ABSTRACTS

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Experimental Observation And Possible Way Of Creation Of Anomalous Isotopes And Stable Superheavy Nuclei Via Process Of Electron-Nuclear Collapse

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The paper presents experimental results and the theory of controlled abnormal fusion of heavy and superheavy isotopes in a cold superdense electronic-nuclear plasma.

During 2000-2003 more then 4000 experiments on superpressing to a collapse state solid density targets by a special coherent electron driver [1,2] were carried out in Electrodynamics laboratory "Proton-21". Investigations were carried out at different coherent exposure conditions with various targets of controlled composition, made of light, medium and heavy elements with $12<A<210$.

In all these experiments several types of anomalous phenomena were observed:

a) fusion of light, media and heavy chemical elements (at $1\leq A<240$) with abnormal and inverted isotopic ratios [2];

b) fusion of superheavy transuranium elements with $240<A<450$ [3];

c) unique spatial distribution of different chemical elements and isotopes with $1\leq A\leq 240$ in the volume of an accumulating remote from the collapse zone screen made of a chemically pure element (all created elements and isotopes are situated in the same very small areas on the same separated thin concentric layers inside the accumulating screen) [4];

d) all created elements and isotopes (including superheavy ones) were stable or quasistable (with very low radioactivity);

These phenomena were interpreted on the basis of the main common idea - creation and evolution of a self-organized and self-supported collapse of electronic-nuclear plasma of initial solid-state density under the action of the coherent electron driver up to a state of large nonstationary electronic-nuclear clusters with density close to that of a nuclear substance [4]. Atom number (mass) of the unknown particles was very large ($A \geq 3000$-5000) [4]. It is supposed that observed unknown very slow and very heavy quasi-neutral subatomic particles with anomalous high penetrating ability are hypothetical neutralized nuclear clusters. Indirect confirmation of existence of clusters with $A>70000$ in the experiments was also obtained. The model and method of creation and evolution of these superheavy clusters in a cold superdense plasma in the zone of controlled collapse are discussed.

This paper considers the physical process of interaction between these hypothetical clusters and a cold solid target and their possible nonstationary evolution at this interaction. These clusters leave collapse area during its natural decay and participate in subsequent nuclear transmutations at the remote special cold accumulating screens, transforming, at that, nuclei of the screen substance into light, media, heavy and super-heavy isotopes. Special attention was paid to the analysis of the possibility for additional accumulating increase of the clusters mass due to transmit interaction with target nuclei and their barrier free absorbtion.

Clusters identification was based on deceleration distance, time of flight registration technique and analytic analysis of the process of secondary formation of isotopes with atomic numbers $1<A<240$.

We assume that these superheavy clusters are partially similar to abnormal superheavy neutralized nuclei that were proposed by A. Migdal about 20 years ago on the basis of the hypothetical superdensity nuclei forming process at pion condensation in the nuclei volume during the shocking impact [5,6]. From the other hand we think that the mechanism of nuclear transmutation in our system is differ from Migdal's model.

The paper also considers possible ways of reaching necessary initial nuclear collapse conditions. It is shown that such process can be initialized by means of specially organized coherent combined influence on the solid target with full energy less than one kilojoule.

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[3]. S.V. Adamenko, A.A.Shvedov// abid, p.41.
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Ascending Diffusion Or Transmutation

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In view of arising interest to cold nuclear fusion and searches of consequences of its occurrence the study of the interaction of hydrogen with metals is performed in coincidence with micro-probe X-ray spectrum analysis. This analysis provides performing measurement of alloying element concentration with resolution on an area of about 1x1 μm^2.

Savvotimova et al. [1] revealed the appearance of residual elements on the surface of a palladium cathode after electrolysis in the plasma of a glow discharge in deuterium medium and established that concentration of these elements was increased by tens and thousands times. The authors ascribe the local concentration of elements (Ag, B, Ni, et al.) to transmutation resulted from nuclear reactions , though, according to the measurements made by the authors, the number of detected γ-quanta is 8-10 times less of magnitude than it is required for case of appearance of such amount of residual elements.

We assume that appearance of impurity elements on the surface of metals during their saturation by hydrogen isotopes may be explained by ascending diffusion reasoning from the well known literature data on interaction of hydrogen with metals. As the hydrogen concentration increase, in the metallic matrix the constant lattice grows and at room temperature this results in initiation and growth of internal stresses. These stresses generate dislocations which have their own non-symmetric stress fields. The region of tension created by these stresses is inhabited by interstitial and substitutional atoms which size is larger than the atom size of the basic metal, while the region of compression is inherited by substitutional atoms having a size less than the basic metal. As a result, Kottrel atmospheres are created [2]. Under the effect of internal stresses these atmospheres can move and appearance of clusters of residual elements on the surface depends only on duration of hydrogen saturation which should be long because of the low rate transference of the atmospheres.

1. Karabut A.B., Kucherov Ya.R., Savvatimova I.B. Phys. Lett. A, 1992, v. 170, p. 265.

2. Alefeld G, Völkl I, editors. Topics in applied physics. Hydrogen in metals, vol. 1. Berlin, Heidelberg, NY: Springer, 1978.

Fr02

High-Frequency Radiation And Tritium Channel.

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The experiments revealed that in the process of the compression of preliminary hydrogen saturated (up to the concentration C_D = 12 13 at.%) coarse-grained titanium alloy samples at the T= 710 and the velocity of traverse movement v=0,25 mm/min, there occurs radiation not of a neutron origin which is accompanied by tritium precipitation on the near surface layer of samples.

High frequency radiation within the range of radio waves (HFRRW) was detected in titanium alloy samples being under increasing pressure of deuterium at the temperature $T\approx 840^0$ C,. The rate of deuterium pressure increase was $\Delta P\approx$ 0,8 kPa/sec, the signal occurred as the pressure reached P≈ 24 kPa and its duration was 2-3 minutes.

On the basis of the experimental results obtained it was concluded that cold nuclear fusion occurred only by tritium channels since no neutron radiation was detected and formation of only tritium was observed.

We surmise that the occurrence of HFRRW radiation, which accompanies CNF is more likely caused by the interaction of products of nuclear reaction ($D+D\rightarrow p^+ + T^+$), namely, tritium and proton with metallic matrix, and it is retardation of these particles that may cause occurrence of this radiation.

We offer to use registration of HFRRW as an indicator of proceeding of cool nucleus fusion.

1. D.D.Afonichev, M.A. Murzinova Indicator of the process of cold fusion.., Int. J. Hydrogen Energy. 2003,V 28, No 9 pp. 1005-1010.

We10

Characteristics of Compact and Practical "Solid Deuterium Nuclear Fusion Reactor"

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As widely known, the fuel in the thermonuclear fusion is "gaseous deuterium". In this article, however, we demonstrate, a new concept of "solid deuterium nuclear fusion", where "solid-state deuterium" (or "metallic deuterium") locally solidified with ultrahigh density deuterium-lumps ("pycnodeuterium-lumps") within metals are used as the fuel. This reaction was caused easily within the highly deuterated special crystal lattice using a stimulation energy such as powerful high energy density beams which have been practically used in industry (for instance, in welding process and/or other material processing). A lot of ^{4}He (~10^5 ppm) was produced with an extremely high rate of 17% ^{4}He against deuterium concentration using a powerful welding process for only 10[sec] operation. On the contrary, in usual bulk metals (even bulk Pd), the nuclear fusion was never observed, because it was impossible to form "pycnodeuteirum-lumps" due to the bulk Pd property which could not contain beyond 100% deuterium concentration (practically about 80% as well known). It is concluded that "solid deuterium" is by far the excellent fuel against the "gaseous deuterium" in the thermonuclear fusion and characteristics of "solid deuterium nuclear fusion reactor" is described based on the above events, although it is small in size but provides excellent practical applicability.

