial formula with five adjusted numerical parameters [2] or similar. This model [1] explains also that reactions in the picometer distance with a probability about 28 orders of magnitude slower than the usual nuclear reactions is possible with the details that neutron emission is less probable than production of tritium or helium-4. These facts agree with the rarely possible safe evaluations of gas discharge driven cold fusion [3] and confirm the fully reproducible measurements of low energy nuclear reactions (LENR) following Boltzmann probabilities, magic numbers [4] and supporting the model of endothermic heavy element generation in the Universe with the limit of uranium generation [4,5].

Our model that the high density protons or deuterons in palladium, nickel or similar host metals undergo LENR, needs the explanation why the Coulomb repulsion of these hydrogen isotopes is cut at the distance of picometers (pm). This is possible by two different models about which no decision has yet been made. The one model assumes the state of the hydrogen nuclei in the host metal as a Boltzmann gas where it was shown that the Debye screening is possible [3,4] to drop any Coulomb interaction above pm distances. These screened protons or deuterons can then interact (not the p-p-reactions because of the weak force!) even with heavy nuclei within the low probabilities due to the pm distance. The alternative model uses the plasma dielectric constant of much less than unity in the metal resulting in hydrogen atoms with Bohr radii in the pm range permitting nuclear reactions in pm distances. The observations of LENR are similar to the K-shell electron capture of nuclei where the Bohr radii are in similar ranges of pm and the reaction times are comparable with the megaseconds of LENR. Recent elaborations about weak force involvement are under discussion.

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Accelerator Experiments and Theoretical Models for the Electron Screening Effect in Metallic Environments

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An overview of our experiments and their results for the screening energies is presented. The measurements of the reactions ${}^2\text{H}(d,p){}^3\text{H}$ and ${}^2\text{H}(d,n){}^3\text{He}$ were performed with a electrostatic accelerator at incident deuteron energies between 5 and 60 keV at different self-implanted target materials. The resulting screening energy values are about one order of magnitude larger compared to gas target experiments and exceed significantly the theoretical predictions [1]. A thorough investigation of the processes in the targets under ion irradiation shows that there are multi-parameter collateral effects which are crucial for the correct interpretation of the observed enhancements. They mainly originate from target surface contaminations due to residual gases in the vacuum as well as from inhomogeneities in the deuteron density distribution in heterogeneous targets. For the special situation of deuterium in the metallic environment an adapted analysis method has been developed beyond the standard procedures. Experimental evidence for the influence of such effects and a mathematical model for their assessment are given [2] and compared with the results of other groups [3,4].

We also present a numerical model of the electron screening effect in metallic lattices based on an ab-initio Hartree-Fock simulation. Further possible improvements of the model will be discussed.

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Evidence for a Target-Material Dependence of the Neutron-Proton Branching Ratio in d+d Reactions for Deuteron Energies below 20 keV

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Angular distributions and the neutron-proton branching ratio of the mirror reactions ${}^2\text{H}(d,p){}^3\text{H}$ and ${}^3\text{H}(d,n){}^3\text{He}$ have been investigated using different deuterized metallic targets at the projectile energies ranging between 5 and 60 keV. Whereas the experimental results obtained for Al, Zr, Pd and Ta targets do not differ from those known from gas-target experiments, an enhancement of the angular anisotropy in the neutron channel and a quenching of the neutron-proton branching ratio have been observed for Li and Sr targets at the deuteron energies below 20 keV. A theoretical analysis of the experimental results has been performed using a parameterization of all possible channel-spin matrix-elements [1,2]. Assuming an induced polarization of reacting deuterons, the observed asymmetry effects between the neutron and proton channels could be explained within an adiabatic approximation.

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The influence of “strange” radiation on Mössbauer spectrum of Fe57 in metallic foils

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Mössbauer investigations of thin foils of metallic iron exposed to "strange" radiation generated by electric explosion of thin wires in liquid are presented. The method of conversion electron spectroscopy has been used to determine the nature of detected particles admittedly named magnetic monopoles. The experiment has shown that the number of monopoles absorbed by the sample is enough to detect its influence on the Mössbauer spectrum. Determined changes of the effective magnetic field on iron nuclei essentially exceed measurement inaccuracies. The following has been determined: a) the effect value depends on time from irradiation moment; b) the change of effective magnetic field on iron nuclei correlates with the direction of the external magnetic field applied to the sample during the irradiation, that is the magnetic field separates N- and S-monopoles.

Th-W and Hg transmutation experiments by D2 gas permeation through Pd/CaO/Pd complexes.

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Following some specific, and intriguing, experimental results obtained by:

Y. Iwamura team (at Mitsubishi Heavy Industries, Japan) on fully reproducible transmutations of Cs (to Pr) and Sr (to Mo) ions by a so-called “Palladium complex thin plate” permeated for 1-2 weeks with Deuterium gas (data presented at ICCF9, JCF4, ICCF10, JCF5, and published on JJAP on 2002);

F. Celani team (at Frascati National Laboratory, Italy) on evidence of some “fission” of Th-Hg ions electrolytically deposited on thin and long Pd wire, with solution of ultrapure C₂H₅OD and D₂O at 90/10% concentrations (data presented at ICCF10, JCF5); this paper investigates, by the Iwamura experimental set-up, in Japan, the fission like elements coming out from Th-Hg-Pd-D system.

Because of some experimental constraints, the short time available for the experiments, and the need to separate the origin of the fission products detected by the Celani team, only 2 different kinds of experiments were made, both using Iwamura’s Palladium complexes:

Thorium based experiment: ThW(SO₄)₂ solution electrochemically deposited on Pd complexes surface, 3 experiments in total;

Mercury based experiment: pure Hg ion implanted (20kV, 10¹⁵ ions/cm²), 2 experiments in total.

It is interesting to note that, when the permeation flux was sufficiently large (2.5sccm) and maintained for a sufficiently long time (over 160h) it was clearly detected, in Hg based experiment, the appearance of Copper in situ (by XPS analysis): external contamination ruled out.

Later on, such results were confirmed by SIMS-TOF analysis: in addition to Copper identification isotopic anomalies were also detected on ⁶³Cu/⁶⁵Cu ratio (1.97 instead of 2.25, natural one).

The value of isotopic anomaly ratio of Copper is quite similar to previous results obtained by the Celani team, in an electrochemical environment, by ICP-MS analysis, in a Th-Hg-Pd-D system.

Observation of Nuclear Transmutation Reactions induced by D₂ Gas Permeation through Pd Complexes

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Anomalous low energy nuclear transmutations have been observed on the Pd complexes, which are composed of Pd and CaO thin film and Pd substrate, after subjecting the Pd complexes to D₂ gas permeation. Our experimental method can be characterized by the permeation of D₂ gas through the Pd complex and the addition of an element that is specifically targeted to be transmuted. We already reported experimental results in the reference [1] and [2].

In this paper, we describe recent progress and results. The following items are main new results.

Transmutations of Ba into Sm were observed both for the case of natural Ba on Pd complex samples and for the case of mass 137 enriched Ba. SIMS analysis showed that ¹⁵⁰Sm is the largest in the case of natural Ba and ¹⁴⁹Sm is the largest in the case of mass 137 enriched Ba. ¹³⁸Ba is the largest isotope (71.7%) in natural abundance therefore it can be considered that ¹⁵⁰Sm was derived from ¹³⁸Ba. On the contrary, we used 82% ¹³⁷Ba enriched Ba material, therefore it could be said that ¹⁴⁹Sm was derived from ¹³⁷Ba. In other words, we obtained mass distribution of Sm depending on given isotopic distribution of Ba by our experimental method.

Nuclear transmutations which showed mass increase of 4, 8, 12 and correspondingly atomic number increase of 2, 4, 6 were observed. For example, transmutation of Ba into Sm belongs to the category of mass increase 12 and atomic number increase 6. Nuclear transmutation induced by our experimental method is not limited to the transmutation of mass increase 8 and atomic number 4 (Cs → Pr, Sr → Mo)

One of our experimental apparatus was carried to SPring-8, which is the world's largest synchrotron radiation facility located in the west part of Japan, for the purpose of in-situ measurement. Although we are now at first step of the experiments and did not perform in-situ observation, we obtained some Pr signals by X-ray Fluorescence method.

Some experiments were done to explore the physical effect of CaO layer. According to a D⁺ ion beam bombardment experiment performed at Tohoku University, deuterium density of our Pd complex indicated one order larger than normal Pd. When we replaced CaO with MgO, we did not obtain any positive results. These results give us the data for consideration on the role of CaO layer in the Pd complex.

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Excess heat power production in Pd/D for the pulse periodic discharge current of various conditions

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Experimental measurement of excess heat power production, yield of the element isotopes impurities in cathode material, registration of heavy particles emission and soft X-ray emission were carried out using a high-current glow discharge device for a long time. The results on excess heat power production and stable impurity elements yield upon the glow discharge cathode in relation to the operating parameters of high-current glow discharge are reported. The pulse-periodic electrical power supply was used. The discharge was carried out in H₂, D₂, Ar, Xe, Kr at pressure up to 10 Torr, current up to 500 mA and discharge voltage of 500-2500 V. The cathode samples were made of Pd. The pulse period, pulse duration and value of discharge current were changed. The excess heat power up to 10 –15W and efficiency up to 150 % were registered under the experiments for Pd cathode samples in D₂ discharge. The excess heat power up to 5 W and efficiency up to 150 % were registered for previously deuterium charged Pd cathode samples in Xe, Kr discharges. This result shows that the excess heat power continues to be liberated in the cathode sample after the current is turned off (during the time interval between the current pulses).

The elements impurities were approximately half the Pd mass and near equal to Pd mass in the near-surface layer having the thickness of 100nm in amount up to some tens of percent. The impurity content in depth of 800 nm decreased by 1.5 - 2 times in comparison with the near-surface layers.

Carrying out the non-equilibrium nuclear transmutation reactions was possible in such medium. The totality of the experimental results allows the assumption that the energy of the excited nuclear levels of the formed nuclides converts into heat. The specific physical mechanism of such conversion requires additional research.

Reserach into characteristics of X-ray emision laser beams from solid-state cathode medium of high current glow discharge

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X-ray emissions ranging 1.2 – 3.0 keV with intensity up to $1.0 \text{ Gy/sec} \cdot 4\pi$ have been registered in experiments with high-current Glow Discharge in $\text{D}_2, \text{H}_2, \text{Kr}$. The emissions energy and intensity dependence of the cathode material used, kind of plasma-forming gas and the discharge parameters have been studied. The experiments were carried out on the high-current glow discharge device using deuterium, hydrogen and Kr, Xe at pressure up to 10 Torr, as well as cathode samples made from Al, Sc, Ti, Ni, Nb, Zr, Mo, Pd, Ta, W, Pt, at current up to 500 mA and discharge voltage of 500-2500 V. The pulse-periodical power supply of the glow discharge was used.

Two emission modes were revealed under the experiments:

1 - Diffusion X-rays were observed as separate X-ray bursts (up to 10^5 bursts a second and up to 10^6 X-ray quanta in a burst)

2 - X-rays in the form of laser microbeams (up to 10^4 beams a second and up to 10^9 X-ray of quanta in a beam). The emission of the X-ray laser beams occurred during the discharge burning and within 100 msec after current turning off. The laser microbeam diameter of 100 μm from the cathode was equal to 5 - 10 μm , angular divergence was up to 10^{-4} . The X-ray intensity in the mode of diffusion bursts changed with the distance under the inverse square law ($1/r^2$). In the generation mode of the X-ray laser beams the emission rate decreased insignificantly when increasing the distance from the detector to the cathode from 20 cm to 70 cm.

The results of experimental research into characteristics of secondary penetrating radiation occurring when interacting primary X-ray beams from a solid-state cathode medium with targets made of various materials are reported.

The temporal radiation spectrum of the primary laser X-ray was of a discrete character. The kind of the temporal radiation spectrum of the primary laser X-ray was defined by the cathode material. The separate burst (up to 10^9 X-ray of quanta in a burst) were registered within 85 ms after the current was turned off.

The secondary radiation of two types was observed.

1-The emission with a continuous temporal spectrum in the form of separate bursts with intensity up to 10^6 fast electrons per burst. This emission began in 0.5 - 1.0 ms after the discharge current was turned off.

2-The emission with a discrete temporal spectrum and emission rate up to 10^9 fast electrons per burst. The bursts distribution of this emission with time was defined by the target material.

A third type of the penetrating radiation was observed as well. This type was recorded directly by the photomultiplier placed behind the target without the scintillator. In this scheme the target was positioned between the shield with the thickness of 3 mm made of plastic and PM detector. The type of the secondary radiation was defined by the detector material. The abnormal high penetrating ability of this radiation type requires additional research to explain.

The obtained results were the direct experimental evidence of existing excited metastable energy levels with the energy of 1.0-3.0 keV in the solid of the cathode sample. Hypothetically, the mechanism of forming the metastable energy levels with the energy of 1.2-3.0 keV in the solid was caused by exciting the inner electrons M and L of the solid atom shells when bombarding the cathode surface by plasma ions. Hypothetically, the inverse medium population with the energy of 1.2-3.0 KeV was created in the volume of separate crystals having the sizes of 0.1-0.01 mm. When generating the laser X-ray in the mode of super intensification, the duration of the separate laser beams must be $\tau = 3 \cdot 10^{-13} - 3 \cdot 10^{-14}$ s, the separate beam power must be $10^7 - 10^8$ W.

The obtained results show that creating an optically active medium with long-living metastable levels with the energy of 1.0-3.0 keV and higher is possible in the solid state.

Enhanced reaction rate of the Li+d reaction and the screening energy in metal

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A series of measurements on DD fusion reactions in metals[1] has revealed that DD reactions are anomalously enhanced at low incident energies in metal environment. This finding is of particular importance to understand the ultra-low energy DD reactions in metal environment, since the reaction rate at the thermal energy estimated from the observed enhancement reaches more than 10^7 events/sec/cm³. Although the enhanced reaction rate can be interpreted to be due to a large screening potential, its origin is still unknown.

In order to explore the mechanism of enhanced screening, we have studied the Li+D reactions in various conditions. A deuteron beam with several 10 μ A from 25 to 80 keV obtained from the low-energy high-intensity ion beam generator was used to bombard Li nuclei in various conditions; they are Pd-Li and Au-Li alloy, LiF, solid and liquid metal Li. A ΔE -E counter telescope consisting of 20- and 100- μ m thick Si surface barrier detectors was used to detect α particles emitted in the ${}^{6,7}\text{Li}(d, \alpha){}^{4,5}\text{He}$ reactions.

Results for Pd-Li and Au-Li were already published in [2]: (1) Yields of α particles emitted in the ${}^{6,7}\text{Li}(d, \alpha){}^{4,5}\text{He}$ reactions in PdLi_x and AuLi_x clearly show that the reaction rate in Pd at lower energies is enhanced strongly, but no enhancement is observed in Au. (2) Screening energies introduced to reproduce the excitation function of the thick target yield are 1500 ± 310 eV for Li in Pd metal and 60 ± 150 eV for Au. The enhancement in the Pd case cannot be explained by electron screening alone but suggests the existence of an additional and important mechanism of screening in metal.