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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**: { $(Pd \mid D)$, $(Pd \mid H)$, $(Ni \mid D)$, $(Ni \mid H)$ } 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 a 50:50 chance of being correct in any one of the four instances, and so there is a $(1/2)^4 = 1/16 = 0.0625 = 1 - 0.9375$ 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 370 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 shall 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 as follows:

(i) In a simplified/idealized 1-D 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;

(ii) using standard QM (as in Bohm's classic book) I have 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 or not a de Broglie wave for an excited particle can fit into the potential well between two adjacent bound particles.;

(iii) the **spectrum of resonant transparency** of the Coulomb Barrier on either side of said excited particle is a function of the 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!

[1] Robert W. Bass, "Resonant Transparency Spectrum of Deuterium Lattices in $Pd.D_{1.0}$ Cold Fusion Reactors," ICCF5, 1995.
[2] Robert W. Bass, "Parmenter's Fundamental Breakthrough Contributions," *Infinite Energy*, issue 21, 1998, pages 45-49 & 59.

Generalized Cold Fusion Demonstration Protocol

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This is a generalization of the protocol proposed by Bass [1], which is more realistically flexible in several respects. An arbitrary number $N \geq 3$ of similarly prepared samples is allowed, and neither the voltage nor the current is required to be constant. However, the previous protocol may be recovered as a special case when $N = 5$.

Let $N \geq 3$ denote the number of similarly prepared samples. Let the suffix k denote any particular sample, $k = 0, 1, 2, \ldots, (N\text{-}1)$, where the suffix $k = 0$ is reserved for the case of a control blank. Let $\{ C_k \}$, $k = 0, 1, 2, \ldots, (N\text{-}1)$, denote the hypothesized ***causal*** inputs, where, as in Bass & Gleeson [2], each C_k may be e.g. the result of continuous monitoring of the input electrical power [product of instantaneous voltage & current] and its numerical integration over the complete duration of the preparation of the k^{th} sample to give the total amount $C_k \geq 0$ of electrical work done on the sample, or the total energy input. By definition, $C_0 = 0$. Similarly, let $\{E_k\}$, $k = 0, 1, 2, \ldots, (N\text{-}1)$, denote the measured ***effect*** outputs. Three possibilities for the output effects $\{ E_k \}$ are:

(1) E_k = amount of excess enthalpy;
(2) E_k = amount of Helium-4;
(3) E_k = amount of Helium-3.

Now define the estimator of *variance* σ^2 by the sum over all k of

$$\sigma^2 = [1/(N\text{-}2)].\, \Sigma \{ (E_k - dE - C_k .\delta E)^2 \}$$

where dE denotes mean ***effect-bias error***, and where δE denotes mean ***effect-increment*** factor. Next, again summing over all k, define

$$\alpha = \Sigma \{ E_k \},$$

$$\beta = \Sigma \{ (E_k . C_k .) \},$$

$$\gamma = \Sigma \{ C_k \},$$

$$\delta = \Sigma \{ (C_k)^2 \},$$

and verify by setting to zero the gradient of σ with respect to the vector $[dE, \delta E]^T$ that a necessary & sufficient condition for sample ***standard deviation*** σ to be minimized is that

$$dE = (\delta.\alpha - \gamma.\beta)/\Delta,$$

$$\delta E = (N.\beta - \gamma.\alpha)/\Delta,$$

$$\Delta = N.\delta - \gamma^2.$$

The confidence in ***cause/effect correlation*** is great if $\max(\sigma, |dE|) \ll |\delta E|.\min_k\{C_k\}\}$.

[1] Robert W. Bass, "5 Frozen Needles CF Protocol," *Journal of New Energy*, vol. 6, no. 2 (Fall, 2001), pp. 30-32. Also available online at: http://www.lenr-canr.org/acrobat/BassRWfivefrozen.pdf
[2] Robert W. Bass and Wm. Stan Gleeson, "Theoretical and Experimental Results Regarding LENR/CF," *Trans. of the American Nuclear Society*, vol. 83 (Winter, 2000), pp. 355-56; and: http://www.padrak.com/ine/BASS_7.html

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MetaStable Deuterium (MSD) as Ideal Cold Fusion Fuel

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This is an elaboration & elucidation of [1], [2] and invited presentations given to the NASA-JPL Advanced Space Propulsion Workshop, March 2003. Earlier version are available online at the NASA website for ASPW2001, and the cited most recent presentation will be available online soon at NASA's website for ASPW2003.

[1] Robert W. Bass, "MetaStable Helium: An Overlooked Rocket Fuel, Cold Fusion Catalyst, and Much More," *Infinite Energy*, Issue 49, 2003, pages 57-63.
[2] Robert W. Bass and Wm. Stan Gleeson, "Theoretical and Experimental Results Regarding LENR/CF," *Trans. of the American Nuclear Society*, vol. 83 (Winter, 2000), pp. 355-56; and: http://www.padrak.com/ine/BASS_7.html

Tu08

Optimal Wavelength for Laser-Induced Cold Fusion

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Following the announcement by Dennis Letts at the March, 2003 APS meeting in Austin, TX that use of 680 nm wavelength laser light enhances and stimulates the Cold Fusion excess enthalpy effect in a Fleischmann-Pons type of heavy-water electrolysis with a $Pd.D_{1.0}$ cathode, this "Letts Effect" has been replicated by several other well-known CF researchers, e.g. Edmund K. Storms (this ICCF10, to be presented). Indeed, Storms has found that a 250 milliwatt, 680 nm wavelength laser light causes an increase in excess power of 2.5 watts. This **ten-fold** ***power-multiplication*** suggests that Laser-Induced Cold Fusion may become the long-sought technique for scaling up the Fleischmann-Pons Effect to useful power levels.

Accordingly the question arises: does any ***predictive CF theory*** suggest what may be the **optimal** wavelength for such laser-induced Cold Fusion reactors?

Theoretical arguments, consistent with experimental evidence, will be presented that a reinterpretation of the Spectrum of Resonant Transparency of the Coulomb Barrier presented by Bass [1] at ICCF5 suggests that the Letts Effect will be maximal at a **wavelength of 40.38 nm** (which, as will demonstrated in an ICCF10 companion paper, seems to coincide with the center of the Chubb & Chubb **ion band-state** [2],[3]).

[1] Robert W. Bass, "Resonant Transparency Spectrum of Deuterium Lattices in $PdD_{1.0}$ CF Reactors," ICCF10 *Poster Paper*, Monaco, 1995.
[2] Scott R. Chubb & Talbot A. Chubb, Proc. ICCF8, 385-390.
[3] Talbot A. Chubb & Scott R. Chubb, Proc. ICCF8, 391-396.