Experimental techniques have been developed, recently, for the reactions with solid and liquid Li metal, and we have measured α -particle yields as a function of target temperature as well as bombarding energy. The screening energy for the solid Li metal has been deduced to be 450 ± 100 eV, which is slightly enhanced over the bare reaction. In addition, a clear difference for a solid-liquid phase change has been observed in α -particle yields measured at 80 keV. The possible origins which cause the difference will be discussed as well as a possibility of strongly enhanced Li+D reaction in liquid phase.

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Alternative Interpretation of Low-Energy Nuclear Reaction and Transmutation Processes with Deuterated Metals Based on The Bose-Einstein Condensation Mechanism

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Recently, the Bose-Einstein condensation (BEC) mechanism has been generalized to a ground-state mixture of two different positively charged bosons (such as deuterium and palladium nuclei) in harmonic traps [1]. One of the main predictions of the BEC mechanism is that the Coulomb interaction between two charged bosons may be suppressed for the case of a large number of particles and hence the conventional Gamow factor may be absent [1]. The theory has been used to analyze low-energy nuclear reaction (LENR) experiments involving atomic clusters (Pd black powders) [2] and acoustic cavitations [3]. The generalization to the two species case allows us to propose an alternative theoretical interpretation of LENR processes in deuterated metals to include the two-species reactions with entrance channel (D + X) where X represents a Bose nucleus other than D, in addition to the conventional one-species (D + D) reaction. Both (D + X) and (D + D) reactions may be occurring in LENR and transmutation experiments.

For application of the BEC mechanism to LENR and transmutation experiments involving metals, we assume that non-equilibrium fluctuation might make either vacancies or impurities sufficiently mobile so as to allow Bose nuclei to move collectively in localized regions. Another possibility is that these non-equilibrium fluctuations might enable the particles to tunnel so as to create localized BEC states. These mechanisms are expected to be more favorable with micro- and nano-scale atomic clusters, dendrites, and cavities, and are consistent with proposed “crud” scenario [4].

The proposed theoretical interpretation will be discussed for the results (excess heat and nuclear emission) of LENR experiments with deuterated metals (heavy water electrolysis, deuterium gas, etc.) including triggering requirements [5], and laser stimulation [6], and deuteron beam experiments [7]. To assess the validity of this proposed theoretical interpretation for the LENR experiments, it is essential to carry out accurate probes of isotope abundance ratios in deuterated metals by neutron activation analysis (NAA), time of flight secondary ion mass spectroscopy (TOF-SIMS), and trace-element accelerator mass spectroscopy (TEAMS) [8,9].

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Mixtures of Charged Bosons Confined in Harmonic Traps and Bose-Einstein Condensation Mechanism for Low Energy Nuclear Transmutation Processes in Condensed Matters

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A mixture of two different positively charged species of bosons in harmonic traps is considered in the mean-field approximation. It is shown that depending on the ratio of parameters involved, the ground states of two components may coexist in the same regions of space, in spite of the Coulomb repulsion between the two species. Application of this result will be discussed for a generalization of the Bose-Einstein condensation mechanism for low-energy nuclear reaction in condensed matters [1-5] to describe transmutation processes involving two different integer-spin nuclei (Bose nuclei) in condensed matters [6,7].

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Proposal for New Experimental Tests of the Bose-Einstein Condensation Mechanism for Low Energy Nuclear Reaction and Transmutation Processes in Deuterium Loaded Nano-Scale Cavities

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New experiments are proposed for testing the Bose-Einstein condensation (BEC) mechanism for low energy nuclear reaction (LENR) and transmutation processes in nano-scale traps.

Theoretical studies of the BEC mechanism have been carried out by approximately the many-body Schrodinger equation for a system of N identical charged integral-spin nuclei ("Bose" nuclei) confined in ion traps [1-5]. The ground-state solution is used to obtain theoretical formulae for estimating the probabilities and rates of nuclear fusion for N identical Bose nuclei confined in an ion trap or an atomic cluster. One of the main predictions is that the Coulomb interaction between two charged bosons is suppressed for the large N case and hence the conventional Gamow factor may be absent. The theory has been used to analyze LENR experiments involving atomic clusters (Pd black powders [4]) and acoustic cavitations [6].

The proposed experiments involve the direct use of nano-scale cavities in porous vycor glass [7], aerogel [8], and nanogel (aerogel bead of \sim a few mm diameter) [9], which has interconnecting cavities or pores with average pore diameter of \sim 10nm. After saturating it with deuterium gas, heavy water, or other deuterated materials, and stimulating it with lasers, electromagnetic fields, or acoustic waves, etc., we may look for experimental signatures (fast neutrons, etc.) of nuclear processes in deuterium-saturated porous silica materials including electrically conducting carbon aerogels [10] as a function of pressure or temperature, both during and after external stimulations.

Some details of the proposed experiments will be discussed including proposals to repeat LENR and transmutation experiments and also the recent deuterium gas experiment of Mizuno et al. [11], using porous aerogel, nanogel, or vycor glass.

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A documented history of seven rejections

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A review paper, summarizing recent cold fusion claims, was consecutively submitted (after the last cold fusion conference, ICCF10) to seven physics journals. In each case it was rejected by the editor. The paper, to be described, was limited to science of cold fusion; controversial social issues surrounding the field were deliberately ignored. Why was this paper rejected without allowing it to be peer-reviewed? I will address this social question and show the letters of rejections.

Charged particles from Ti and Pd foils.

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A TiDx foil, prepared by S. Jones, (1) was sandwiched between two CR-39 detectors for the time interval of two months. A direct current of 1.5 A was sent through the foil to match conditions under which emission of protons was first observed. A small number of tracks, on the CR-39 surface facing the foil, was compared with even smaller number of background tracks. A palladium cathode, used by D. Letts (2), was analyzed in the same way (but without electric current). The two CR39 detectors surrounding the cathode were etched and examined. The number of clustered tracks found on detectors exposed to Pd turned out to be at least several hundreds times larger than in the background.

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A summary of recent cold fusion claims

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Cold fusion consists of nuclear reactions occurring in solid metals loaded with hydrogen. Considerable progress has been made in that area in the last ten years. This 2004 paper summarizes recent claims without attempting to evaluate their validity. The manuscript was submitted to seven physics journals. Unfortunately, the editors rejected it without the benefit of the usual peer-review process.

Using CR-39 to observe charged particles from a TiDx foil

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A TiDx foil, prepared by S. Jones, (1) was sandwiched between two CR-39 detectors for the time interval of two months. A direct current of 1.5 A was sent through the foil to match conditions under which emission of protons was first observed. Numbers of tracks on CR-39 surfaces facing the foil were compared with numbers of tracks on the opposite surfaces. A palladium cathode, used by D. Letts (2), was sent to me to be analyzed in the same way (but without electric current). The two CR39 detectors surrounding this target will soon be etched and examined. Results from these attempts to see tracks of charged particles will be presented and discussed.

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Cold Fusion Phenomenon and Solid State-Nuclear Physics

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Since the discovery of the cold fusion phenomenon (CFP) in 1989, there has been steadily developed research of the science of CFP experimentally and theoretically revealing its complex nature; sporadic occurrence of various events including nuclear transmutations (NT) of elements with large mass numbers in compound systems under ambient radiations with qualitative reproducibility. Such typical characteristics of CFP as: occurrence of CFP only in fcc (and hcp) transition metal alloys with hydrogen isotopes but not in bcc alloys, the stability effect in NT (H. Kozima, Proc. ICCF10), helium production only in electrolytic systems with lithium electrolyte in heavy water, optimum combinations of [cathode-electrolyte-hydrogen isotope], etc. are investigated quantum mechanically in this work.

It is shown that quantum mechanical states of hydrogen isotopes in transition metals worked out in the physics of transition-metal hydrides have a close relation with appearance of CFP; H in Ni and D in Pd in favor of CFP are related with wave functions of protons (deuterons) in these metals. Quantum-mechanical calculation of the interaction between occluded protons (deuterons) at interstitial sites and neutrons in nuclei at lattice points (lattice nuclei) [1] have shown that neutrons in different lattice nuclei interact strongly with each other through the “super-nuclear interaction” mediated by occluded protons (deuterons). Neutrons in excited states with rather extended wave functions are favorable for this interaction. This super-nuclear interaction between neutrons in different lattice nuclei makes possible appearance of neutron bands at around zero-level of energy (the neutron evaporation energy of the lattice nuclei), which induces accumulation of neutrons at surface/boundary layers and formation of cf-matter there. Neutron drops in the so-realized cf-matter induce nuclear reactions in the region observed as CFP very different from those reactions in free space investigated in nuclear physics, hitherto.

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On the New Standard Model of Particle Physics

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Many phenomena of the cold fusion phenomenon appear not to be explicable within the framework of quantum mechanics. We would like to point out that the new standard model of particle physics extends quantum mechanics even in basic concepts. In contrast to quantum mechanics, the new standard model includes velocity and force operators, challenges the Copenhagen interpretation of quantum mechanics and violates the relativity principle.

The new standard model of elementary particle physics is described by three Lagrangians. These are the Weinberg - Salam Lagrangian of quantum flavour dynamics (QFD) [1, 2], the Fritzsche - Gell-Mann - Leutwyler Lagrangian of quantum chromodynamics (QCD) [3], and the Kühne Lagrangian of quantum electromagnetodynamics (QEMD) [4, 5].

Both QFD and QCD are non-Abelian gauge invariant quantum field theories (Yang - Mills theories) [6]. The gauge group SU(2) explains the quantization of isospin [7] and the gauge group SU(3) explains the quantization of colour charge [3].

By contrast, the gauge group U(1) of quantum electrodynamics (QED) cannot explain the quantization of electric charge.

QEMD is a generalization of QED. It includes Dirac magnetic monopoles and two kinds of photons, Einstein's electric photon and Salam's magnetic photon. The gauge group U(1) x U'(1) of QEMD explains the quantization of electric charge [4, 5].

The revolutionary concept of QEMD is the introduction of velocity coupling [4]. The magnetic photon couples via velocity coupling to electric charges. This requires the introduction of a velocity operator and allows the definition of a force operator. Recall that the original formulation of quantum mechanics does not include velocity and force operators [8, 9]. The concept of motion is also not included in the Copenhagen interpretation of quantum mechanics. Therefore QEMD challenges the Copenhagen interpretation [5].

QEMD requires that the velocity coupling for emission and absorption processes does not describe a relative velocity but the absolute velocity of the electric charge which emits or absorbs, respectively, the magnetic photon [4, 5].

The concept of the absolute velocity violates the relativity principle of Special Relativity. However, I have shown [10] that it is compatible with General Relativity which even requires an absolute frame.

The magnetic photon rays predicted by QEMD [4] have been observed in two recent experiments [10]. So we suggest that the new standard model of particle physics includes QFD, QCD, and QEMD.

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The Micro Hot Fusion Scenario

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During the years 1986 and 1989 three experimental teams independently reported to have discovered cold fusion. The experiments differed strongly from one another, both in the applied methods and the reported results. Hence, the observational results need not necessarily result from one unique physical mechanism. Let us take a brief look at these three types of cold fusion.

Type 1: Mechanically treated LiD and heavy ice samples were reported to have emitted neutron bursts having lasted for roughly ten minutes [1].

Type 2: Motivated by geophysical observations (anomalous isotope ratios [2, 3]), electrolysis of deuterided metal was performed and reported to have generated low levels of neutrons of 2.5 MeV energy [2]. These emissions appeared a few hours after the start of electrolysis and terminated several hours later [2].

Type 3: Electrolysis of deuterided metals was reported to have emitted high levels of heat appearing days after the start of electrolysis [4, 5]. Signals of nuclear fusion (neutrons, gamma rays) were at least 10 orders of magnitude too small to explain the reported heat emissions [4, 5].

The experiments of type 1 were motivated by positive results of fracto-emission experiments and explained by the fracto-fusion model [1]. An analogous "micro hot fusion" scenario was suggested [6] for the explanation of the type 2 experiments.

The micro hot fusion scenario can be described as follows [7, 8]. When hydrogen is absorbed by metals, then it can form hydrid bubbles around impurities and dislocation nuclei. During their growth the bubbles deform the metal lattice and build up mechanical stresses. After several hours these stresses have become strong enough to create cracks which propagate through the metal lattice. These cracks are expected to form preferentially at the boundary between hydrid bubble and the weaker hydrid metal. If strongly hydrid bubbles behave like insulators, then the different electronegativities of bubble and metal generate electrically charged crack sides. In strongly hydrid metals the electrons can be assumed to be stronger bound than the hydrogen nuclei. Therefore the electric fields within the cracks are allowed to accelerate the hydrogen nuclei up to keV energies. If the hydrogen isotope deuterium is used, then the keV energy deuterons are able to fuse. Subsequent neutron emission is the consequence.

This scenario is able to explain many characteristics of the neutron and charged particle emissions reported by successful cold fusion experiments [7, 9]. It is also able to explain why a high number of cold fusion experiments yielded negative results [7, 10]. Main reasons for failures appear to be insufficient sensitivity of the detectors and ignorance of the essential original observation [1-3] that the emissions terminated a few hours after the start of electrolysis or several minutes after the mechanical treatment, respectively. Micro hot fusion is not able to explain the cold fusion experiments of type 3. A highly speculative attempt, "extended micro hot fusion" [11], was suggested as a unifying scheme for the explanation of all cold fusion experiments. To decide whether micro hot fusion is indeed the mechanism for the cold fusion of types 1 and 2, experiments of the kind suggested in Refs. [7] and [10] should be performed.

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Interaction of magnetic monopoles on polar molecules having a structural instability

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According to experiments described by Leonid Urutskoiev and al concerning production of a “strange light” during transmutation at low level of energy, it appears also a production of magnetic monopoles according to model proposed by Georges Lochak.

In the near neighbourhood of magnetic monopoles the magnetic field is in the range of 100,000 teslas which is an enormous incredible value for a magnetic field.

The idea aroused to test a possible effect of such magnetic monopoles on polar molecules such as ammonium nitrate. Is a such local magnetic field able to create a macro effect ?

The experiment has been performed and repeated hundreds of times.

The ammonium nitrate is placed in a little cylindrical container, volume 1cm³, made in duralumin 1mm thickness, screwed tightly performing an excellent Faraday’s box.

Magnetic monopoles are produced at a distance up to 2 meters from the container.

It appears a decomposition of the ammonium nitrate with production of gas and water.

Some questions are arising on the possible origin of the explosion of the French ammonium nitrate production plant near Toulouse 2001 9/21. 31 Died, 2500 injured. Investigation hasn’t yet given a sure conclusion. Are magnetic monopoles a possible origin of this blow out?

Cold Fusion Is part of a Scientific Revolution

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The cold fusion phenomena are several of a larger group of anomalies in physics. These anomalies are discerned because they are contradictions of the basic ideas of Q. M. and Relativity theory. Q.M. and Relativity is the established paradigm. The present development of the field of cold fusion and the elucidation of these anomalies are a part of a scientific revolution in the field of physics. This is not the first time the basic ideas of an established paradigm have been contradicted. There have been similar revolutions in the field of physics of the kind described by Thomas Kuhn every 80 years since 1506 when there was the beginning of the Copernican Revolution. Understanding cold fusion and the CF field in the broader historical context is helpful for understanding the development of the field and the significance of the phenomena.

The various kinds of phenomena now collectively termed “cold fusion” are a part of a “crisis period” in physics. In the Structure of Scientific Revolutions, Kuhn described crisis periods as ten or twenty year periods of time during which the fundamental ideas of an established paradigm are challenged by the discovery of anomalies. The cold fusion phenomena, together with anomalies of ball lightning, superconductivity, sonoluminescence, cavitation, and some astrophysical anomalies are a part of the basis for a revolution in physics theory. The current revolution is following the pattern of the past revolutions that was described in his book. Starting about 1973 or so, physicists began to test the basic ideas of the established paradigm and to fulfill long established predictions because Q. M. based technology had improved sufficiently and the experimenters had matured, as physics entered a crisis period. From 1973 to 1993 or so, they validated important predictions such as showing the effect of altitude on time and the relativistic treatment of the lamb shift, but a group of middle aged researchers including Lipson, Shoulders, Pons and Fleischmann, and others began to discover basic anomalies. Though the anomalies haven't been widely studied or believed, there is sufficient evidence for the formulation of novel theory.

After Copernicus conceptualized both a new astronomy and a new physics explaining natural phenomena from a heliocentric standpoint in 1506, there have been revolutions in physics every 80 years: the Galilean, about 1593; the Newtonian, 1664; the Fluid paradigm about 1745 that was originally formulated by Franklin; the Classical Field theory, 1820 that was rudimentarily formulated by Faraday and developed by Maxwell; and the Quantum Mechanics and Relativity theories, about 1905. Two factors have limited the rate that scientifically advanced societies have replaced physics paradigms.

Older, more experienced people learn basic physics ideas that are different from their own slowly or not at all. I call this constraint the inhibition of apprehension.

Theoreticians are usually not the best experimenters or technicians, and vice versa. I call this constraint the difference between theoreticians and technicians.

Kuhn described these ideas in his books. These constraints play out to give the history of physics a three generation, three step pattern of development with a periodicity of about 80 years. Understanding the past pattern of development may help people understand how physics will develop in the future, and about cold fusion's pattern of technological development and its future economic effects. If the past pattern is followed, a new theory will emerge that is accepted by young people who will develop the paradigm and thus enable the development of new industries with a few decades. One may expect that the theory will not be accepted by the older, established physicists who already believe Q. M. The theory will begin as rudimentary hypotheses, and then be developed over time.

Microscopic ball lightning in Cold Fusion

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What is the connection between ball lightning and cold fusion? The phenomena have many similar characteristics and effects. There is evidence of microscopic ball lightning (BL) in the usual kinds of cold fusion and transmutation experiments such as those conducted by Savvatimova, Matsumoto, Shoulders and Miley. There is also evidence of their having cold fusion and transmutation effects. Matsumoto found evidence of BL in many electrolysis cold fusion experiments using various metals for electrodes in both light and heavy water and also in electrical discharge CF experiments. Shoulders found evidence that BL-like objects created by electrical discharge causes transmutation. Savvatimova reported that the glow discharge experiments she conducted produced anomalous markings like Matsumoto's BL traces and markings, and that there was a clear correlation between number of markings and the amount of transmutation products. Lewis, upon investigation of 2 or 3 electrolysis cells at Miley's Fusion Studies lab, found that Ni/plastic Run #8 had copious markings like BL markings and the others didn't. According to Miley, it was Ni/Plastic run #8 that produced by far the most excess heat of all the different microsphere containing electrolysis cells that were studied.

The markings produced by microscopic BLs associated with CF and transmutation experiments are interesting. The objects evidently range from a few millimeters across to submicron sizes. For this reason, they are difficult to see. However, as Savvatimova and Matsumoto showed, they may leave evidence such as markings on X-ray films, electrode surfaces, and plastic sheets. They sometimes leave holes in materials. At other times, they leave ditch-like trails or discoloration when they interact with materials. They also leave the long trail and brush or blot markings like those shown by Matsumoto and Savvatimova.

On the other hand, some microscopic BL don't leave discernable markings when passing through materials. One of the well known and documented, but mysterious characteristics of some BL is the ability to pass through materials like glass without leaving any kind of trace or marking, and there is evidence that a type of these microscopic BL in CF experiments have the same ability. For example, many of the anomalous traces shown by Matsumoto, such as one shown in ref. of a tornado-like trail and several hopping marks that were on a sheet of Acrylite plastic, were made by toroidal or cylindrical BL phenomena that passed through water, glass, and air. The BL that made that marking was produced through electrical discharge in water and shows a combination of tornado behavior and BL behavior.

The excess energy characteristics of natural BL has been studied by BL researchers such as Egely, and the role of natural ball lightning in nuclear reactions were studied by researchers such as Dijkuis. The microscopic BL produce some markings that are similar to the "plasmoid" markings investigated by Bostick, Nardi, and others and like the EV markings shown by Shoulders. The EVs studied by Shoulders behave like BL in many ways. The EVs' high speed is due to their mode of production by electrical discharge in the electrode configuration used in his experiments. For several decades, electron beam filaments and plasmoids like these were studied as means to cause atomic fusion and fission.

Evidence of BL is the various holes, pits, and tunnels people may find in apparatus, various kinds of deposits, areas of magnetization, transmutation, localized and anomalous melting or disruption of materials, various kinds of discoloration, and spots of excess heat, because BL may sit on conductors or other materials. K. Shoulders and Matsumoto showed how to investigate sites of BL contact with materials by microscopic techniques to determine the chemical composition of spots of BL contact, and they published their findings that the sites of BL or EV contact were indeed associated with transmutation.

BL leave characteristic markings in the apparatus of CF experiments such as shown by the articles of Matsumoto, Shoulders, Savvatimova, and Lewis. Photographs of microscopic BL effects from the four researchers who worked independently are shown in this article. Lewis's pictures are from Ni/Plastic Run #8 and are of markings on each of the component parts of the cell. Common characteristics and effects of BL are described to help experimenters recognize the phenomena. The research evidence shows that the microscopic ball lightning causes transmutation in CF experiments.

Deuterium (Hydrogen) Flux Permeating Palladium and Condensed Matter Nuclear Science

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Deuterium (Hydrogen) flux permeating palladium has been analyzed using mass spectroscopy in a new apparatus. The mass 6 component has been confirmed again. It is found that Langevin rate of D_3^+ generation in the mass spectrometer plays an important role. However, mass 6 component can not be attributed to D_3^+ only. The reactions in palladium plays an important role as well. The mixture of deuterium and hydrogen gas has been used to test the prediction of resonant tunneling theory as well.

During ICCF-10, Cambridge, USA, the correlation between the deuterium flux and the heat flow was reported [1,2]. After ICCF-10, a deuterium flux experiment was conducted at Institute of Engineering Application Research, USA to detect the heat and the nuclear products. The preliminary experimental results was reported in The 5th Asti Workshop on Anomalies in Hydrogen / Deuterium Loaded Metals [3], March, 2004. It was reported that the temperature gradient in the radial direction of the Pd disk was reversed when the deuterium flux was permeating a thin palladium disk. The mass spectroscopy data showed that a mass 6 component appeared in the deuterium gas permeating through the thin palladium disk also. It is desirable to confirm this mass 6 component and analyze this component. Particularly, the tritium production would be a test of the selective resonant tunneling theory, because the selective resonant tunneling theory predicts more tritium production if the mixture of deuterium and hydrogen gas were used instead of pure deuterium gas.

In the new apparatus, the mass spectrometer analyzed the deuterium flux on-line. The components from Mass 1 to Mass 7 were all detected when they were changing with the time. It clearly showed that Mass 6 was not caused by lithium contamination because the Mass 7 was always much lower than Mass 6 (The natural abundance ratio of ^7Li to ^6Li should greater than 12). It revealed also that Mass 6 component increased with Mass 4 component quadratically. This is the characteristics of Langevin rate of D_3^+ generation inside the mass spectrometer in terms of $D_2^+ + D_2 \rightarrow D_3^+ + D$. However, we still found that there was a Mass 6 component which did not increase with Mass 4 while the mixture of hydrogen gas and deuterium gas were permeating through the thin wall of a palladium tube. A new time-of-flight mass spectrometer was developed in combination with a laser stimulated fluorescence spectroscopy. D_3^+ and T_2^+ should be distinguishable in this new system. The preliminary results in the newly developed system would be reported.

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Multiple Scattering Theory (MST) and Condensed Matter Nuclear Science

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Multiple Scattering Theory (MST) is applied to the surface layers of the crystal lattice of the palladium deuteride in order to reveal the wave-like nature of the deuterons inside the crystal lattice of the palladium deuteride. This wave-like nature is inferred from the three anomalous features of the deuterium flux permeating the palladium film, and it explains qualitatively two correlations confirmed by the experiments in Japan and in China.

The three anomalous features of the deuterium flux permeating the palladium film are:

The deuterium flux might increase instead of decreasing, when we increased the number of layers on the surface of palladium [1]

The deuterium flux permeating through the palladium showed a peak-wise feature instead of monotonic trend, when we increase the temperature of palladium [2].

The heat flow is accompanied with this anomalous deuterium flux [2].

These three features are not the characteristics of a diffusion model. If we assume that the deuterons are a group of particles in diffusion; then, the deuterium flux should decrease when the number of layers on the surface of palladium is increasing, because the thickness of the diffusion path is increased. On the other hand, the diffusion coefficient is supposed to increase with the temperature of the palladium because the higher the temperature is, the more deuterons will be excited to become active in diffusion process.

In ICCF-9, the "Super Absorption" model was proposed to show this wave-like nature of deuterons permeating through the Pd film [3]. It was a simple 1-dimensional model; however, it showed that when the total reflecting wave vanished due to the interference between reflecting waves from different surface layers, the total transmission coefficient would increase sharply.

In ICCF-10, the simple 1-dimensional model developed into 3-dimensional model using multiple scattering theory [4]. The numerical calculation of the deuterium flux permeating the palladium film showed all three abovementioned anomalous features.

In the present work, the 3-dimension model is further refined to include the selective resonant tunneling model[5,6]. The nuclear effect is included in the Transition Matrix (T-matrix)[7,8,9] such that the resonant tunneling would enhance the absorption and the elastic scattering simultaneously. We expect that it would explain the two major anomalous phenomena in D/Pd systems:

The excess heat would reach its maximum when the deuterium flux reaches its maximum[2].

The nuclear transmutation would be enhanced when the deuterium flux was enhanced by the multiple layers coated on the surface of a palladium substrate[10].

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Anomalous neutron capture and plastic deformation of Cu and Pd cathodes during electrolysis in a weak thermalized neutron field as an evidence of nuclei-lattice exchange

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Anomalous neutron capture in the hardened Cu and Pd cathodes has been established under combined action of electrolysis and a weak thermalized neutron field (WTNF) with a flux in the range of 180-400 n/s-cm²[1,2]. The 100- μ m thick Cu and Pd cold-worked foils were used as the cathodes during electrolysis in 1MKOH/H₂O and 1MNaOD/D₂O, respectively. The electrolytic cell (80-mm diameter, 120-mm height) with Pt anode and Cu/Pd cathode immersed into separated spaces was put inside the 100 mm thick-lead shielded cavity surrounded by large amount of moderator (water bags and PE(Co) polyethylene). The cell was placed in the front of a HpGe γ -detector about 50 mm from the lead shield. A large amount of lead was employed to decrease the fast neutron flux inside the set up. A Cf²⁵² neutron source with an intensity of $I_n = (2.0-20) \times 10^3$ n/s in 4 π solid angle was placed in a borated polyethylene box outside the lead shielded cavity at the distance about 30 cm from the Cu cathode position. To provide neutron moderation and minimize neutron leakage out of the cavity water bags (200 mm thick each), containing about one metric ton of water were placed around the cavity.

Experiments with a hardened Cu cathode showed about 10 % decrease in 2224 keV gamma peak accompanied thermalized neutron capture inside the cavity during electrolysis compared to electrolysis experiment with annealed Cu and Background runs (with no electrolysis). The number of neutrons captured in the sample during electrolysis is in good agreement with β -⁶⁶Cu nuclide count rate from the cathode. This anomalous neutron capture is accompanied by a strong plastic deformation (bending) of the Cu sample that is not occurred during electrolysis without WTNF irradiation [1].

Similar data was observed during combined electrolysis and WTNF of Pd cathode in D₂O electrolyte. The corresponding gain in neutron capture by the cathode was found to be ~ 25 % of the WTNF flux. The plastic deformation beneath the surface of the cathode was studied by a SIMS technique. Significant isotopic shifts compared to the pristine Pd were found at the depths down to 50 nm in Pd samples after combined electrolysis and WTNF exposure. These shifts are almost completely eliminated by annealing of PdD_x sample at T=800 C [2].

The anomalous neutron capture and plastic deformation of Cu and Pd cathodes under combined action of electrolysis and WTNF could be explained energetically suggesting a selective radiationless thermalized neutron capture beneath the surface at the high internal strain concentration sites. The results of these experiments present a simplest (avoid Coulomb barrier penetration issue) evidence for nuclei-lattice exchange resulting an increase in neutron capture probability and radiationless de-excitation of the lattice compound nuclei formed during this capture.

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Emergence of a High Temperature Superconductivity in hydrogen cycled Pd compounds as an evidence of superstoichiometric hydrogen/deuterium sites.

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Recently, Ashcroft [1] presented strong arguments that hydrogen dominant metallic alloys, might demonstrate a high temperature superconductivity (HTS) over a modest range of external pressures. Earlier experiments showed that after hydrogen/deuterium cycling (H-loading-unloading) of Pd, the residual hydrogen ($x=H/Pd < 10^{-3}$) tends to localize inside deep dislocation cores or nano-tubes ($R_d \sim 2.75 \text{ \AA}$) with a linear density exceeding 5.0 H atoms/ \AA [2]. A simple estimate shows if such linear H density along the dislocation line occurs, the loading ratio x with respect to the Pd atoms, attached to the core can achieve $x=H/Pd=2.8-3.0$. Notice that the pressure inside such deep core of the edge dislocation should be comparable with a local palladium bulk modulus ($P \approx 140 \text{ GPa}$). Thus, the conditions for both hydrogen “precompression” and external pressure impelling would be fulfilled.

Here we report on transport and magnetic properties of a PdH_x ($x \sim (4 \div 6) \times 10^{-4}$) nano-composite consisting of a Pd matrix with hydrogen trapped inside dislocation cores [3]. Pd and PdO/Pd/PdO samples were hydrogen gas and electrochemically cycled, respectively. The high purity Pd single crystals were cycled in hydrogen gas at 1 atm H_2 pressure and $T=300 \text{ K}$, followed by degassing at $T=350 \text{ K}$. The PdO/Pd/PdO samples were prepared from cold-worked 12.5- μm foils. and cycled (7-10 times) by electrolysis in 1M- Li_2SO_4/H_2O solution. Cycling of the samples produced a high concentration of dislocations ($N_d \geq 3 \times 10^{11} \text{ cm}^{-2}$), which trap hydrogen and form closed dislocation loops. Residual hydrogen analysis was carried out using a high-vacuum thermal desorption facility equipped with a quadrupole mass-spectrometer. Residual hydrogen atoms that remain in the Pd and Pd/PdO samples after the cycling are tightly bound to the Pd lattice (activation energy of H desorption were found to be $\epsilon_H = 1.6 \text{ eV}$ in PdH_x and $\epsilon_H = 0.65 \text{ eV}$ in $Pd/PdO:H_x$) and tend to be trapped inside deep dislocation cores as a condensed phase. A special 4 and 2 probe resistance measurement carried out with both pristine and hydrogen cycled Pd/PdO heterostructure showed resistive transition near 75 K in $Pd/PdO:H_x$ sample suggesting increase in its conductivity caused by trapped hydrogen. SQUID AC and DC magnetization measurements vs. T and H carried out with the same samples indicate an appearance of a strong diamagnetic response of the trapped hydrogen phase in $Pd/PdO:H_x$ samples below 70 K in a weak magnetic field ($H \leq 5.0 \text{ Oe}$). The similar results on SQUID measurements obtained for a hydrogen cycled Pd-single crystal also indicate a diamagnetic response below 30 K. These results provide strong evidence of HTS in a hydrogen cycled Pd [4].