Th37

Spectrum of Resonant Transparency of Coulomb Barrier

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Using well-known QM formulae in a simplified 1-D point-particle model of a $Pd.D_{1.0}$ lattice, with greater [MATLAB] numerical accuracy than at ICCF5, it will be shown both theoretically plausible and consistent with experimental evidence, that the Spectrum of Resonant Transparency of the Coulomb Barrier to deuterium-deuterium fusion has ZPF-induced line-broadening greater than 50% between n = 99 and n = 336 [an improvement of the ICCF5-announced n = 95 to n = 360], whence a **continuum spectrum** [identical to or at least closely related to Chubb & Chubb's **ion band-state**] exists for 17.5639 eV $< E <$ 60.7959, with line-breadth greatest at n = 190, E = 30.8681 eV.

```
function [En,dfEn,dEn,deltaEn,BroadRat] = RTSpectrumAppx3(n);
%*********************************************************************
%
%  Inputs:
%        n  =  integer, 0 </=  n  </= 600
%  Outputs:
%        En      =  nth energy level of Resonant Transparency Spectrum,
%                   from quartic fit to 20 best-computed values
%        dfEn    =  Enp - En, where np = n + 1
%        dEn     =  Line-Breadth (induced by ZPF), fit to 10 values
%        BroadRat =  dEn./dfEn, using preceding two quartic fits
%        deltaEn  =  quartic fit to 10 best-computed values of BroadRat
%
%  E(191) = 31.0342 eV = E(190) + 0.1656 eV
%  E(190) = 30.8681 eV is approx max of BroadRat in that line-breadth
%        dE(190) = 0.0984 is 59.43% of distance 0.1656 to next line
%  Note that dEn > 0.5 for 99 < n < 337 (at UCCF5: 95 < n < 360)
%
%*********************************************************************
Eo =  6.28361787789068;   % (at ICCF5:) 6.28
dE1 = 0.10239735208775;   % (at ICCF5:) 0.1024;
dE2 = 0.00008512851650;   % (at ICCF5:) 8.516e-5;
dE3 = 0.00000033805923;   % (at ICCF5:) 3.38e-7;
dE4 = 0.00000000020174;   % (at ICCF5:) 2.016e-10;
En = Eo + dE1*n + dE2.*n.*n + dE3.*n.*n.*n - dE4.*n.*n.*n.*n;
np1 = n + 1;
Enp1A = Eo + dE1*np1 + dE2.*np1.*np1;
Enp1B = dE3.*np1.*np1.*np1 - dE4.*np1.*np1.*np1.*np1;
Enp1 = Enp1A + Enp1B;
dfEn = Enp1 - En;
DEo = 0.00249297142391;   % (at ICCF5:) 0.0025;
DE1 = 0.00078210671613;   % (at ICCF5:) 7.821e-4;
DE2 = 0.00000170979858;   % (at ICCF5:) 1.71e-6;
DE3 = 0.00000000135819;   % (at ICCF5:) 1.36e-9;
dEn = DEo + DE1*n - DE2.*n.*n + DE3.*n.*n.*n;
BroadRat = dEn./dfEn;
dlEo = 0.02399512497696;  % (at ICCF5:) 0.0165;
dlE1 = 0.00777727865775;  % (at ICCF5:) 0.00896;
dlE2 = 0.00003571015455;  % (at ICCF5:) 4.93e-5;
dlE3 = 0.00000006320703;  % (at ICCF5:) 1.05e-8;
dlE4 = 0.00000000003942;  % (at ICCF5:) 7.7e-11;
deltaEn = dlEo + dlE1*n - dlE2.*n.*n + dlE3.*n.*n.*n - dlE4.*n.*n.*n.*n;
% end of RTSpectrumAppx3.txt
```

[1] Robert W. Bass, "Resonant Transparency Spectrum of Deuterium Lattices in $PdD_{1.0}$ CF Reactors," ICCF10 *Poster Paper*, Monaco, 1995.

Th10

The History of the Discovery of Transmutation at Texas A&M University

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I received a letter from Roberto Monti in 1989. He claimed his theory showed transmutation in the cold possible. I estimated the writer to be senile but was surprised to meet at ICCF Como - an active younger scientist employed Italian Institute.

Joe Champion, an electronics technician, visited me in early '92 and claimed he had carried out transmutation at a Mexican University. Later he produced a Mr. Telander who offerred $200,000 to Texas A&M. He expressed interest in confirmation of Champion's claim.

Champion introduced an electro-magnetic approach. Electromagnetic radiation would be absorbed by quadrupole frequencies in the nucleus, build up energy, and cause fission. Tried six weeks. Failed.

Champion then introduced the impact method: Hg and Pb mixed with explosive mixture. Mild explosion. Wait three days. Examine product.

This method tried out by post docs Lin and Bhardwaj (later Monti) under my supervision. Five runs showed transmutation Pb and Hg to Au in 100 ppm concentrations and smaller concentrations for other noble metals. This work ended in June '92.

Search for expected gamma radiation negative. However three runs showed beta. Lifetime of the intermediate corresponded to expected isotope Pt.

Impact method work resumed December '92: negligible results tho' beta radioactivity. Additional work lead by Monti, in Feburary '93 was fruitless.

Work with Sundaresen in 1993 used an arc struck between carbon electrodes in water and gave Fe (2-20 micro grams)

Work with Minveski (1993) found new materials created inside electrodes after three weeks H2 evolution. Distinction was made from impurities in solution which were found on the electrode surface.

Kevin Wolf of Texas A&M Cyclotron Institute claimed (1992) he had had transmuted in Pd with H2 evolution. However, Tom Passell (EPRI) found (2003) he could repeat Wolf's results by classical irradiation.

First International meeting on Transmutation was held Texas A&M in 1995. Eight independent authors presented work claiming transmutation. 1996 attempt to host second meeting at Texas A&M 1996 was denied by a Chemistry Department Committee, which described the work as a hoax or fraud. Papers were presented at a local hotel. Professor Miley, of Illinois University co-chaired the meeting with me.

Full account in paper illustrates the need to neglect old theories and believe facts. Universities should not suppress new facts because they disagree with old theories.

Th23

The Cold Fusion Phenomenon: a Hypothesis

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Abstract:

There exists corroborating evidence of a "cold fusion phenomenon". There also exists corroborating evidence that heavy water electrolysis with palladium cathodes does not induce fusion. These two facts seem to imply the following. Cold fusion is supported by certain molecules in the palladium composed of trace impurities. These molecules are decomposed by the energy released when fusion occurs – thus making occasional corroboration possible. (Similar ideas have been proposed by others.) A possible mechanism would be that the cold fusion molecules are like "boxes", with shells semi-permeable to deuterium. Thus deuterium penetrates the shell of a "molecule sized box" and then cannot escape. When sufficient deuterium has entered, due to their proximity to one another, fusion occurs, energy is released, and the box is destroyed.

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[6] New York Times 1989, April 19, I, 8:3
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Catalytic Fusion of Deuterium: II, Heat Output and Activation Energy from New Palladium Catalyst

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Procedure

Catalyst —the new, proprietary catalyst, at 0.1% Pd loading was used, with a charge of 61.5 grams. The configuration of the catalyst was similar to that used in the original 1.6 "football."

The reaction was in an approximately 20-liter dewar flask, 8-inches OD x 30-inches tall, with insulated cover. The heat loss of this dewar was about 30 watts at 185°C.

Results

With H_2 inside the dewar, at about 1-2 psig, the temperature stabilized at:

185 °C, 76.5 V, 0.202 A, and room temp. of 7.0°C
208°C, 82 V, 0.435 A, and room temp. of 10.0°C

With D_2 inside the dewar, at 1-2 psig, the temperature stabilized at:

180°C, 75 V, 0.390 A, and room temp. of 12.3°C
194.5°C, 77 V, 0.390 A, and room temp. of 13.1°C

(The interpolated heat input for 185°C is 29.75 W)
208°C, 80+ V, 0.420 A, room temp. 11.0°C.

Thus, the net heat output (net) for D_2 at 208°C is 35.67 W - 33.6 W = 2.07 Watts
At 185°C, the heat output is 30.75 W - 29.75 W = 1.0 W.

The heat output increased two-fold in 23 °C. The calculated energy of activation is thus about 13 Kcal/mol, which is in the lower-part of the region characteristic of chemical reactions (and far too low for nuclear reactions). And this activation energy may be low enough to be consistent with the value predicted by Peter Hagelstein's mechanism.

Mo02

Energetic Charged Particles from Deuterium-Metal Systems

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We report on measurements made a number of years ago of energetic charged particles which were emitted from thin deuterium-metal systems subject to non-equilibrium conditions of temperatures and electric currents. The preparation of the metal foils, the calibration of the charged particle spectrometers and efforts at particle identification will be discussed. This work was supported by the U.S. Department of Energy and the Electric Power Research Institute.

Th02

Thermal and isotopic anomalies when Pd cathodes are electrolysed in electrolytes containing Th-Hg salts dissolved at micromolar concentration in C_2H_5OD/D_2O mixtures.

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The activity on electrolytic Pd/D system at the Frascati National Laboratories met some problems due to various impurities (organic, inorganic and biological contamination normally present in 'reactor grade' heavy water) which interfere with our electrolytic loading procedures. In particular a new type of bacteria (*Ralstonia detusculanense* discovered by us in 2000), which is present in heavy water, largely grows up during the electrolysis and modifies (significantly) the pH of our electrolytic solutions. In order to overcome those problems a new electrolyte based on C_2H_5OD/D_2O mixtures, carefully vacuum distilled and ultra filtered (100nm), has been developed.