The possible role of hydrogen/deuterium filled dislocation nano-tubes in various non-equilibrium LENR processes involving highly loaded Pd deuteride will be discussed. It suggested that the deep dislocation cores filled with deuterium could be considered as active centers of LENR triggering due to (i) shortest D-D distance (\sim Bohr Radius); (ii) highest D-loading of Pd and effective lattice compression; (iii) large optic phonon energy resulting in a most effective lattice-nuclei energy transfer.

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Energetic charged particle emissions from the hydrogen loaded Pd/PdO surface enhanced by a 4He-ion implantation

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Earlier we showed that both Pd thin film cathode electrolysis, Ti glow discharge bombardment and exothermic deuterium/hydrogen desorption from the Pd/PdO heterostructure are accompanied by emission of energetic charged particles: protons of 1.5-2.0 MeV and alphas of 10-16 MeV. [1] The occurrence of energetic charged particles (ECP) during deuterium desorption from Pd/PdO:Dx samples has been confirmed in independent experiments involving as dE-E surface Si-barrier detectors and open - shielded CR-39 track detectors. We have shown that ECP emission is a surface phenomenon observed only in metals with large hydrogen/deuterium solubility, e.g. Pd and Ti. No such emissions were observed in experiments with other metals, including Cu, Al, Ta and stainless steel cathodes. In summary, ECP is found to be detected both in hydrogen and deuterium loaded Pd and Pd/PdO metal foils and is independent of DD-reaction yield, only increasing proportional to the increase in specific power applied to the sample. This data is apparently in contradiction to the theory of lattice-nuclei energy exchange for the metal deuterides, where triggered DD reaction in one site could provide ~ 24 MeV energy to eject alpha particle in another site [2]. Earlier [3] we have showed that ECP emissions from Pd and Ti loaded with deuterium or hydrogen demonstrate some similarities with ECP induced by powerful laser striking the same targets. If lattice mechanisms provide energy focusing, then the ECP in electrolysis or D/H-desorption could resemble laser induced processes via Coulomb explosion of "hot" spots beneath the surface of metal deuteride. The energy released in such a process could be transferred to the closest light nuclei (including, p, d and He-4) captured in the lattice. In order to verify such a process we have performed a new series of experiments using Pd foils with an increased surface He concentration.

To do this, Pd foils implanted with He-4 were studied in-situ during its electrochemical loading with hydrogen. 50 μm thick Pd/PdO heterostructure samples were used as a cathode. The complex cathode consists of a large area ($S=4 \times 2 \text{ cm}^2$) Pd/PdO substrate and two smaller area Pd/PdO:He pieces ($S=1 \times 1 \text{ cm}^2$) tightly attached to one side of the substrate. Both parts of cathode were cut from the same foil. 20 keV 4He-ions were implanted into the surface of Pd/PdO small pieces with a total fluence $\Phi = 2 \times 10^{16} \text{ cm}^{-2}$, using a He - ion gun. The electrolysis was carried out in 1M Li₂SO₄/H₂O solution at current density $j = 20 \text{ mA/cm}^2$. The calibrated CR-39 track detectors (Landauer inc.) were applied to both the Pd/PdO substrate and Pd/PdO:He coating side. Background detectors were placed at the bottom of the electrolytic cell.

Reading of etched CR-39 Foreground and Background detectors showed energetic alpha and proton tracks in the Foreground runs and an absence of such tracks in the Background. Comparison of Foreground detectors attached to Pd/PdO and Pd/PdO:He parts of the cathode showed also significant (2.5-3 X) increase in a number of 7.0-7.6 μm alpha (10-16 MeV) and 6.2 μm proton (1.7 MeV) tracks in He-implanted cathode with respect to pristine Pd/PdO. Moreover, lower energy alpha tracks ($d > 8.0 \mu\text{m}$) ranging from 7.5 to 2.5 MeV are also appear on Pd/PdO:He detectors at a statistically significant level vs. the alpha Background in this energy range.

These CR-39 results support the lattice energy "lasing" model and could be explained in terms of 4He distribution in the sample during electrolysis. He-atoms are mostly bound at the surface, giving rise to energetic alpha enhancement. Part of the implanted He due to defect motion stimulated by electrolysis could diffuse in the bulk giving lower energy alpha emission caused by energy losses in the Pd cathode. The measured enhancement of 1.7 MeV protons at Pd/PdO:He side, can be attributed to a change in near-the-surface mechanical properties of the Pd/PdO:Hx sample caused by He implantation.

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Wave equation for a magnetic monopole

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There is room, in the Dirac equation, for a massless monopole.

The basic idea is that the Dirac equation admits a second electromagnetic minimal coupling associated to the chiral gauge $\exp i\gamma_5\theta$, which is only valid for a massless particle. We have found on this basis in 1983 a new spinorial equation which has been proved to describe a magnetic monopole. The equation automatically satisfies all the symmetry laws of a monopole, predicted by Pierre Curie in 1894. In the problem of the diffusion on a central electric field, we find the Poincaré integral and the Dirac relation $eg/hc = n/2$. At the geometrical optics limit we find the well known classical equation of Poincaré.

Monopole and antimonopole have opposite helicities (as for the neutrino), but not opposite charges : this precludes a vacuum magnetic polarization.

These massless monopoles appear to be excited states of the neutrino, which explains that all the experimental proofs are related to weak interactions (Transmutations under electric discharges by Urutskioiev et al.).

These monopoles may be produced in some circumstances in beta decay, instead of neutrinos. Consequences on the solar activity are considered.

Nuclear transmutations in D-Pd and H-Pd films induced by low power excimer laser beams

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Nuclear transmutation has been clearly observed in thin palladium layers loaded with deuterium and hydrogen gas after ultra-violet laser beam irradiation. To make these experiments thin Pd layers were deposited on silicon wafers having a 50nm film of Ti to improve Pd adhesion. Some of the wafers were implanted with phosphorus and others with arsenic with beam energy of 150 keV. With such energy the projected range for P and As ions in the palladium is 66 and 32 nm, respectively. Samples have been obtained from wafer dicing in many 1cm² parts. The process chamber, filled with deuterium or hydrogen at a pressure of 4bar, contained two identical samples with just one exposed to the laser beam.

The laser irradiation process consisted of 600 shots at a repetition rate of 1 Hz. The samples were processed for 26 times from July 16th to September 23rd 2004.

The laser source was a KrF operating at 248 nm, 20 ns at a fluence of 25 mJ/cm²

At the end of the treatments the samples were analysed by a scanning electron microscope (SEM) and an electron probe micro analyzer (EDX). The samples were then analysed by a plasma spectrometer.

An appropriate quantity of reference material was kept in air and analysed as all the processed samples.

The appearance of coloured spots in the processed samples was the sign that transmutation occurred. Inside the spots for both the H₂ and the D₂ loaded samples treated with laser beam the insurgence of transmutation of elements qualitative analysis was made. The resulting element density was higher in the H₂ loaded sample than in the D₂ one. The main detected elements were: Ca, Co, Ga, K, Mg, Ni, O.

Characterization of nuclear transmutations by 638 nm laser beams

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In this work we report on the transmutation of elements observed in palladium films irradiated by cw HeNe laser beams. The samples used were silicon wafers having a Ti layer with a Pd layer on it. The Ti layer is necessary to improve the adhesion between the substrate and the Pd layer. The samples, cut in small dies of about 1cm^2 , were implanted with boron at 150 keV acceleration voltage. With such energy the B ions are implanted reaching a maximum concentration at a depth of 158 nm.

Two stainless steel chambers have been used to perform the experiments, with each chamber containing two equal samples and just one exposed to the laser beam. Every sample was soaked with hydrogen or deuterium by filling the chambers up to a pressure of 4 bar.

The samples were irradiated at a laser power density of 2 mW/cm^2 . They were processed from July 16th to September 29th 2004.

After the treatment the samples have been analyzed by a scanning electron microscope (SEM) and a microanalyzer (EDX), followed by a further plasma spectrometer (ICP) analysis.

As a control some specimens were kept in air and analyzed in the same way as the processed samples.

The irradiated samples showed morphological modifications such as spots of about $30\mu\text{m}$ size. Such spots show the transmutation of elements; Al, C, Ca, Cl, Cr, Fe, Si, Na, Ni, K, Mg, O, P, S, Ti et al. A high oxygen concentration have been measured, namely 73.19% and 74.89% for H_2 and D_2 gas, respectively.

Review of Cold Fusion by the U.S. Department of Energy

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As a result of the successful last conference in Cambridge and the emerging understanding and solidity of the cold fusion field, input was directed to the U.S. DoE by Peter Hagelstein and Randy Hekman encouraging the department to reevaluate the field. As a result of these initiatives, the four authors were invited to DoE in early November 2003 to recommend a review of the topic and determine a course of action, exactly 14 years after the last formal action by DoE [1].

We will describe the procedure of the review, the ground rules, our rationale in choosing a particular course of action, and summarize the material delivered to DoE in written report [2], oral and electronic forms. We sought to focus on material that we could best defend and make a case that could stand up to a determined attack. It was always our objective to have a transparent review, and we use the opportunity of this conference to fully disclose our view of the process.

At time of writing this abstract, the concluding statement of DoE's position has not been released to the public; possibly it has not yet been formulated. Whatever the result of this review, however, the opportunity to open this topic, to discuss and disclose materials freely, has brought significant advantage to the cold fusion community. Now that the experiments are somewhat under control and theory is beginning to shed useful light, the greatest challenges we face are ignorance and apathy in the scientific and policy arenas. The process of the review, although very demanding of effort and time, has provided ample reward in promoting an elevated discussion.

The four of us appreciate the serious attention given to this review by personnel within the DoE and their reviewers. Dr. James Decker agreed to have the review. Dr. Patricia Dehmer and Dr. Dennis Kovar designed and conducted the review with help from Dr. James Horwitz and Dr. Gene Henry. We salute these individuals and the external reviewers for their concerned interest and participation.

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On energetics of complex nuclei in LENR

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Swimming Electron Layer theory plus fission of resulting heavy “complex nuclei” were proposed earlier to explain the reaction products observed in previous Patterson cell experiments using multi-layer thin films of metals on mm-size plastic beads [1]. More recently we proposed a modified version of this model to explain the Iwamura transmutation experiment [2]. This model is also consistent with recent measurements of energetic charged-particle emission during flat-plate thin-film electrolysis and certain localized reactions and x-ray production during plasma bombardment experiments [3]. The binding energy per nucleon has been estimated for states in the thin-film bead experiments by an energy balance combined with identification of the products associated with each complex. For example, the complexes with average $A \sim 39$ and $A \sim 104$ are found to have excitation energies of ~ 0.05 and 0.2 MeV/Nucleon, respectively. The excitation energy in the case of Iwamura complex is much lower due to the reduced potential of trap sites available at a surface layer multi-atom interface, as is also the case for near surface charged-particle and x-ray emission. The latter are mainly associated with subsurface defect center traps as opposed to the internal trap sites created by multi layer thin films in the case of the bead experiments. In the extreme case of x-ray emission, energies of only a few keV/Nucleon are found, consistent with other treatments of Deutex formation studied by Dufour [5]. The complex nuclei calculations and corresponding experimental data will be discussed in detail.

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Experiments on Condensed Matter Nuclear Events in Kobe University

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Experimental studies on condensed matter nuclear reaction using ion beams at Kobe University are reviewed. In the first study, keV-deuterium ion irradiation of deuterated Au/Pd samples [1] is performed to find possible anomalous nuclear reactions in solids. The Au-coated surface of the Pd sample is irradiated with the keV-deuterium ions and with MeV ion beams for simultaneous characterization of the surface, while the rear surface can be exposed to D₂ gas at atmospheric pressure to load the sample.

In addition, a modified version of the sample system without the implanter has been installed at the another beam line of the accelerator to examine by in situ PIXE analysis exclusively the nuclear transformation observed in ref.[2]; conversion of ¹³³Cs into ¹⁴¹Pr during forced permeation of deuterium through a multi-layered film of Pd and CaO.

A third system has been installed to reproduce the experiments made by H. Ikegami et al.; enormous enhancement of ⁷Li(d,nα)⁴He reaction rate in liquid Li [3]. To purify the experimental condition, we have set up a keV-deuteron irradiation system with a liquid-Li-loop, which enabled us to implant pure Li with deuterons. Liquid Li droplets are dripped into a manifold, and bombarded with a deuteron beam extracted from a duoplasmatron ion source and mass-analyzed with a 60-deg. sector magnet. The α particles produced in the surface region of Li droplets are observed using an SSBD and some sheets of solid-state track detector (CR-39).

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Neutron emission from D2 gas in magnetic field under low temperature

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We observed neutron emissions from pure deuterium gas after it was cooled in liquid nitrogen and compressed under a magnetic field. Neutron emissions were observed in ten out of ten test cases.

The reaction cell was a Pyrex glass tube of 6 mm diameter, 3 mm inner diameter and 100 mm in length. A coil wound around the reaction tube supplied the magnetic field. The magnet coil is made of 1.5 mm diameter copper wire, 10,000 turns. The whole system was put in a stainless steel vessel. The outer surface of the vessel is insulated by Styrofoam, and another layer of 1.5 mm thick stainless steel plates were placed on top of the Styrofoam insulation to prevent electromagnetic noise from reaching the neutron measurement system. The vessel was filled with liquid N₂ to cool the coil and the reactor tube.

The magnetic field was 8 kG at the center of the reaction tube. The current for the magnetic coil was supplied by a stable direct current power supply through a resistive wire, to control the current. The magnetic field passes through the reaction tube along its length. The height of the coil is 100 mm; the same as tube length. The current passing through the coil was increased from 0 to 100 A, which gives the change of intensity of the magnetic field from 0 to 8 kG. Neutrons were measured with three external He3 detectors placed around the cell, 20 cm from the vessel walls.

The experiment was performed 10 times. A typical example is shown below. Neutron burst of 5.5 c/s were 1000 times higher than the background counts. These bursts occurred 2 times within a 300 second interval. The total neutron emission can be estimated from the counting efficiency, and it was $10^4 \sim 10^5$ c/s.

The reaction we observed came about after cooling deuterium gas to a low temperature in a magnetic field. The reaction appears to be highly reproducible, reliably generating high neutron emissions. We conclude that the models proposed heretofore based upon d-d reactions are inadequate to explain the present results, which must involve magnetic field nuclear reactions.