Recently (December 2002) we substituted Strontium (Sr) salts, used in our previous experiments, with Thorium (Th) salts for two main reasons: Th ions can be induced to precipitate on the cathodic surface, as $Th(OH)_4$, because of its low solubility product (10^{-50}), due to the pH increase produced by the electrolytic current in the environment around the cathode; moreover, taking into account some previous results (1998) on possible "Th transmutation" observed during high-power AC (50Hz) electrolysis with Zr electrodes, we decided to test whether something similar could be found also in our experiments.

We have performed several experiments in an electrolytic glass cell (volume 750 cc) operating in flow calorimeter conditions; thin (diam. 50μm) Pd wires (length 60cm) were used as cathodes.

The loading ratio is estimated by means of the well known loading-ratio/resistance curve. The resistance is monitored continuously during the experiments by measuring the voltage drop due to an AC current (15mA RMS, 10KHz, SW) injected along the Pd wire.

A mixture of C_2H_5OD/D_2O, 90/10 by volume, was used as electrolyte; 5mg of soluble $Th(NO_3)_4$ was added to the electrolyte and the pH of the resulting solution was adjusted to about 3 by a very small amount of HNO_3. The electrolytic current was maintained at 10mA. When the D/Pd ratio was at 0.8 the power was disconnected and 3ml of Hg_2SO_4 10^{-3}M were added. In the "*best experiment*" (1 over 4), after the power was switched on again, a fast D loading was observed and in few hours an asymptotic value of D/Pd=0.96 was achieved.

The loading ratio remained stable for 6 days as far as we decided to stop the experiment. Anomalous and large excess heat was detected, after Hg addition, during all the experiment (input power 100-200 mW, output 1500-2500mW).

We would like to remark an unusual and very interesting phenomena observed during the experiments: when the power was disconnected the Pd resistance, which normally tends to increase because of D deloading, ***dropped down*** abruptly (e.g. R/Ro changed from 1.650 to 1.640); later on, in about five minutes the wire resistivity dropped down gently to a R/Ro ratio of about 1.600! At this point the tendency was finally inverted and the Pd resistance started to increase.

A possible interpretation of this phenomenon is that, during the electrolysis, some heat was produced into the Pd wire, so that the wire temperature was higher than that of the solution. When the power was switched off the resistance dropped down and the wire temperature moved toward the solution temperature. We tried to estimate the power emitted from the wire by injecting large AC or DC current along the wire: we measured that the power needed to increase of 1% the R/Ro is about 700mW. It means that, in the above mentioned example, the total drop down of the Pd resistance is equivalent to the emission from the wire of about 2500mW.

It appears that, if the previous interpretation is correct, the excess heat production could be cross-checked by the amount of the resistance drop-down when the electrolytic current is switched off; the wire itself, acting as a thermometer, reveals its own excess heat production.

At the end of the experiment the electrolytic solution was dried: the residue and the Pd cathode, dissolved by aqua regia, were ICP-MS analysed. Large amounts of Cu and Zn were detected: the isotopic abundance of Cu was different from the natural one. The detection of "new elements", in the 4 experiments up to now performed, seems related to: value of overloading and its duration, numbers of cycles of "loading-anodic stripping" performed, amount of Th added.

Works are in progress in order to repeat/ improve, the results described in the "*best experiment*".

Tu10

Coherence Factors In Many-Particle Three-Level Systems

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The appearance of an enhancement of matrix elements due to coherence effects is well known in the case of many-particle two-level system models. In this case, the associated algebra is the Dicke algebra that is equivalent to the angular momentum algebra associated with a many-spin system. Coherence factors arise in this case mathematically, and these describe observations of enhancements of the spontaneous decay rate in Dicke superradiant systems.

We have recently examined states of many-particle three-level system models as part of an effort to evaluate the new phonon-coupled SU(3) unified model for anomalies in metal deuterides. In the case of states of maximum symmetry, an explicit construction of the states is possible, and an evaluation of the associated matrix elements indicates that coherence factors analogous to those of the two-level Dicke problem arise.

Tu11

Few-Body Nuclear Wavefunctions

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The use of explicit antisymmetric electronic wavefunctions for calculations in atomic physics is well known. In the case of two-electron problems, correctly antisymmetrized nonrelativistic wavefunctions are created by taking products of symmetric (triplet) spin functions combined with antisymmetric spatial functions, and antisymmetric (singlet) spin functions combined with symmetric spatial functions. In the nuclear problem, if we consider protons and neutrons as fundamental particles, then we must develop antisymmetric states that include spin, isospin and spatial components. We have recently constructed explicitly antisymmetric wavefunctions for the three-nucleon and four-nucleon states. These states are useful in analyzing models for anomalies in metal deuterides, and for understanding phonon exchange in few-body reactions that take place in a lattice.

The Application of Multiple Scattering Theory (MST) in Calculating the Deuterium Flux Permeating the Pd Thin Film

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14 year pursuing in gas-loading D/Pd system at Tsinghua University results in the discovery of the anomalous feature of the deuterium flux permeating the Pd thin film[1]. Instead of the monotonic feature of the deuterium flux, the peaky deuterium flux appears at certain temperature, which is higher than the boiling point of the heavy water. This is unexpected if the diffusion model is applied to this permeation process. Based on the conventional diffusion theory, the diffusion coefficient increases dramatically when the temperature of the palladium increases. However, we observed the peaky feature repeatedly at certain temperature. It implies a resonant feature; hence, the phase factor of deuteron wave must manifest itself somehow.

The multiple-scattering theory[2] is applied to the de Broglie wave of deuterons inside the palladium film. The formalism for band structure calculation and the reflection and transmission calculations for finite slices is presented. The latter is based on a double-layer scheme which obtains the reflection and transmission matrix elements for the multiplayer slice from those of a single layer. With a relative simple model for the potential of palladium crystal lattice, we calculate the band structures of probability wave of deuterons propagating in the palladium, as well as the transmission coefficients through finite periodic slices. Selective resonant tunneling theory is adopted when obtaining the scattering matrix T. Our calculations consist with experimental results which can not be explained by diffusion theory. We also show that diffusion theory is a special case of our theory-selective resonant theory in the multi-scatter case.

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Th04

Comment On Carbon Production In Deuterium-Metal Systems

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A control experiment using a thin nickel foil cathode, light water and very low current density and three electrolysis experiments of loading deuterium into a palladium foil and two sputtered thin films were preformed using the same electrolysis cell. The cathode surface was analyzed by Scanning Electron Microscopy and by Energy Dispersive Spectrometry. High magnification images of the surface of the cathodes were taken. They reveal that the surface is embrittled and that it presents fissures. The fissures were produces by the mechanical strain induced by lattice expansion and this is a simple way to verify that deuterium was actually loaded in the metal.

The palladium foil was thoroughly cleaned and was analyzed both before and after electrolysis. No amount of carbon was present before loading but a considerable amount was found after electrolysis. Other two experiments were conducted using sputtered thin films, titanium and palladium. The targets used for sputtering had the purity above 99.97 % and the loading experiment started right after manufacturing the cathode. After electrolysis the cathode was analyzed by SEM and EDS and again a considerable concentration of carbon was found.

The multi-body fusion of D-s is a process that is very improbable in vacuum at room temperature but can become significant at high D density, caused by a strong confinement inside the palladium or titanium lattice and in the presence of an increased "free" electron concentration. The "free" electron concentration can be tripled when titanium is loaded with deuterium at a loading ratio close to 2, simply because the sample keeps being electrically neutral by absorbing an electron for each absorbed deuteron. The increased "free" electron concentration can act like a strong screening factor for the Coulomb barrier, but can not stand as the only explanation for the low energy nuclear reactions. Low energy reactions, mainly deuterium multibody fusion, undergoing in a novel way are probably the explanation for the amount of carbon found after loading deuterium in palladium and titanium and for the new elements found after loading hydrogen in different metals, as described in many excellent experimental papers, not referenced here.