Reproducibility of LENR Experiments

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Reproducibility of experiments within and between laboratories is a cornerstone of the scientific method. Problems with reproducibility have plagued the field of low energy nuclear reactions (LENR) since the Fleischmann-Pons announcement in 1989. This paper deals with reproducibility of experiments both in science generally and in the field of LENR specifically.

One can ask if the quantification of reproducibility is possible. That is, can the degree of reproducibility of a subsequent experiment be measured in comparison to the initial experiment, and possibly be expressed as a percentage? If this is possible, can it be done without subjective factors entering into the evaluation?

Lack of reproducibility within a laboratory indicates ignorance or lack of control of variables or conditions that are significant to the outcome of an experiment. Shortcomings in reproducibility between laboratories may also be due to poor communications, even if the originating laboratory achieved repeatable performance.

There are five fundamental factors that determine the execution and outcome of an experiment, and are, therefore, relevant to the issue of reproducibility:

1. Materials. The composition of materials, including both the major, minor and impurity elements, and the lattice and defect structures of materials are usually critical.

2. Apparatus. The materials out of which the experimental equipment is constructed, and its geometry, are generally very influential.

3. Protocols. What is done and in what order almost always determines the results of experiments, whatever the subject.

4. Experimenter. The experience, skills and predilections of the experimenter(s), usually determined by education and past work, are important, especially for very inter-disciplinary subjects like LENR.

5. Organization. The organization within which experiments are conducted certainly influences their course because of the importance of available infrastructure and the actual or psychological support of managers and colleagues.

It would be desirable, but difficult to examine all of the 2000+ experimental papers on LENR for the degree of reproducibility reported for each experiment. A database could be constructed with qualitative or quantitative summaries for each paper. Then, a summary of the degree of reproducibility could be tabulated and plotted year by year. Such a major study would exhibit any trends in the reproducibility of LENR experiments. It is expected that it would show increasing reproducibility within and between laboratories over the last 15 years.

The reproducibility of some types of LENR experiments will be addressed in two categories, intra- and inter-laboratory. Some researchers report very high degrees of reproducibility within their laboratories. Their experiments will be described. There have been several situations where an experiment originated in one laboratory has been successfully reproduced in another, sometimes with modifications. They will be noted.

The relationships of experimental reproducibility to process optimization and controllability, which are necessary for commercialization, will be discussed.

Energetic particle shower in the vapor from electrolysis

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Approximately 40,000 energetic charged particles were recorded in a pair of plastic detector chips suspended in the vapor over an active electrolysis cell. Particle track locations and orientations were revealed by examining the etch pits produced by chemical etching. Analysis of track orientations indicates that the shower originated in a compact source in the vapor between the chips. The total magnitude of the shower is estimated to have been 150,000 particles and its duration is estimated to have been a few seconds. Analysis of etch pit cone angles and sizes indicates that the tracks were produced by 2 MeV alpha particles. A previously unknown type of nuclear reaction is indicated. [These results will be shown in a poster session, along with results from other experiments that produced particle showers outside the electrolysis cell in air under a nickel cathode, in deuterium gas under a palladium cathode, in oxygen gas over the anode, and in air beyond the glass wall of the cell.]

Nuclear Reactions produced in an operating electrolysis cell

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We report the results of experiments in which plastic particle-detection chips were exposed in various environments within, and surrounding, operating electrolysis cells. The detected particles carried energies in the range of a few MeV, indicating that they must have arisen in nuclear reactions. Evidence for such reactions was found in deuterium gas behind a palladium cathode that served as part of the cell enclosure, in air behind similarly disposed palladium and nickel cathodes, in air beyond the glass wall of the electrolysis cell, and in oxygen gas above the anode when anode and cathode were placed in separate arms of a U-tube cell. These results, augmented by earlier work indicating nuclear reactions within the electrolyte and in the hydrogen-oxygen gas over a linear-tube cell, cannot be understood in terms of conventional nuclear theory. It is clear that an extension of the theory is required.

Evidence for the occurrence of LENR type process in alchemical transmutations

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The relevance of experimental aspects of alchemy have been neglected for too long in the academic milieu, but in recent years more thoughtful studies of texts from the middle ages and early modern European alchemy evidence the presence of coherent and relevant laboratory practices (1). However, the central core of western alchemy, the quest for the Philosophers' Stone, the substance claimed to transmute base metals into gold, remains, needless to say, elusive. While no book will ever tell us how to prepare such substance, it is nevertheless also true that detailed reports on alchemical transmutations, often authored by witnesses of such events, can be found profusely in alchemical literature. These reports usually contain valuable information regarding quantitative aspects of the transmutation processes. Taking into account numerical parameters of alchemical transmutations such as the weights of starting base metal, gold and Philosophers' Stone, and the duration of the transmutation experiences, it has been found that the transmutation processes follow a specific pattern similar to that generally observed in conventional catalytic reactions (2).

In the present work, several examples of alchemical practices and objects are reported that, taken as a whole, challenge our actual view on the constitution of matter. First, new data are presented which support the catalytic-like performance of the Philosophers' Stone. Indeed, such behaviour is consistent with the alchemical view on the evolution of metals, which conceives the transmutation as an acceleration of the ripening of base metals towards the more perfect gold which takes place in Nature by means of a slow maturation process inside the Earth's womb.

Second, differences between the weight of the starting base metal and the weight of the gold (or silver) obtained at the end of the transmutation process are often noticed in the texts, but no satisfactory explanation for such observation has been given so far. Weight decreases are reported but, more surprisingly, weight increases are reported as well. Analysis of available data evidences a consistent weight variation pattern, which is a direct function of the difference in atomic number between the base and the noble metal. This correlation suggests that nuclear fusion/fission events would take place simultaneously in an appropriate balance during the process.

The noble metal obtained from the transmutation experience, either silver or gold, was used in some cases to cast coins or medals to commemorate the event. Some of them are still preserved in several museum collections across Europe, waiting for a systematic series of physicochemical analyses to be carried out. Other pieces of noble metals of alchemical origin are described in alchemical literature, but descriptions of their chemical and/or physical properties are extremely scarce. One of the very few examples of such products has been recently brought to light (3). Robert Boyle reported the density of a certain piece of a metallic substance of alchemical origin to be 25. No metal with such extremely high density is actually known, but no experimental mistake on his side can account for this surprising result, as in the same text he accurately reported the density value of gold, namely 19. The consistency of this result with more recent reports of alchemical practices is discussed.

It is believed that this new approach to study the alchemical experimental procedures not only would shed new light on the true nature of alchemy, but might be useful as well in exploring new avenues in the transformation of matter.

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Assessment of the biological effects of “Strange” radiation

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The results from studies of the effects produced by electrical explosions of foils made from super-pure materials in water point to the emergence of new chemical elements. An additional finding was the discharge of “strange” radiation accompanying the transformation of chemical elements [1]. However, currently, the mechanism involved in the interaction between “strange” radiation and a substance or a biological entity remains obscure. Therefore, the aim of the present research is to investigate the biological effects of the “strange” radiation.

Pilot studies were performed at the RECOM RRC “Kurchatov Institute” in April-May of 2004. The animals used in the experiment were female mice of C57Bl/6 line aged 80 days with body weight 16-18 g. The animals were exposed to radiation discharged during explosions of Ti foils in water and aqueous solutions [1].

The cages with animals were placed at 1 m from the epicenter of the explosion. Explosions were carried out on the 19th (3 explosions), 20th (4 explosions) and 22nd (3 explosions) of April, 2004 (explosions №1373 - №1382, respectively).

The animals were assigned to 4 experimental groups comprised of 17-20 mice per group. The animals received experimental exposure within 1, 2 and 3 days of the experiment. In total, the experimental groups were exposed to 3, 7 and 10 explosions, respectively.

In order to identify the biology reactions, the following parameters were estimated: number of nucleated cells in the bone marrow, number of CFU in the spleen after additional gamma-irradiation (6 Gy), cell composition of the bone marrow, the rate of erythrocytes with the different level of maturation in the bone marrow, the rate of erythrocytes with the micronuclei in the bone marrow, the reaction of bone marrow cells to additional gamma-irradiation (2 Gy), number of leucocytes in the peripheral blood, and cell composition of the peripheral blood.

The following conclusions were drawn from these studies:

1. “strange” radiation resulting from explosion of Ti foils in water and aqueous solutions has the capacity to produce a biological effect.
2. The biological effect of “strange” radiation is manifested by a 13% increase in the number of nucleated cells in the bone marrow, as compared to that in controls, after exposure of the animals to 10 explosions within 3 days of the experiment.
3. The assessment of micronucleus rate in the bone marrow erythrocytes did not reveal the genotoxic effect of “strange” radiation.
4. The exposure of mice to “strange” radiation resulting from 10 explosions carried out within 3 days leads to 1.5 fold decrease of genotoxic effect resulting from additional gamma-irradiation (2 Gy). Such reaction may be described as an adaptive response.
5. “Strange” radiation resulting from 10 explosions carried out within 3 days after the gamma-irradiation (6 Gy) leads to decrease of bone marrow repopulation.
6. The exposure to “strange” radiation can bring about an increase in the proportion of neutrophils in the peripheral blood of experimental animals.
7. It can be suggested by the results of the test exposures that “strange” radiation can affect human health.
8. It has been shown by these preliminary studies that in order to gain an insight into the biological effects of “strange” radiation further investigation would be necessary.

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Changes of intensity for gamma radiation in the stationary discharge with a magnetic field

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The research of generation for gamma-radiation and neutrons in conditions of the glow discharge on hydrogen isotopes in a magnetic field is carried out. The registered peak of gamma-radiation in the range of 827-907 keV which may be attributed to an isotope Mn-56 (846,8 keV), at realization of researches with the sample-cathode of Mn-55.

The excess of the account for the combined gauge on fast and slow neutrons in the glow discharge with a natural mix of hydrogen isotopes, in comparison with the account without discharge is not revealed and also of neutrons generation is not fixed. The absence of neutrons generation can not serve the sufficient proof of absence for nuclear reactions, at presence of deuterium generation, tritium generation, high-energy beta and gamma-radiation and, also, certain quantity of the excess heat[1,2].

The essential changes of intensity for gamma-radiation in conditions of the glow discharge in a magnetic field, as in the extended power range (accounting mode; 15 keV-10 MeV), and in narrow, a low-energy range (spectrometer mode; 20-72 keV) are marked. It is shown, that the intensity registered of low-energy gamma-radiation created by the stationary glow discharge on hydrogen isotopes in a magnetic field, essentially, is non-uniform. After inclusion of the discharge the intensity within several hours grows, then, within several hours, falls. Between rise and recession the stable intensity of gamma-radiation within several hours can be observed.

The excess of intensity for gamma-radiation in the glow discharge is registered in comparison with background, up to 100 % in narrow (28-31 keV) and up to 500 % in extended (15 keV-10 MeV) power range. The excess of intensity on energy spectrum had monotonous character and to allocate new peaks which are distinct from background, yet it was not possible.

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Cold Fusion And The Future

Jed Rothwell

LENR-CANR.org

Cold fusion will be the ideal source of energy, provided its introduction can be handled properly.

A few cells have shown power density and temperatures suitable for real-world applications. Once these cells can be replicated on demand, commercial development will be straightforward. Manufacturing should not be too demanding, so thousands of companies will compete, and costs will fall quickly. The transition from fossil fuel to cold fusion will be rapid.

Many extraordinary new applications will become possible, and seemingly intractable problems such as global warming may be fixed. Some examples will be presented.

Public support is essential to funding research, and commercialization.

CR-39 track detectors in Cold Fusion experiments : review and perspectives

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Earlier experiments [1,2] have showed emissions of DD-reaction products (3-MeV protons) and energetic charged particle emission (α -particles) during exothermic D(H) desorption from the Pd/PdO:D(H) heterostructures. The occurrence of these emissions was confirmed by independent experiments using both Si-surface barrier and CR-39 plastic track detectors.

The access to purified track detectors along with knowledge of track characteristics produced by various types of particle allow to use CR-39 chips in long-time experimental exposure during electrolysis with Pd and Ti cathodes. The purified CR-39 detectors by Landauer Inc. with background track density $N_b < 30 \text{ cm}^{-2}$ were employed to detect the emissions with very low intensity ($10^{-4} - 10^{-3} \text{ cm}^{-2}\text{s}^{-1}$) The calibration of detectors by α -particles ($E_\alpha = 2 - 30 \text{ MeV}$) and protons ($E_p = 0.6 - 3.0 \text{ MeV}$) as well as utilization of shielding foils gives rise to energy estimate of emitted particles.

The new computerized set up for track detector processing (PAVICOM), which is employed in Lebedev Physical Institute is described. This device allows scan different types of track detectors (CR-39, X-ray films, nuclear emulsions) automatically and stored video information in file. Than these files can to processed by special computer programs for track measurement.

Simultaneous detection of single and multiple types of particles is presented. A new finding regarding the events when 3 or more α -particles directed from the one site on the sample's surface will be discussed. Measurement of ranges of these particles with CR-39 detector showed that the significant part of them are emitted with energies $E_\alpha > 8 \text{ MeV}$.

The analysis of CR-39 data showed that in some cases energetic charged particle tracks (α -particles and protons) concentrated on the small spots of detector. It was found the "hot zone" with $\sim 10^2$ tracks on the square $0.2 \times 0.2 \text{ mm}^2$. It is possible that the emission of these particles were from the high energy concentration site, suggesting maximum internal strain at the sample surface.

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Influence of the magnetic field on structure of the cathode in the glow discharge

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Influence of a magnetic field on structure changing of the cathode material in experiments with a glow discharge in deuterium was revealed.

Spiral formations on a Pd cathode surface were observed at additional imposition of a magnetic field in glow discharge with impulse current. Directions of axes of spirals on a Pd cathode surface preferentially corresponded to a direction of a magnetic field.

Occurrence of spiral formations in experiments with a pulsing current was result of self-organizations structure of a cathode material as a synergetic activity on a material of the cathode of electrical and magnetic fields.

Formation of spirals could consider as an effect of charged particles clusters moving at simultaneous action of electrical and magnetic fields.

However, appearance of spiral formations was occurred in near surface layer of metal at imposition concerning weak of a magnetic field (<100 oersted) and an electric field (≤ 1 keV). It is supposed, that this effect could be a result of a motion of charged particles clusters in thin near surface layer, taking place in a state of pseudo-melting. Pseudo-melting is understood as a state of a crystalline lattice of a material of the cathode irradiated by high density of ions flow, similar its state (of the crystalline lattice) at temperature of melting. Really these effects were observed earlier in the Mo cathode in a glow discharge at temperatures much below to temperature of melting in (1).