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Th43

Accountability in Research in the Cold Fusion Controversy

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In 1995, Adil Shamoo, Chief Editor of the Gordon and Breach (now Taylor and Francis) Ethics in Science, journal, Accountability in Research, asked me to document what precisely might have happened in the underlying scientific adjudication process and/or dialogue (or lack of adjudication process and dialogue) that occurred in 1989, concerning the conflicting claims by Pons and Fleischmann and Jones et al, which at the time were thought not only to be related to each other, but to what was perceived as a "colder" version of conventional fusion. Unfortunately, the name, Cold Fusion, has lasted. But the testimonials, by journalists, editors, and scientists, who prepared material for the resulting collection of articles provide useful information that may help to eliminate the kind of chaotic situation that occurred in the initial adjudication and disclosure process from repeating itself. Lessons about the associated disclosure (or lack of disclosure) include a serious breakdown in protocols, not only involving the manner in which scientists dealt with (or should have dealt with) new and novel disclosures, but with the manner in which controversial ideas are dealt with by Funding agencies, how scientific societies (in particular, the American Physical Society) should deal with them, how the Press should respond to them, and how Universities and National Laboratories should (and have) respond(ed). An unanticipated problem has been the requirement that a degree of accountability be imposed. Part of the reason for this appears to involve new forms of technology (the use of FAX machines and the Internet). These technologies, in particular, had such a serious impact during the initial stages of the debate because through their use, de facto, the papers by PF and Jones et al were published worldwide, in an informal, pre-print form, prior to any formal publication. Unfortunately, as a consequence, incorrect, and inaccurate information was attributed to PF. Also, as a consequence, the usual process for reviewing new articles that was employed both by NATURE and SCIENCE ceased to be objective. With time, it has become apparent that the procedures associated with the adjudication of the relevant scientific claims and the manner in which they were (and were not) disclosed were so seriously compromised that even after 14 years the fact that the initial claims by Pons and Fleischmann and Jones et al are known to be entirely different, in and of itself, is not widely known by most mainstream scientists. In 2000, a special two edition issue, containing this collection of articles appeared in Accountability in Research[1], dealing with questions related to the breakdown in communication about Cold Fusion. Taylor and Francis has granted permission for the collection to be made available on-line, without charge[1].

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We09

Impact of Boundary Effects Involving Broken Gauge Symmetry on LENR's

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Boundaries have a huge impact on reactions in Condensed Matter. Nominally the associated effects result from changes in the local environment. But long-range coherent forms of interaction can occur. These kinds of effects, which are at the heart of modern surface science in Solid State Physics, can cause many charged particles either to acquire a common phase (a broken gauge symmetry[1]) and become wave-like or become coupled to the electromagnetic field (also through broken gauge symmetry[1]) in such a way that the particles can become localized. The effects may seem counter-intuitive. In metals, for example, particles can appear to become localized (through interactions involving surface and/or interfacial states) near interfaces, but in a highly anisotropic manner, in which charge builds up near the interface but becomes dispersed parallel to it. Anisotropic, long-range coupling can occur in which large amounts of charge are found in the immediate vicinity of the interface, as a consequence. This can lead to evanescent matter waves (for example) being created in which large matter content is found localized immediately parallel to the interface. Alternative forms of overlap can evolve from this kind of situation that may inhibit or enhance processes related to the chemisorption and adsorption of gases and related effects (including contamination/oxidation and corrosion at metallic surfaces) and the poisoning of particular catalytic reactions. Metallic impurities can introduce alternative, de-localized interactions, resulting in longer-range magnetic or electronic coupling, potentially leading to macroscopically-large regions of ferro-magnetically active material (for example), or to other effects involving dramatic changes in the transport of heat and electricity or optical properties in a particular material. The results are counter-intuitive because they frequently occur through small changes in particular quantities. Other cases involving seemingly small redistributions of charge at the boundaries can lead to especially dramatic changes and modifications of the bonding that may appear to be small locally but (because of the long-range coupling that can occur through broken gauge symmetry) can lead to macroscopic-scale, coherent electromagnetic coupling, involving novel effects (including normal and super- conductivity, and the Meissner and Mossbauer effects). Related coherent phenomena in insulators and semi-conductors provide the basis for a number of technologies, including the use of doping, and (in the case of insulators) effects from highly non-linear electrostatic forces. In the talk, the role of Broken Gauge Symmetry will be introduced as a pedagogical tool for re-examining seemingly disparate forms of interaction, based on mainstream ideas. This provides a useful framework for accounting for a number of seemingly disparate effects, both in older, and more recent LENR experiments. From this perspective, I will discuss potentially important consequences of broken gauge symmetry at interfaces that could provide insight into some apparent forms of longer-range coupling involving changes in the interfacial chemistry that occur with the addition of CaO layers within the Pd matrix that was used in the Iwamura transmutation experiments. The potential role of coupling to the X-Ray photoemission currents that were used to monitor new products in the experiments is also discussed.

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Mo18

Metal Deuterides: Theory and Experiment

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A theory that is successful, by definition, can be used to interpret and to guide experiment. In the case of metal deuterides, the development of theoretical models that are relevant to anomalies has been hindered due in part to various issues; for example, the variety of phenomena observed, the variation in observed results from experiments that are thought to have the same conditions, and materials and conditions that are not well characterized (at least with respect to parameters that might be expected to be important from theoretical considerations).

Over the years, we have learned from experiment that there are some experimental factors which seem to be important. Near room temperature, high loading is good. A higher operating temperature seems to be beneficial. Deuterium flux appears to be a good thing, especially in connection with thin layers of different materials. Low intensity laser stimulation of the surface is effective. Perhaps a limited volume on the micron or submicron scale is good.

Some of the theories presently under development in the field now address these issues. It seems reasonable that an increased loading probably improves the chances that deuterons can find each other (perhaps important due to the observation of dd-fusion products, and the observation of helium in association with excess heat). Improved performance at higher temperature might imply that deuterons need to be in states that have a higher energy than the lowest energy crystallographic sites. A deuterium flux is expected to generate high frequency phonons efficiently when passing through a chemical potential discontinuity, and layers of different materials will lead to different chemical potentials. Limitations on the volume impact the details of the phonon mode structure.

Efforts at the development of theory would seemingly benefit from experiments that clarify some of these issues. For example, experiments that show effects correlated with flux might seek to quantify the flux. Experiments in which layers make a difference might explore the details of the importance of layer thickness, material (and hence chemical potential), and perhaps quantify the generation of phonons. Experiments that exhibit effects that are sensitive to volume limitations might seek to quantify what ranges of microscopic volume lead to what results (several theories suggest that a limited volume is good, but that if the volume is too small certain effects would be excluded). Experiments in which temperature variations are explored might seek to quantify which states are occupied by deuterium, from Bose condensates at low temperatures, to crystallographic sites at elevated energy as well as double occupancy. A characterization of the local order and defects would be of great interest, as the various proposed models depend differently on such things.

Nuts and Bolts of the Ion Band State Theory

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The "Nuts and Bolts" that hold together or tear apart the Ion Band States that we have suggested play a part in Low Energy Reactions (LENR's) are the electrons in the solid and the way they bond (or don't bond) to hydrogen (H) or deuterium (D) nuclei. Potentially this fact means bonding features can inhibit or trigger coherent forms of Fusion in Palladium Deuteride (PdD). In the past, we haven't emphasized these points, but they have been implicit in our predictions. These have helped to guide[1] and motivate[1] experiments. This process began in 1989 when we suggested electrolysis of D_2O by Pd might cause coherent forms of nuclear reaction, in which ^4He is released with low energy, outside heat-producing electrodes. This prediction required sufficiently high D-loading. This would cause coherent forms of nuclear reaction. A foreign concept was that a macroscopically small number of deuterons (d's) occupy, wave-like, Ion Band States. Two points we did not emphasize were: 1. This picture becomes rigorously valid in the limit of vanishing temperature T when a small number of additional D's are forced into fully-loaded Palladium Deuteride (PdD); and 2. The special relationship that exists between H and D Ion Band States, and the known H and D -acoustical phonon modes in PdD that are induced in this limit.