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A brief review of the magnetic monopole and the charge quantization condition

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The Maxwell equations are not symmetric with respect to the interchange of the electric and the magnetic objects. We can restore such symmetry by adding the terms of the magnetic charge density ρ_m and its current density i_m at appropriate places. Once we modify the Maxwell equations, we can consider a system in which a particle with the electric charge Q and another particle with magnetic charge q_m coexist. A novel property of such a system is the appearance of the extra angular momentum $(q_m Q/c)\hat{s}$ in addition to the ordinary orbital angular momentum $-\mathbf{m} \times \mathbf{r}$, where \hat{s} is the unit vector connecting the two particles. If we remember that in the quantum theory a component of the angular momentum can assume only the integer multiple of $\hbar/2$, we obtain the charge quantization condition of Dirac: $q_m Q/\hbar c = n/2$ with $n = 0, \pm 1, \pm 2, \dots$ (D) On the other hand, Schwinger claimed that the extra angular momentum can assume integer multiple of \hbar , because this quantity has the classical correspondence, and his charge quantization condition becomes: $q_m Q/\hbar c = n$ with $n = 0, \pm 1, \pm 2, \dots$ (S)

From this condition, we can firstly understand why the electric charge Q appearing in Nature is discrete. Because if we substitute the magnetic charge q_m by e_m in equation(D), where e_m is the smallest magnetic charge, the charge quantization condition (D) becomes $Q = (\hbar c / 2 e_m) n$ with $n = 0, \pm 1, \pm 2, \dots$, and this equation indicates not only the discreteness but also the equality of electric charges of proton and the electron for example, up to sign. Secondly we can determine $e_m^2/\hbar c$, the magnetic counterpart of the fine structure constant, from equation (D) and the value of the fine structure constant: $e^2/\hbar c = 1/137$. It turns out $e_m^2/\hbar c = 137/4$, which means that the interaction between the monopoles is super-strong. Because $e_m e/\hbar c = 1/2$, the potential energy of a nucleus with the magnetic moment $\kappa(e/2m)$ in the super-strong magnetic Coulomb field produced by a monopole is $V(r) = -\kappa(e_m e/2m\hbar c)(\vec{\sigma} \cdot \vec{r})/r^3$, and which has the strength of the nuclear potential. The spin dependence of $V(r)$ indicates that half of the nuclei are attracted and can form the bound state with the monopole. It is this potential $V(r)$ between the magnetic monopole and the nucleus with the non-vanishing magnetic moment that enables us to construct the nuclear fusion reactor which operates at ordinary temperature, when the magnetic monopole is available.

A rational example of the nuclear cold fusion reaction

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The nuclear physics has been generalized by adding new ingredients to the original ingredient, the nucleons. In 1960's, the hyperons were included in the list of the ingredients, and now the study of the hyper-nuclei is a branch of the nuclear physics. Recently, the kaon joined to the ingredient list. We can go one step further by introducing the magnetic monopole. It is known the magnetic monopole and the nucleon form the bound states. We can compute the binding energy and the radius of the ground state of such a system, they are 0.188MeV. and 11.0 fm., respectively for the proton for example. The magnetic moment of the proton in the super-strong magnetic Coulomb field produced by the monopole gives rise to the large attractive potential necessary to form such a bound state, when the spin of the proton is oriented outward.

It is well-known that in vacuum, in the case of the very low incident energy, the repulsive Coulomb barrier prevents the two nuclei come close to fuse. However the novel feature of the monopole-nucleus system is that the repulsive potential between nuclei is lowered appreciably, for example in the $p + t$ reaction the peak value of the repulsive potential lowers from 1MeV. to 17keV. The reason of the change of the repulsive potential is that, suppose that the proton is trapped to the monopole first, the potential felt by the incoming triton is the sum of the repulsive Coulomb and the attractive potential between the monopole and the triton. After the penetration of the triton, we have a three particle bound system ($*e+p+t$), where $*e$ represents the magnetic monopole. Since the nuclear potential has the spin-flip term, the three particle system is unstable, it must decay to $*e+p+t \rightarrow *e+He(4)$. However since the spin of He(4) is zero, it cannot form the bound state with the monopole, so the monopole must release He(4). There remains a fresh monopole, and it starts to attract the adjacent small nuclei with magnetic moment again. In this way, a single magnetic monopole plays the role as the catalyst of nuclear fusion reaction at ordinary temperature

It is the charge quantization condition of Dirac, which says $*QQ/\hbar c=n/2$ with integer n , that make it possible to form the composite system of the monopole and nucleus and leads to the nuclear cold fusion. Since the charge quantization condition is derived from the quantum condition that a component of the angular momentum can assume only the integer multiple of $\hbar/2$, the quantum theory plays the central role in understanding the occurrence of the nuclear cold fusion reaction.

Origin of the sporadic nature of the cold nuclear fusion and a way to avoid it

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In the framework of the quantum field theory, we learned that the existence of the magnetic monopole implies the appearance of the cold nuclear fusion by lowering the repulsive Coulomb barrier between nuclei. Although the Coulomb barrier protects our world from the disastrous nuclear fusion reactions, abundant existence of the monopole must destroy the stability of our world. However since the magnetic monopole is a rare particle, this world stays stable as a whole. When we prepare the domain in which the small nuclei such as proton, deuteron and triton are highly concentrated, the cold fusion may occur locally if a single magnetic monopole comes in to such a region. When we do not detect the magnetic monopole beforehand, the occurrence of the cold nuclear fusion looks sporadic.

It is meaningful to check the magnetic monopole in the cathode before and after the nuclear cold fusion, because the lattice of atoms with magnetic moments has the ability to trap the magnetic monopole, and the order of magnitude of the trapping energy at temperature T is $5.0 \text{ keV} \cdot \sqrt{T}$, when the magnetic moment is 1 Bohr magneton and the lattice constant is 1 Å, for example. The standard device to observe the magnetic monopole is the superconducting ring of the torus shape. When a magnetic monopole passes through the ring, because of the Meisner effect, the total flux ϕ trapped by the superconducting ring changes by $\phi_0 = 2\pi \hbar c / e$, which is the unit quantum magnetic flux and is $\phi_0 = 4.14 \times 10^{-7} \text{ G cm}^2$. If we remember that the permanent current circulating on the inner surface of the superconducting ring is proportional to the magnetic flux density ϕ/S , we can check the change of the flux by monitoring the current by SQUID.

In the nuclear reaction two body \rightarrow one body type such as $d+d \rightarrow \text{He}(4)$ or $p+t \rightarrow \text{He}(4)$, the energy and the momentum conservations are not compatible unless the reaction proceeds under the influence of the external potential. There are three types of external fields to which the nuclei can respond, they are electric, magnetic and nuclear. Among three possibilities, only the magnetic field can distinguish the fuel nuclei such as p, d, t and He(3) from the product nucleus He(4). Therefore, if the cold fusion is $d+d \rightarrow \text{He}(4)$ or $p+t \rightarrow \text{He}(4)$, the magnetic monopole must play the roll of the catalyst of such processes.

An overview of experimental studies of H/Pd over-loading with thin Pd wires and several different electrolytic solutions.

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Many hundred of systematic tests have been performed in order to achieve very high concentration of Hydrogen into Palladium wires.

The electrodes (cathode in central position: Pd wires 50 or 100 μm thick and anode: Pt wires 0.5 mm thick) were placed in a coaxial geometry into a small cylindrical electrolytic cell.

A unusual study has been performed in order to optimise the electrolytic solution based on H_2O (400 cm^3) + HCl (50 \div 200 μM) and small amounts (tenth of μM) of one of these alkaline elements: Li or Ca or Sr; furthermore, very small amount (hundred of nM) of HgCl_2 has been added to the solution. The addition of Mercury has been crucial to achieve very high H/Pd loading.

Moreover, an electrolytic solution based on Ethylic Alcohol 95% (400 cc) + HCl (200 μM) + H_2SO_4 (60 μM) and additions of very small amounts of SrCO_3 and HgCl_2 , has been tested in order to study loading with Deuterium instead of Hydrogen.

To increase the reproducibility of the over-loading an unusual loading protocol based on high/low (or OFF/ON) cathodic current cycles has been tested successfully.

The H/Pd loading ratios have been estimated by the on-line measurement of the normalised wire resistance (R/R_0).

Loading results are quite satisfactory: $\text{H/Pd} \geq 0.97$ ($R/R_0 \leq 1.30$; input electrolytic power: 7V, 5mA) are typically reached and sometimes $\text{H/Pd} \geq 1$ ($R/R_0 \approx 1.15$; input power: 11V, 2.5mA) has also been achieved. The reproducibility of the results is quite satisfactory.

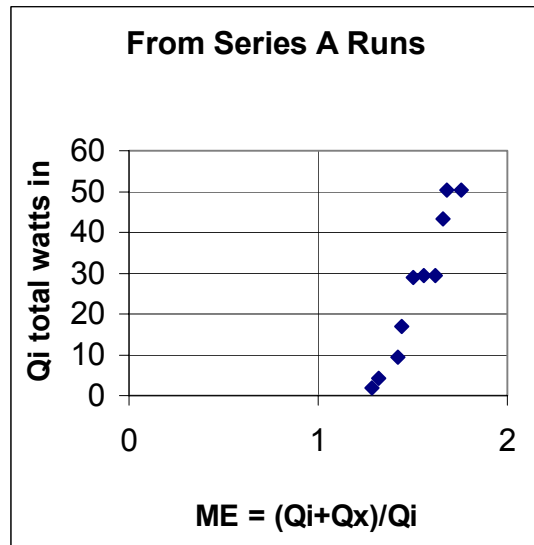
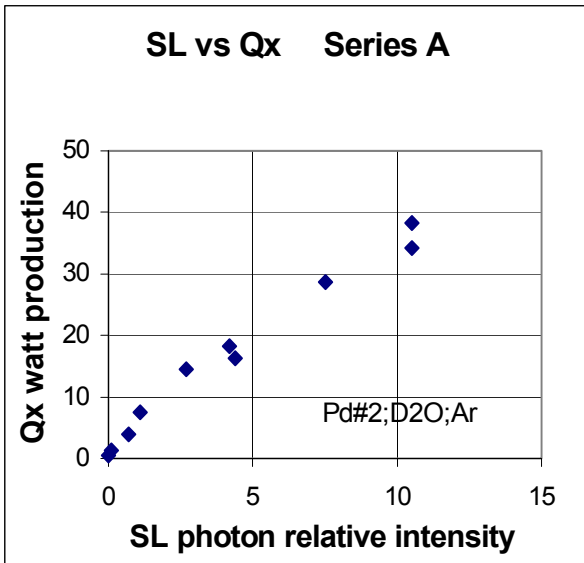
Studies are in progress in order to optimise the composition of the electrolyte and to substitute Deuterium instead of Hydrogen in the solution.

Low Mass 1.6 MHz Sonofusion Reactor

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We at First Gate Energies have developed a high out-put LM , low-mass of 20 gm, sonofusion reactor. It was fueled by D2O and driven by a 1.6 MHz piezo generating TCBs, transient cavitation bubbles. The Qx, excess heat, was a function of the SL, sonoluminescence, and voltage input to the piezo. The experiments were performed in a light proof box for the correlation of SL to Qx. [1]



The ambient temperatures were near constant day and night. The calorimetry was conservative with the actual values of Qx higher than the measurements. The two graphs below show this pulsed data from Series A runs with a duty cycle of 1 min.

The Qx/(gm Rx) was 2 watts at high Qa, acoustic input, of 16 watts. The volume of D2O was 1 cc. and the rate of D2O flow was 1 cc/sec. The DT, delta temperature, Tout - Tin, was 13 so Qx = 13x1x4.184 – Qa was about 40 watts. We used target foils about 100µm in thickness of Pd and an alloy of CuBe 98/2. It appears these LM reactors are robust but do require the efficient removal of heat as the interior of the reactor, the piezo or the oscillator will fail. To make the calorimetry measurements the system was pulsed with a 60 sec. duty cycle (on/off) voltage. This removed the RF interference in the thermocouple measurements. The oscillator and transformer, O&T, were isolated in a calorimetry box with a Joule heater for calibration. Calibration and run time to steadystate was ten times longer for the O&T than run time to steadystate of the LM reactor. The efficiency E for the Qi, total input of 50 watts, in producing Qa was .33 and gave the value of 16 watts for Qa.

The commercial possibilities by ganging these LM reactors units into a large power supply for producing heat is feasible. Heat removal via a circulating liquid is used for space heating and hot water. The Qa/.33 + Qx is the total heat out including O&T + Qa + Qx and produces an ME, multiplier effect, of (Qa/.33+Qx)/Qa/.33, so if Qa = 16 watts, and Qx = 40 watts then ME = 1.8. To improve the ME the E can be increased from .33 to perhaps .75 increasing ME to 3.0 [2] and the cost of electric heating will be reduced to 1/3. Increasing Qx will further increase ME. A system that sustains itself has an ME of 10 using, TEDs, thermoelectric devices.

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Factors affecting the excess enthalpy observed after cessation of electrical input power

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Following experimental results, we have derived a lumped parameter electrical analytic model of cold fusion loading (1), activation at the optimal operating point (2), excess heat production (3) and tardive thermal power (4). The model was tested against experimental data and has had a good correlation. The analytic model of cold fusion excess heat production clarifies the excess heat production both during the desired reactions driven by the applied electric field intensity and thereafter to include the excess heat which is sometimes observed for several hours to days after cessation of all input electrical power to a previously active, loaded, properly driven (at the optimal operating point) cold fusion Phusor cathodes (Pd/D₂O/Pt) at their optimal operating point (2).

One advantage of the model is the ability to follow in situ some of the reactions. We report the ability to predict the excess heat during electrical drive (2,3) and after all electrical input is terminated (4). Another advantage is that the model includes several factors which are predictive of the actual magnitude of the HAD excess enthalpy which can be obtained. A most important corollary is that our previously reported values of excess heat obtained (2,3) were lower limits of what these systems are capable of demonstrating.

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Two sites of Cold Fusion reactions and their roles in heat after death

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The time integral of the observed excess tardive thermal power is known as "heat after death" [HAD; 1)]. We have examined the dynamic magnitude and kinetics of excess tardive thermal power (TTP) which occurs after driving, fully loaded, activated, spiral wound cold fusion Phusor cathodes (Pd/D₂O/Pt; 2,3) at their optimal operating point (4). This study has involved not only time integration and the controls presented at ICCF-10 Phusor demonstration (3) but has also used additional controls which together enable the deconvolution of the TTP into separate source components, each characterized by distinct parameters.

We report that following full loading and drive conditions sufficient to produce excess energy, deconvolution of the HAD reveals that there are two distinct, physical sites producing the desired cold fusion reactions. Some of the sites are characterized by a tardive thermal power which falls off with a time constant of a few minutes. The rest of the sites have a time constant which is two orders of magnitude greater. These two sites of cold fusion reactions in the palladium heavy water system could be consistent with the deeper (5) and more vicinal to surface (6) sites of excess heat reactions previously reported.

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Precursors and the fusion reactions in polarised Pd/D D₂O system : effect of an external electric field

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Charging of the Pd lattice with hydrogen isotopes has been, in the past, investigated under a variety of conditions. Here, we present results obtained by yet another experimental procedure that initiates and promotes the occurrence of low energy nuclear reactions. This procedure involves the placing of an operating electrochemical cell, Pd/D//D₂O, Li⁺, Cl⁻/Pt, in a stationary electrostatic field (2500 - 3000 V cm⁻¹) followed by scanning electron microscopy (SEM) examination using an instrument equipped with an energy-dispersive X-ray analysis system.

The polarized Pd/D electrode, prepared by co-deposition, undergoes significant morphological changes when exposed to an electric field[1]. These changes range from minor, eg re-orientation and/or separation of weakly connected globules, through forms that result from a combined action of the field and the evolution of gaseous deuterium, to shapes that require substantial energy expenditure which can only be supplied by nuclear reaction(s). These new structures, viz craters, boulders and folded thin layers, are randomly distributed over the electrode surface. If these structures are the result of a nuclear event then their chemical composition should reflect it. Indeed, an analysis by energy dispersive X-ray method showed elements not originally present, namely Al, Mg, Si, Ca and Zn.

The charging cell current profile puts the system in a state far from equilibrium. Under this condition, chemical instabilities (arising from eg fluctuations) lead to spontaneous “self—organization” provided that the system is able to transfer part of its energy or matter to the outside world, ie an open system is required [2]. Thus, in an operating cell far from equilibrium, conditions exist that promote the formation of “supermolecules”. Furthermore, the high values of the chemical potential tend to form clusters, here of the type Pd...[(D⁺)_n- D⁺]⁺. These molecule-ions interact with the energetic s-electrons to yield precursor Pd...[(D⁺.e⁻)_n-D]. The precursor is the last step in the set of processes comprising the charging of the Pd lattice. The nuclear event is of the type:



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3He/4He Production Ratios by Tetrahedral Symmetric Condensation

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Tetrahedral Symmetric Condensate (TSC), for example, by orthogonal coupling of two D₂ molecules (4 deuterons plus 4 electrons), has been proposed as a seed of clean fusion in condensed matter¹). Applying the EQPET (Electronic Quasi-Particle Expansion Theory) model, modal fusion rates for 2D, 3D, 4D and 8D fusion reactions in TSC and OSC (Octahedral Symmetric Condensate) were numerically estimated. These analyses could explain consistently the major experimental results of excess heat with 4He ash, minor tritium generation, very weak neutron emission, and transmutation and fission of host metal nuclei^{1,2,3}).

In this work, the theory was extended to analyses for H/D mixed systems. It is concerned that usual D₂O electrolysis experiments with open cells would be contaminated with hydrogen (H) as experimental time elapses. Modal fusion rates for HD, DD, DDDD, HDDD and HDHD fusion reactions were calculated by EQPET, as a function of H/D mixing ratio. 3He is produced by HDHD and HDDD reactions. As a result, 3He/4He ratios were given as a function of H/D ratio, to be for example 3He/4He = 0.1% for H/D=1% and 3He/4He=25% for H/D=60%. Secondary transmutation reactions by 3He-particles were estimated to have very small reaction rates.

Discussions are added for the pure hydrogen TSC (4p plus 4e). Since the EQPET model gives approximate size of TSC to be less than 1 pm in radius, TSC will behave as a “charge-neutral pseudo-particle” when it approaches to a host metal atom which has much larger atomic (electron cloud) radius than 100 pm (1 angstrom). We may expect therefore direct nuclear interaction between TSC and host metal nucleus, because TSC can drastically reduce Coulomb barrier to host nucleus. Thus, we have a possibility of nuclear reactions as Ni+p, Ni+4p, Pd+4d, W+4p, Cs+4d, and etc. with very enhanced reaction rates. The theory may therefore explain a variety of claims by H- or D-systems.

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“Excess Heat” during the Electrolyzing in Pt/K₂CO₃/Ni Light Water System

Tian J, Jin L.H., Weng Z K, Song B, Zhao X L, Xiao Z J, Chen G, Du B Q

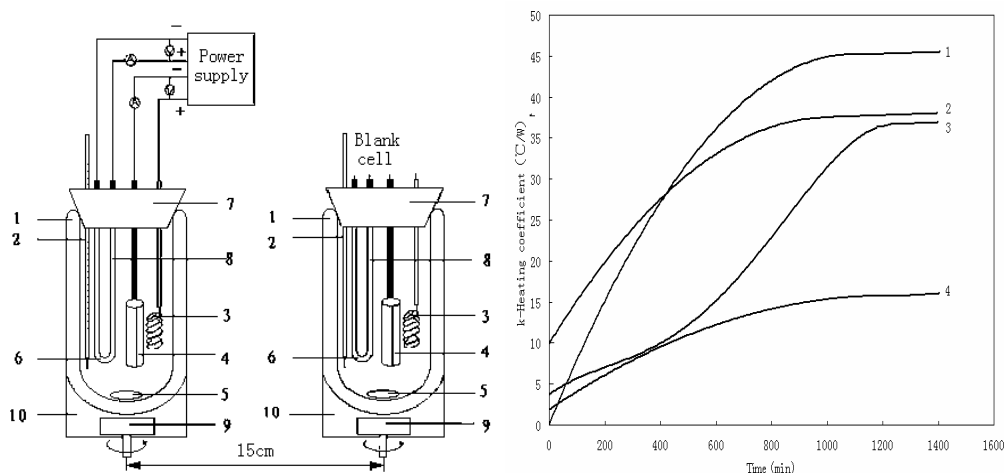
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Based on the Noninski's research work [1] the characteristic variation of heating coefficients ($k = \frac{\Delta T}{\Delta P} (^{\circ}C / W)$) of Pt (H)-Ni electrolytic system with K₂CO₃ and Na₂CO₃ solutions was further studied in both situations of electric and electrolytic heating respectively. The results in equilibrium revealed that there was an obvious difference of k in electrolytic-heating ($\Delta k \approx 30^{\circ}C/W, k_{K_2CO_3} > k_{Na_2CO_3}$) between these two systems whereas there was a little difference of k in electric heating ($\Delta k \approx 2^{\circ}C/W, k_{K_2CO_3} < k_{Na_2CO_3}$ between them:

Other factors including input-power, electrolyzing temperature and electrolyzing duration were also discussed in order to inspect the relation between k and any one factor of the three. The data shown that it would benefit to increase the value of k when the input power was 0.53W, electrolyzing temperature 40°C and prolonging the electrolyzing time suitably in this system. The “excess heat” of about 2.5×10^4 Joules was calculated in the electrolysis of K₂CO₃ solution during a day's electrolyzing. The differences of K₂CO₃ solution after electrolyzing in the potential of hydrogen value ($\Delta pH=0.15$) and in absorbency ($\Delta A=0.108$) implied that some new Ca⁺⁺ might formed in the electrolytic system, which could be explained by $^{39}_{19}K + ^1_0P \rightarrow ^{40}_{20}Ca + 8.33MeV$ or $^{41}_{19}K + ^1_0P \rightarrow ^{42}_{20}Ca + 10.3MeV$ [2]

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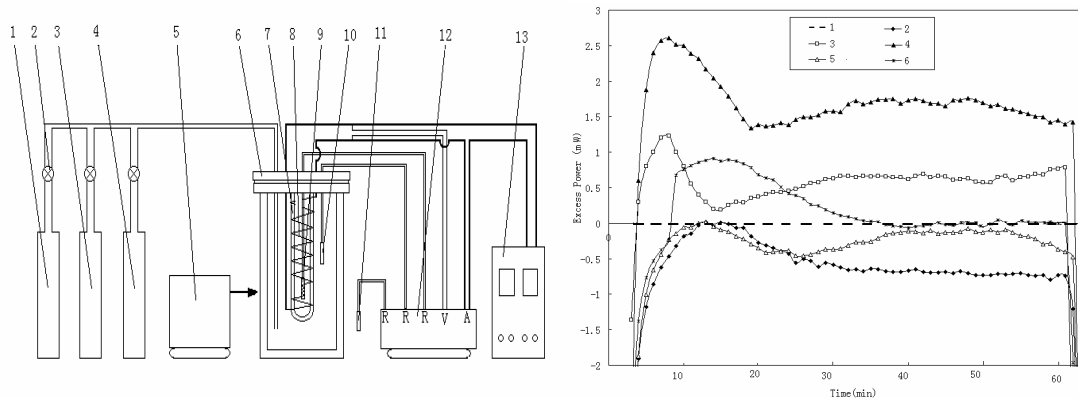


“Excess Heat” Stimulation by a 632.8nm Laser in a Hydrogen/Palladium Gas-loading System

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Laser Stimulation is a potential method for “Excess Heat” production [1]. Hydrogen has often been known as a control in “excess heat” experiment. Here a laser with 632.8 nm wavelength was used to irradiate a series of palladium hydrides that have different loading ratio of hydrogen. The configuration of our stimulating system and the experiment results are shown as in the figures below:



The experiment started from loading hydrogen into a palladium wire ($\phi=0.1\text{mm}$, $L=100\text{cm}$). When the H/Pd ratio were 0.25, 0.35, 0.45 and 0.69 respectively, the loading was stopped and a He-Ne laser ($P_{\text{max}}=30\text{mW}$, $\lambda=632.8\text{ nm}$) was turned on for an hour. The light beam was passed through a glass wall (6.9mW power left) and the light spotted on a small section ($\phi=5\text{mm}$) of the Pd wire. The “excess power” was considered as zero before hydrogen charged into the palladium. (line 1, $x=0$). As the sequence the “excess powers” were -0.77mW (line 2, $x=0.25$), 1.15mW (line 3, $x=0.35$), 2.30 mW (line 4, $x=0.35$), -0.15 mW (line 5, $x=0.45$), 0.92 mW (line 6, $x=0.69$). The reason why the “excess power” reaches the maximum is unclear, but the exothermic energy of each Pd atom can be estimate calculated as $1.15\text{E}-17\text{ joule}$, which is about five times more than the maximum energy, a hydrogen atom could release in a chemical process.

Two possible conclusions could be drawn from the experiment above, those are:

1. Hydrogen can also produce “excess heat” as deuterium does.
2. High loading ratio may not be a necessary condition for “excess heat” production.

Maybe there is an optimum ratio for a specific experiment condition.

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Effective Interaction Potential in the Deuterium Plasma

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The effective interaction potential for charged particles is calculated in the deuterium plasma formed in the surface region of the palladium cathode in the electrolysis of heavy water. It is shown that the Coulomb potential is overscreened producing, in certain distances, an attractive potential between deuterium nuclei pairs and also between the deuterium nuclei and the surface atoms. This behavior of the effective potential in the deuterium plasma can be regarded as a counterpart of the Friedel oscillations of the electron gas at zero temperature. Because of this attractive potential, there are bound states for the deuteron pairs as well as for the surface atoms and deuterons. In these bound states the equilibrium distance between the nuclei is of the order 0.15 - 0.2 Å depending on the number density of deuterons. The fusion rate is calculated for the bounded deuteron pairs and it is found to be of the order $\lambda = 10^{-22}$ 1/s per deuteron pair for the highest deuteron densities. It is argued, that larger fusion rates are possible for the deuterons bound to the surface atoms.

Theoretical Study of Nuclear Reactions Induced by Bose-Einstein Condensation in Pd

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Over the past few years, several studies have been made on the condensed states of deuterons in metal. For example, deuteron cluster fusion was pointed out by A.Takahashi.1) In the previous work, we also pointed out nuclear reactions induced by condensed deuterons in Pd.2) If many deuterons are accumulated in metal and local density of the deuterons at lattice defects becomes high enough, Bose-Einstein condensation (BEC) may happen and induce nuclear reactions when $T < T_c$.

In this work, nuclear reactions in Pd induced by BEC are estimated. Quantum states of deuteron clusters trapped at a void in Pd are calculated by applying Kim-Zubarev theory.3,4) The condensed state solutions give T_c of local BEC and local nuclear reaction rates. If the local reaction rate at a void, the number of the void in the lattice and the thermal conductivity of Pd are given, the total power generated from the bulk Pd can be estimated. As a result, extremely high rates of nuclear reaction are obtained. However, even if the rates are extremely high, only one reaction in the void raises local temperature around the deuteron cluster. Then immediately it reaches T_c and higher, and the probability of the ground state occupation becomes zero. This means that our model does not give explosions by continuous reactions but explain calm and static reactions.

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Low-energy nuclear reactions and the Lochak monopole.

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The report briefly surveys the experimental and theoretical results obtained at the daughter enterprise REKOM of the Kurchatov Institute in 1998-2004

1. It was found experimentally that the electric explosion of a titanium foil in doubly distilled water induces a shift (up to 5%) from the natural isotope distribution of titanium toward a decrease in the proportion of Ti^{48} . When doubly distilled water is replaced by an aqueous solution of glycerol, the isotope distortion of titanium increases (to 10%) following an increase in the glycerol concentration in the initial solution. The magnitude of the shift was reliably measured by a mass-spectrometric procedure and confirmed by γ -activation analysis. Considerable attention is devoted to analysis of the measurement procedures and the possible errors of measurements. The results of an independent verification performed by scientists from Dubna (Kuznetsov’s research group) are also given.

2. It was shown that a decrease in the proportion of Ti^{48} in the titanium isotope mixture is accompanied by appearance of “foreign” impurities of other elements (Fe, Si, Al, Na...). The total fraction of the impurities is proportional to the titanium isotope shift. The effect is macroscopic ($\sim 10^{19}$ atom/pulse). Along with the results obtained with titanium foil, the results on transformation of zirconium, lead and other elements are described.

3. It was proved experimentally that the transformation takes place not only in the foil material but also in salts in solutions. For this purpose, experiments with uranium salts were carried out. The report outlines the results indicating that electric explosion is accompanied by transformation of U^{238} , resulting in violation of the secular equilibrium and effective enrichment in U^{235} .

4. The report gives a phenomenological model based on allowance for the energy conservation law and the conservation laws of the baryon, lepton and electric charges. The results of numerical modeling coincide qualitatively with the experimental results. It follows from the model that the addition of vanadium admixtures should give rise to Fe^{57} . The experimental verification confirmed the prediction of the phenomenological model.

5. The modeling allowed us to understand that: (i) the low-energy nuclear transformation does not contradict the conservation laws; (ii) it is a fundamentally collective phenomenon; (iii) it is necessary to select a catalyst able to initiate this process.

6. No any noticeable neutron fluxes or residual radioactivity were detected in the experiments; thus, the acceleration mechanisms of initiation of low-energy nuclear nuclear reactions and the participation of strong interactions in the transformation processes could be excluded from consideration.

7. It was found experimentally that the transformation is accompanied by the appearance of a “strange” radiation. The application of a magnetic field and experiments on recording the “strange” radiation by means of nuclear emulsions and the Mössbauer effect provide the conclusion of a magnetic nature of the radiation.

8. The observed display of the “strange” radiation resembles most closely the magnetic monopole predicted theoretically by G. Lochak, which is a sort of magnetically excited state of neutrino. The lepton nature of the “strange” radiation (Lochak monopole) was manifested most clearly in experiments with uranium salts. In this series of experiments, distortions of the β -periods of the daughter products, U^{234} and Pr^{234m} , were found.

9. The report outlines the results of tentative experiments on the distant interaction of the magnetic radiation with ammonium nitrate and biological objects.

Study of the gas outburst formed upon electric explosion of titanium foils in liquids

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The paper outlines the results of a study of the gas mixture formed upon the electric explosion of a titanium foil in liquids. The study was performed using optical spectrometry, gas chromatography, gas mass spectrometry, solid-state laser mass spectrometry and X-ray fluorescence analysis coupled with electron microscopy. The experiments were carried out in both hydrogen-containing liquids (H₂O, D₂O, H₂O₂) and liquids devoid of hydrogen (C₆F₆, CCl₄).