Because the hole and electron states, immediately above and below the PdD Fermi Energy are 5S-like[2], and they have anti-bonding (Pd-Like) character [3], the bonding of the D's to the substrate, immediately before and after full-loading is weak and isotropic. For the same reason, in the limit in which a macroscopically infinitesimal number of additional D's are loaded into the lattice, to minimize energy, the addition of each D would induce bonding to the substrate in a manner that mimics the way the earlier D's have bonded to it. In this limit, each D effectively would dissociate from its valence electron (which would occupy an s-like electron band state, with negligible addition of charge to each unit cell), and would have no core electrons. Also, each additional D would interact with a periodic, single-particle, periodic Coulomb potential that to an excellent approximation (exact in the limit of negligible additional loading) would be used to define the phonon spectrum in PdD. As a consequence, in the absence of D-D interactions, in this limit, the spectrum of possible single particle Ion Band States would match the phonon spectrum of phonon states, and (because energy minimization requires continuity in the geometry and bonding characteristics of the D's to the host) the associated wave functions would be identical. At finite T, D-D collisions can occur that can invalidate this picture. However, starting from the limit where this picture applies, a limit exists in which reactions can be incorporated without affecting the validity of the picture. A requirement for this to occur is that energy be released (primarily at the boundaries of the solid) through resonantly, coherent, Umklapp processes. Here, momentum from each reaction, effectively, is shared by many charged particles at once through rigid translations (similar to lattice recoil in the Mossbauer effect). In practice, the coupling to these kinds of processes, introduces abrupt (quasi-discontinuous) changes in the momentum (through wave-function cusps) at locations where overlap between the nuclear and electromagnetic portions of the wave functions are allowed to take place. As a consequence, as opposed to a "Coulomb Barrier picture" in which nuclei tunnel across a repulsive potential, at an isolated location, in the Ion Band State case, reaction occurs simultaneously at many locations. Also, as opposed to the limit in which nuclear and electromagnetic interactions become uncoupled, in the Ion Band State picture, the two forms of interaction remain coupled coherently.

We have generalized [4,5] this picture, considerably. At the heart of the theory is the idea that momentum can be shared instantly by many charged particles, as well as by a small number [5].

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LENR: Self-Trapping and Non Self-Trapping States

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Greiner et al.[1] in their study of Bose-Einstein condensates in optical lattices created a coherent population of ^{87}Rb atoms by transferring laser-cooled atoms into a cigar-shaped magnetic trapping potential, and used forced radio-frequency evaporation to create Bose-Einstein condensates with up to 2 x 10^5 atoms with no discernible thermal component. They then imposed a laser-created optical lattice onto the coherent population, partitioning the mass density of the Bose-Einstein condensate among more than 1.5 x 10^5 potential wells. Only a fraction of each indistinguishable atom was present in each unit cell. Superfluid coherency was observed as long as the potential wells created by the lattice were not too deep. In these studies the presence or absence of the rubidium atoms did not affect the geometry of the optical lattice. This means that there was no self-trapping of the rubidium atoms.

When a metal absorbs a hydrogen atom, the hydrogen ion enters the metal lattice at an interstitial site accompanied by a neutralizing electron. Normally the lattice expands around the occupied site to accommodate the added volume of the neutralizing electron. The interstitial hydrogen ion is self-trapped. The condition required for cold fusion is that deuterons go into a wavelike configuration in a process that avoids localized distortion of the lattice. It is important to distinguish between self-trapping deuterons, ${}_{st}D^+$ and non-self-trapping deuterons, ${}_{nst}D^+$, and to recognized that both types of interstitial deuterons may exist concurrently within the same metal crystal. The non-self-trapping deuterons may exist in a different set of sites than the self-trapping deuterons. In ordinary cold fusion the reactive crystal might be described by the formula Pd ${}^{O}_{st}D_{0.8}\,{}^{T}_{nst}D_{.001}$. Here the hosting crystal is a palladium deuteride with a 0.8 D/Pd ratio in which the self-trapping deuterons are in octahedral sites while the nuclearly active component is a non-self-trapping population of (wavelike) deuterons in relatively shallow tetrahedral sites.

Consider an Iwamura et *al.*[2] permeation flow of deuterium through a Pd metal membrane containing a set of thin embedded CaO diffusion barriers. The permeation flow involves 2 species of deuterium, i.e., normal interstitial octahedral deuterium ${}^{O}_{st}D$ and ion-band-state tetrahedral deuterium ${}^{T}_{nst}D$. The ${}^{O}_{st}D$ diffuses through the membrane in response to a concentration gradient. Low resistance ${}^{T}_{nst}D$ flow occurs within each of the pure Pd regions, but at each barrier there is an interface that can be expected to split the current flow into reflection, scattering, and transmission components. Transmitted ${}^{T}_{nst}D$ flow contributes to permeation. Reflected ${}^{T}_{nst}D$ contributes a negative permeation component. Scattering of ${}^{T}_{nst}D$ removes carriers from the many-body system, converting band state deuterons into self-trapped interstitials. Microscopic reversibility suggests that when the ${}^{O}_{st}D$ diffusion flow encounters a CaO barrier, the self-trapped octahedral deuterons undergo a reverse scattering opposite to that occuring in the ${}^{T}_{nst}D$ flow. This reverse scattering creates non self-trapped deuterons, i.e., some of the ${}^{O}_{st}D$ configuration deuterons change into the ${}^{T}_{nst}D$ configuration, as needed to overlap with target Cs nuclei.

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LENR: The Cold Fusion and Transmutation Connection

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Low energy nuclear (LEN) is a promising technology. It includes cold fusion and seeks a protocol that reliably produces nuclear fusion heat. Key characteristics of cold fusion that have been challenging to explain are: 1) the overcoming of the Coulomb barrier, 2) the blocking of the decay modes that produce high energy particles, and 3) the conversion of nuclear energy into a heating of the environment. There is also an item 4. Experiments have shown that other forms of "low energy nuclear reactions" can occur in condensed matter, namely, the creation of various transmutation products. For dd fusion to occur, a subset of the deuterons in a metal must become self-organized into a coherent many-body deuteron system in which the deuterons act in concert like the atoms in a Bose-Einstein condensate. It may be that some of the teachings of Bose-Einstein condensates in optical lattices can provide insight into conditions that enable cold fusion reactions to occur.

This paper assumes that the nuclear active component in LENR is a many-body deuteron system in a periodic environment provided by a metal crystal.**1** The organizing principle is the equivalence of each of Ncell unit cells in a metal crystal. Studies have shown that the Coulomb barrier problem becomes replaced by a correlation factor in the many body-wave equation provided that Ncell exceeds Ncell,critical, where Ncell,critical has been estimated from simplified modeling to be of the order of 1000 to 10000 unit cells.**2** The substitution of many-body correlation for Coulomb barrier is in accord with the teachings of Julian Schwinger. The blocking of the high energy particle decay modes is implicit in a requirement that there be no departure from periodic symmetry during the reaction process. The problem of energy transfer to the environment has been treated in 2 ways: 1) momentum transfer from the coherent many-body system to the metal crystal, with subsequent incoherent phonon generation in multi-crystal metal, and 2) a piecemeal transfer of energy from the product Bloch helium nucleus to the metal's electron fermi sea in which the first electron scattering leaves the nucleus in a mixed state. The mixed state, which is neither a Bloch deuteron pair nor a Bloch helium nucleus, becomes a stationary state after a stepwise transfer of the full 23.8 MeV of nuclear energy to the metal's electrons.**3**

Low energy transmutation reactions occur when Bloch-function deuterons or protons overlap with a transmutation "target" nucleus. Focusing on deuterons, this requires deuteron coherence over a volume exceeding Ncell,critical, where the Ncell,critical for transmutations exceeds that of the Ncell,critical for d-d fusion. The Coulomb barrier becomes replaced with a coherence avoidance term in the combined Bloch-function-hydrogen wave function and the localized transmutation "target" nucleus. The nucleus and the hydrogen Bloch system become a common nuclear system, which allows transfer of nuclear matter between the coherent hydrogen system and transmutation feedstock nucleus. In the Iwamura et *al.* experiments target surface cesium atoms pick up the equivalent of 2 helium nuclei to become product praseodymium atoms. Excess reaction energy is transferred to the metal lattice as in cold fusion.