The experiments reliably demonstrated that the appearance of $(3.7 \pm 0.2) \cdot 10^{18}$ of hydrogen atoms recorded after the electric explosion cannot be attributed to a chemical process. The time dependences of the increase in the H₂ concentration following the electric explosion were found.

Possible hydrogen “generators” visualized by means of an electron microscope represent hollow titanium beads, which resemble in topology Christmas-tree decorations. The report presents the results of elemental analysis of the titanium beads and outlines the regularities elucidated. A nuclear (proton decay) origin of the major portion of the detected hydrogen is hypothesized.

Experiments on controlled decontamination of water mixture of different long lived active isotopes in biological cells

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We studied direct controlled decontamination of highly active water mixture of selected different long-lived active isotopes by growing microbiological systems. The process involved transmutation of long-lived active nuclei to non-radioactive isotopes during growth and metabolism of special microbiological MCT ("microbial catalyst-transmutator"). MCT consists of granules that include: concentrated biomass of metabolically active microorganisms, sources of carbon and energy, (phosphorus, nitrogen, etc.), and gluing substances that keep all components in the form of granules stable in water solutions for a long period of time under any external conditions [1].

The base of MCT microbe syntrophin associated with thousands of different kinds of microorganism in a state of complete symbiosis. These microorganisms are of different physiological groups that represent practically the whole variety of the microbe metabolism and related kinds of microbe accumulation mechanisms. The state of complete symbiosis of the syntrophin associations results in the possibility of maximal adaptation of the microorganisms' association to any external conditions change. The typical reaction of the association for such aggressive effects demands some time for internal adaptation. This time is necessary for mytagene change of about 10 generations that corresponds to several days. During this time occurs a purposeful synergy process of stimulation of the mutant formation of such microorganisms that are maximally adapted to the changed aggressive conditions.

The mechanism of nuclear transmutation in growing biological system is described in [2].

The research has been carried out on the basis of the same distilled water that contained four long-lived reactor isotopes: Eu¹⁵⁴ (initial activity about 500 bq), Eu¹⁵⁵ (≈ 800 bq), Cs¹³⁷ ($\approx 1.8 \cdot 10^4$ bq), Am²⁴¹ (≈ 1000 bq).

In our experiments 8 identical closed glass flasks with 10 ml of the same active water in each were used. The "microbial catalyst-transmutator" was placed in 7 glass flasks.

In six different flasks different pure K, Ca, Mg, Na, Fe and P salts as single admixture were added to the active water. These chemical elements are vitally necessary for any cultures. Each of these replacements completely blocks the channel of transmutation with the use of all biochemical analogs of the concrete chemical element [2]. The results obtained confirmed the importance of such replacements. Two additional flasks were used for control experiments: one flask contained the active water and MCT (but without salts) and in another one was only active water (without salts and MCT). The cultures were grown at the temperature 25⁰ C. Activity of all closed flasks has been measured every 5 days by amplitude Ge detector.

The results of controlled influence on gamma-radioactivity of different isotopes in different biochemical compositions are reported. Among other results it is possible to mark the observed speeded up decay of Cs¹³⁷ isotopes with $\tau^* \leq 1$ year and anomalous of Eu¹⁵⁴, Eu¹⁵⁵ and Am²⁴¹ isotopes decay. In control experiments the standard spontaneous gamma-decay was observed.

References :

[1]. Vysotskii V.I., Shevel V. N., Tashirev A. B., Kornilova A. A. Successful experiments on utilization of high-activity waste in the process of transmutation in growing associations of microbiological cultures //10th International conference on Cold Fusion, ICCF-10, 2003, Programm and Abstracts, p. 121

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The spatial structure of water and the problem of controlled Low Energy Nuclear Reactions in water matrix

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Usual water has a number of unique features, among which there are its stable spatial structure and long-term “memory.” Numerous experiments confirm the existence of water memory, which is activated under the influence of some physical fields (e.g., magnetic field, mechanical impact, abrupt temperature or pressure change) and may store information about such influence for many hours and days. Such activated water has altered physical and chemical (including biochemical) features. Continuously increasing number of reliable experiments shows that the continuous model is inadequate for describing the water structure.

Detailed studies have shown that the so-called “clathrate” model is the one closest to reality. In the basis of this model there is the concept that unification of atoms of oxygen and hydrogen can create spatial flexible tetrahedral frames. Formation of a tetrahedral frame was due to the fact that the natural spatial angle between OH-links in a free H₂O molecule is sufficiently close to the exact value of the tetrahedral angle 109.5°. In the joints of the crystalline frame there are very large (in the scale of a water molecule) empty micro cavities with rigid atomic walls. The main elements of this structure are right polyhedrons linked to each other – dodecahedrons. Such systems are called “clathrate hydrates”. The entire frame is held together by hydrogen links. They fasten together a system of pentagonal dodecahedronic polyhedrons from ions of oxygen and hydrogen, which form the walls of the micro cavities. Each one of the polyhedrons may be characterized by an inscribed sphere with radius about $R_c \approx 2.6$ Å. On the vertexes of these polyhedrons there are 20 molecules of H₂O, each one of which having three hydrogen links. Any 3 polyhedrons may be unified into stable associates containing 57 H₂O molecules. Out of these 57 molecules 17 have fully saturated hydrogen links and they form a tetrahedral hydrophobic central frame, while in 4 dodecahedrons there are 10 centers of formation of hydrogen links located on the surface of each one. Beyond this frame there are quasi free molecules of “regular” isotropic water, the features and the structure of which approximately matches the continuous model. Micro cavities are linked to the outer space by “windows” with diameter of about 2.5 Å, which is slightly less than diameter of H₂O molecule. In the result, each of the micro cavities is separated from “external” amorphous quasi free water by a circular potential barrier with width about 0.13-0.15 Å bounding each “window”. Relative quantity of molecules of “frame” water at room temperature is 20-30% increasing with lower temperatures. In the volume of micro cavities different molecules (e.g., H₂, H₂O, O₂) may be accommodated. Due to the presence of a strong and symmetrical (relative the center of micro cavities) electrostatic field there is a certain ban on formation of hydrogen links of any molecules with the walls inside the micro cavities. In this case there is such a non-trivial phenomenon as repulsion of both free H₂O and H₂ molecules from the walls of the frame also consisting of water molecules. With violation of thermodynamic balance a redistribution of molecules between amorphous water and micro cavities takes place until a new balanced state is achieved. Spontaneous transfer between these states is substantially inhibited due to a very small probability of tunnel penetration of H₂ molecules through “narrow” windows and the time of existence of each of these conditions turns out to be very big.

The same space structure has a heavy D₂O water. The potential energy of D atom in central part of the cavity with “water walls” is close to parabolic. In such well the spectrum of quantum levels of D atom is equidistant. In such compressed isolated system the energy of dd Coulomb interaction of two D atoms is a small amendment and not influence the character of atoms or nuclei movement and interaction (including dd-fusion)[1]. Each such micro cavities like to nonthreshold micro reactor. The process of low energy fusion in such system is discussed.

Reference:

[1]. Vysotskii V.I., Kornilova A.A. Nuclear fusion and transmutation of isotopes in biological systems, Moscow, “MIR” Publishing House, 2003, 302 p.

A Tribute to Gene Mallove – the Genie Reactor

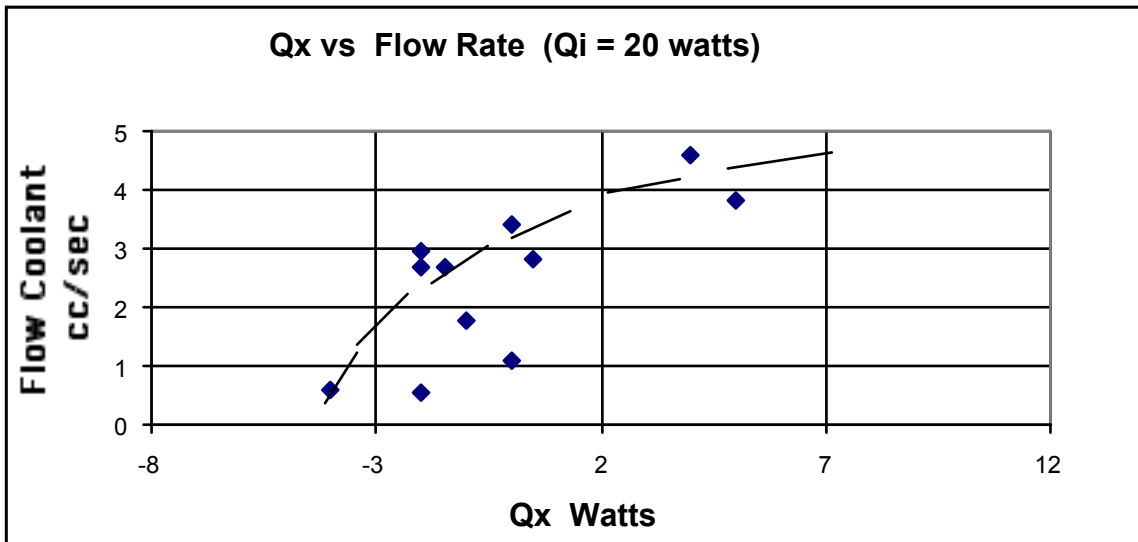
Kip Wallace and Roger Stringham

PO Box 1230, Kilauea, HI 96754 USA

Gene Mallove would be pleased to hear that his work and the work at LENR Laboratory in Bowe, NH produced a cavitation fusion device with reproducible excess heat capabilities after a few modifications. The original work on this device was ceased because of a shortage of money and time. The abandoned device was purchased from Gene by Kip Wallace, my brother in-law, and modified. Kip brought the modified device to First Gate Laboratory in Hawaii for calorimetry measurements and showed positive excess heat results. The initial input from Gene, Ken, and the rest of the LENR lab with some more time and thought supplied by Kip generated positive Q_x .

The original reactor from the LENR Lab. was sent to SRI for testing. It had problems with D_2O and Ar leakage and was not suitable for testing. The modifications that Kip Wallace made improved the functioning of the apparatus so that it can operate free from leaks at a pressure of 5 atm. with no loss of Ar or D_2O . The other change was in the power supply where one piezo stack was the transmitter, the opposite stack a receiver that feeds back to the transmitter the amplified resonance signal of the reactor and transmitting piezo stack.

Using H_2O as a coolant a flow-through type of calorimetry that removed heat from the well-insulated reactor surface was employed. An FMI pump circulated water through 3mm copper tubing tightly coiled around the reactor that removed heat from the surface of the reactor with a flow rate 12 ml/ sec. A delta T measurement of coolant water, $T_{out} - T_{in}$, at steadystate conditions times the water flow rate times the constant 4.184 minus the total power in, Q_i , determined the excess heat. The measurements were dependent on the coolant flow rate. The residence time of the circulating water in the cooling coils was 4 seconds. Also a 3 mm copper tubing coiled around the reactor housed a 46 inch stainless-steel Joule heater which calibrated the calorimetry of the reactor. Also added to the calibration measurements was substitution of H_2O for D_2O in the



reactor.

The figure shows, with the flow through calorimetry, that the high coolant flow rates of Q_x will be over unity (positive). Q_x is heat out minus the 20 watts input, Q_i , from the wall. The reactor operated at a temperature of 30 degrees C, at a 5 atm. pressure of Ar, with a 20cc volume of D_2O , and with a Ti target foil. The efficiency of Q_i was assumed to 100% (it was measured at 70%).

Concentrating on Unique Features of the Cold Fusion System

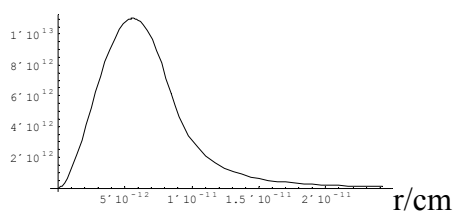
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The system of cold fusion (or low energy nuclear reactions) has its own characteristics, at least, as below: 1) it is a low energy nuclear process, compared with high-energy nuclear processes; 2) it is always induced by another directed low energy process (heating-cooling, electrolysis, diffusion, and so on). The process generally takes place in the bulk- or on the surface of a condensed matter, etc.; 3) the great difference between the cold fusion and the hot fusion is the different system. For the cold fusion it is always in a non-equilibrium system, but for the hot fusion in an isolated system. For suitably describing such system, many models of cold fusion have been reported since S. Pons and M. Fleischmann made the 1989 famous announcement. We suggested a model for the low energy nuclear reactions according to our experimental results with D₂O electrolysis 1990. Under constant current conditions, bursts of excess heat are always observed after a decrease in the electrolytic cell voltage drop. S. Pons and M. Fleischmann reported the similar measurement on ICCF-1. This voltage decrease in an electrolysis cell should be associated with loss of charge on the surface the electrode and a release of heat to take place there at the same time. Our model, related both to nucleus and free electron, is that the deuteron could capture an electron, or the deuterium ion obtain an electron and could react with another nucleus, on the surface of Pd electrode during the D₂O electrolysis process. For proving our model, studies done by us are ab initio type, such as these (Further study on the solution of Schrodinger equation of hydrogen-like atom, Probability of electron captured by deuteron, etc.) on ICCF-9.

Here, further work on the solution of Schrodinger equation of hydrogen-like atom was done on the model in more detail. It is not only on the consideration of the finite size of the nucleus as shown on ICCF-9 but also on the form (U_0 for $r < r_N$, $V_0 \delta(r-r_s)$ for nuclear shell, where r_s is the radius of nuclear shell, $-Ze^2/r$ for $r > r_N$) of potential $V(r)$ in the whole range of atom ($r=0 \rightarrow \infty$). An interesting result ($r_{small-H} \approx 10-12\text{cm}$), as shown below, was obtained.



This is the result under $L=2$, $E=2.178 \cdot 10^{-11}$ ergs there are no solutions at $L=0$ and $L=1$ in the case. It is obvious that these results could let us think how a low energy nuclear reactions could be more easily generated.

Another Replication of Thermal Anomalies in “Dash” type Electrolytic Cells

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After the successful public demonstrations of thermal anomalies in electrolytic cells at Boston (ICCF10) in 2003 and at Asti (5th Workshop) in 2004, we report a further replication at an Italian high school, “Leonardo da Vinci”. One difference between this replication and the previous demonstrations is that we used “off the shelf” materials (i.e. virgin palladium) and we simply followed a written recipe. We hope these facts encourage others to carry out the experiment.

Method :

The experimental arrangement is very similar to that used by John Dash. Two cells are connected in series (i.e. identical current in each). The control cell consists of platinum foil anode and cathode in H₂SO₄+H₂O. The experimental cell is the same but the cathode is palladium foil and the electrolyte is H₂SO₄+D₂O. Both cells use a catalyst to recombine the oxygen and isotopic hydrogen.

Results :

On passing a current through the cells the temperatures both rise in much the same amount. At a certain point the experimental cell temperature accelerates and remains some 8-10 °C above that of the control cell. The duration of this anomaly appears to be dependent on current.

References

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- 2 - Franco Raverdino et al., “[Fusione Fredda ad Asti. L'esperienza di un liceo astigiano.](#)” 5th Asti Workshop on anomalies in Hydrogen / Deuterium Loaded Metals 2004.