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Tu02

Practical Techniques in CF Research

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A collection of useful techniques will be presented that is gleaned from 14 years of CF research and over twenty approaches of attempting to produce excess heat. Special attention will be given to those techniques that seem to trigger or initiate heat production. Such topics as stimulation by electromagnetic waves, heat cycling, pulsing current, and deposition of Pd will be discussed.

Th31

Effects Of Hydrogen Loading By Aqueous Electrolysis On Radioactivity Of Uranium

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ABSTRACT

Previously we reported that aqueous electrolytic co-deposition of hydrogen with uranium on nickel cathodes caused increased rates of radioactive decay of the uranium [1, 2]. A subsequent study found that glow discharge with either hydrogen or deuterium plasmas and uranium foil cathodes resulted in increased rates of radioactive decay of the uranium [3]. Mass spectroscopy showed that glow discharge reduced the concentration of uranium and increased the amount of lead in the samples [4].

In our current research, hydrogen was loaded into uranium foils by aqueous electrolysis with an electrolyte containing light water and sulfuric acid. Afterward, alpha, beta, and gamma radiation measurements were made with a Ludlum Model 3030 counter. Uranium foils containing hydrogen from five different experiments all had significantly higher alpha, beta, and gamma emission rates than the original material. Using an EG&G ORTEC gamma ray spectrometer, it was found that uranium samples from four of the five experiments all had greater intensities of 92.4 keV gamma rays from decay of thorium 234 than the control. Uranium characteristic x-rays also appear in the gamma ray spectra. The intensity of $K\alpha 1$ at 98.5 keV is less for four of the five electrolyzed samples than for the control. This suggests that there is less uranium in four of the electrolyzed samples than in the control, which is similar to our results in the glow discharge experiments. Uranium 235 gamma rays at 186 keV have greater intensities for four of the five electrolyzed samples than for the control. This result was also obtained in the glow discharge experiments.

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Mo16

^{4}He Detection In A Cold Fusion Experiment

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Excesses of enthalpy consistent only with a nuclear process (fusion of Deuterons) have been claimed since 1989, even though they have been considered to be inconsistent with modern nuclear science and discarded by the most of nuclear scientists.

In such a frame the fusion among deuterons occurs within a medium and not in vacuum. Thus energy and momentum can be shared among many components of the condensed system (see Mössbauer effect for comparison), allowing in principle a fast cooling of the "hot" D-D compound nucleus preventing its splitting. Consequently ^{4}He should be expected to be the final product of this newly discovered nuclear fusion.

We have observed ^{4}He production during electrolysis in LiOD solution on Palladium cathode about a factor 20 out of the baseline. Simultaneously an anomalous enhancement of the temperature measured in the cell has been detected. The accountability of our calorimetric measurements (average cathode temperature measurement) requires that the system be at its thermal equilibrium (or in a succession of thermal equilibrium states). Non thermal (radiative) part of the energy produced in the phenomenon can be lost by the temperature transducer (Peltier element) if it thermalizes out of the cell. Then we are able to estimate, at the present time, a lower bound for the produced energy.

Are Nuclear Transmutations Observed At Low Energies Consequences Of Qed Coherence?

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Cold Fusion of deuterons in a Pd matrix releases an output of 24 MeV per fusion, which is transferred to the e.m. fields trapped in the coherence domains of deuterons and Pd electrons. This energy appears for a very short time (less than 10^{-21} sec) as an excitation having the frequency of γ-rays.

It is discussed in the framework of nuclear shell model whether this excitation could start collective excitations in Pd nuclei and then induce nuclear reactions.

Triple D Fusion Between Deuterons And The Nuclei Of Lattice Trapped D_2 Molecules

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Abstract

Low energy nuclear reactions (cold fusion) could involve three-body recombination between deuteron and the nuclei of D_2 molecule trapped in a dense lattice of a chemical compound of transition metal and impurity. Two D's fuse to ^4He, and the energy is converted by expulsion of the third deuteron. Measurable fusion occurs when two D's are within 0.1 angstrom of each other. Three boson (Efimov) interactions have longer range than two boson interactions which would perhaps make interactions in the 0.5-1.0 angstrom range possible; the distance between D's in a D_2 molecule is 0.75 angstrom. If the Efimov state is large enough, energy might be transferred to the lattice by direct knocking on the surrounding atoms. The reaction mechanism explains the short duration and low reproducibility of the effect by rapid destruction of the active structure by sputtering, radiation damage, bubble formation and chemical reduction of impurities to compounds like D_2O, ND_3, CD_4, or BD_3. The mechanism also explains why much ^4He, much less tritium, and neutrons only in very small amounts, is observed.

Fr04

Theory of Low-Temperature Particle Showers

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A theoretical basis is offered for the remarkable observation by Oriani and Fisher of a shower of about 250,000 energetic charged particles that occurred in the vapor of oxygen and hydrogen evolved from electrolysis. The shower was localized in space and in time, originating a few millimeters above the surface of a plastic detector chip and lasting for a few seconds. The responsible nuclear reactions must have been sustained by the vapor constituents.

The theory assumes that neutron aggregates (variously termed neutron isotopes, polyneutrons, or neutron droplets), of size exceeding 6 or 8 neutrons, are bound and stable against strong decay. A portion of the binding energy is assumed to arise from attractive neutron pairing analogous to the electron pairing in superconductivity, and does not reach its full strength until the droplet size reaches a coherence volume of 20 or so neutrons. Weaker binding for small droplets accounts for the gap of instability in the range between 1 and 6 or 8 neutrons. Accepting that bound neutron isotopes exist, the table of isotopes expands to include droplets with tens, hundreds, or thousands of neutrons, all stable against strong decay and with lifetimes determined by the rate of beta decay in which a neutron transmutes to a proton plus an electron and an antineutrino.

We consider two classes of reactions between polyneutrons and ordinary nuclei. In one class a polyneutron donates one or more neutrons to an ordinary nucleus or it accepts one or more neutrons from an ordinary nucleus. These reactions can have extremely large cross sections because there is no coulomb barrier for approach of reactants or for separation of products. In the other class of reactions a polyneutron binds with an ordinary nucleus to form a halo nucleus where the ordinary nucleus dissolves in the polyneutron. Binding energy is provided by a reduction of surface energy of the ordinary nucleus. Halo nuclei are stable against strong decay provided that all potential exchanges of neutrons between the halo and the ordinary nucleus at its core are endothermic. This limits the number of potential core nuclei to particularly stable nuclei including ^{4}He, ^{12}C, and ^{16}O.

The theory suggests that a single polyneutron can ignite a chain reaction that is sustained by ^{18}O as fuel. Polyneutrons grow two neutrons at a time as they interact with ^{18}O to form 16O. When large enough they fission in interaction with ^{18}O and increase the number of polyneutrons in the chain. Halo nuclei with ^{16}O and ^{12}C cores are created in side reactions and interfere with the chain reaction by capturing polyneutrons. For chain reactions in the bubble-growth regions near electrodes during electrolysis, rapid shear deformation of the fluid removes halo nuclei from the reaction volumes and allows chain reactions to continue at a bounded rate. New reactions then can be initiated, in quiescent electrolyte and in the vapor, by emission of polyneutrons in a rare decay channel from halo nuclei generated in the ongoing reactions near electrodes. But reactions in quiescent regions are soon brought to a halt as free polyneutrons are captured by the buildup of halo nuclei. The halo nuclei then decay by successive beta and alpha decays that provide most of the energetic particles in a shower. Shower particles in the vapor phase have sufficient range to register patterns on nearby plastic detectors. Specific reactions are suggested for the various steps in this process. Together they provide a full explanation for the observed particle shower.

Background To Cold Fusion: The Genesis Of A Concept

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Starting in the early 1960's I became increasingly concerned with the question; is it possible to devise experiments in electrochemistry which illustrate the need to invoke the Quantum Electrodynamic Paradigm for the interpretation of the results? In due course five major topics were investigated:

1) the kinetics of fast reactions in solution at time scales below 1μs;
2) the kinetics of voltage-gated transmembrane ion conduction processes;
3) Surface x-ray diffraction;
4) the kinetics of phase growth of single centres on microelectrodes;
5) mass transfer to surfaces due to wall-phase turbulence.

There was also a set of further problems which could not be investigated directly.

It became apparent that the explanations of 1), 2), 3) and 5) required the division of the solvent (water) into two domains, one of which had dimensions between 10^{-6} and 10^{-5} cm and in which the solvent was highly structured; 4) indicated that such a division might be a general phenomenon. The explanation of this phenomenon became available at a later date (1), (2).

In the early 1980's, Stanley Pons and I asked ourselves the question; if the production of structured domains applies to deuterium in host lattices (such as Pd), then would it be possible to induce nuclear processes in the deuterium by adding relatively small energies / species to these domains i.e. could one build a bridge between the low energies (~1eV) of Chemical Systems and the high energies (say 1 MeV) governing nuclear processes ? There were also two further pertinent factors. One was the observation of "cold explosions" by Bridgeman in the 1930's (intense compression of lattices can lead to their fragmentation into small particles in which the high energy of the initial system is contained in the kinetic energy of the fragments; surely a process which can only be explained by Q.E.D.?); the second was our knowledge that absorption of hydrogen isotopes in metals can lead to just such a fragmentation.

We embarked on this project without any great hope that we would obtain definitive results. We investigated the Pd /D system (coupled to the use of the Pt / D system as a suitable "blank") using calorimetric methods (for reasons which we explain below). However, the outcome was radically different to our expectations; the steady-state generation of excess enthalpy without significant formation of the fusion products produced in dilute high temperature plasmas (the formation of ^4He could be detected but could not be related to the magnitude of the excess enthalpy generation).

The results of this investigation (3) have been extensively criticised principally because of the lack of the expected fusion products. The fact that the description of high temperature plasmas is incomplete when considering fusion in a lattice will be illustrated (as was indeed shown in (4), (5) by measurements carried out at the time of the discovery of "hot fusion" (6)) This fact prompted our use of calorimetric methods to investigate the energy balances.

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The "Instrument Function" Of Isoperibolic Calorimeters; Excess Enthalpy Generation Due To The Parasitic Reduction Of Oxygen

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Critics of the topic of "Cold Fusion" frequently assert that isoperibolic calorimeters are imprecise and inaccurate so much so that the measurements of excess enthalpy generation (e.g. (1)) could not have been made. Furthermore, any valid excess enthalpy generation has then been attributed to the parasitic reduction of electrogenerated oxygen although such assertions have not been accompanied by appropriate measurements. It will be shown that there is a connection between these two assertions.

The first step in the development of any investigative methodology must naturally be the determination of the relevant "instrument functions" determined here by the differential equation modelling the calorimeters. It will be shown that such models are characterised by the relevant heat transfer coefficients, $(k_R')_{i, j, k}$ / WK^{-4}, where i =1 denotes the determination of a local differential coefficient, i = 2, 3 denote processes of backward forward integration of the temperature - time series ; k = 5 denotes the time region adjacent to the start of a measurement cycle, k = 6, 7, 8 denote respectively time regions adjacent to the start of an heater calibration pulse, the end of this pulse and a combination of the two time regions ; k = 1, 2 denote respectively the "lower bound" heat transfer coefficient (based on the assumption that there is no excess enthalpy generation) and the "true" coefficient (based on the response to the heater calibration pulse). Omission of the symbol j denotes that we are considering a coefficient throughout the time range of a measurement cycle while omission of i denotes that we are considering "robust" estimates of the "lower bound" and "true" heat transfer coefficients at the end of the calibration period (compare e.g. (2)). The terminology (k_R') denotes that we are considering a pseudo radiative coefficient (based on the neglect of any conductive contribution to heat transfer in the Dewar - type cells).

It will be shown that the determination of the most precise and accurate coefficients (errors $< 0.01\%$) should be based on the backward integration of the time series giving for example, $(k_R')_{261}$ and $(k_R')_{262}$. Such determinations require that the rates of any excess enthalpy generating processes are constant in time. These conditions are satisfied for "blank" experiments such as the Pt / D_2O system which we have used in our investigations. Excess enthalpy generation is restricted to that due to the reduction of electrogenerated oxygen which is constant in time for the conditions of the experiment. It is therefore straight forward to determine this rate of excess enthalpy generation which is shown to be close to the value predicted from the rates of reduction available in the literature (3); it is also close to the value determined in the original investigation (1) where the evaluation was carried out using non - linear regression (see Table 4 of (1))

An alternative strategy is to base the evaluation on the differential coefficients $(k_R')_{11}$ and $(k_R')_{12}$ coupled to the appropriate signal averaging of the derived rates of excess enthalpy generation and this methodology must be used when the precise and accurate integral coefficients cannot be evaluated. The results of the two methods of investigation will be shown to be closely similar (3)

The classification of calorimeters according to the principles of Chemical Reaction Engineering (4) will also be discussed and it will be shown that accurate evaluations should be based on the "ideal reactor", the "well stirred tank" description characterising the isoperibolic calorimeters used in the investigations.

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Mo10

Fusion Reaction Within A Microcrack With CFC Lattice Structure At Low Energy And Study Of The Non Semi-Classic Tunneling Effect

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Abstract

This work presents the theoretical results obtained analyzing the reaction of deuteron-plasmon fusion in lattices with cubic structure at variable temperature.

The enhancement of the Tunneling effect, resulting from the increase in temperature and the concentration of impurities *J*, opens the way for the "theoretical hypothesis that a form of chain reaction, favored by microcracks formed in the structure as a result of deformation D_L of the lattice, can allow the phenomenon".

This result can be interpreted considering the trend of the curve of potential *V(r)* which describes the effective interaction between deuterons within the metal. In fact, this shows that plasmon-deuteron coupling in the presence of impurities is able not only to reduce the thickness, but also the height of the Coulomb barrier represented by (J/ς).

Th40

New Energy Devices Reduce Atmospheric Pollution

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ABSTRACT:

Professionals involved in reducing atmospheric pollution (which is deemed to be killing off many earth life forms) have failed to recognize successful new-energy devices. Although not yet commercialized, four such new energy devices have demonstrated some degree of capability to provide pollution free energy. The following devices will be discussed:

1. High density, electron charge clusters (HDCC) tapping space energy.
2. Dr. Randell Mills collapsing of the hydrogen below its ground state.
3. The Russian device that produces thermal energy from the surging of heavy water through a special material.
4. (If permission granted by inventor) Electromagnetic coupling of electrical energy from space energy.

Any one of these new-energy devices could be commercialized within two years if properly funded. A verbal commitment for a $40 million dollar grant has been received for a special application of the HDCC technology.

Th34

Stabilization of High-Level, Radioactive Waste

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EEMF, Inc. will receive a $60 million grant to demonstrate that the on-site transmutation of high-level, radioactive, solid waste can be accomplished. This development is expected to save billions of dollars of taxpayer funds that are scheduled for the preparation, shipment, and long-term storage of spent-fuel pellets from nuclear power plants. The process of on-site stabilization of radioactive wastes has been developed over the past several years beginning with investigations into the excess heat that is observed with successful replication of the Fleischmann-Pons low-energy nuclear reactions (LENR). Much of the excess heat from LENR of the Fleischmann-Pons effect is considered to result from the cracking of stressed, deuterium-loaded palladium with the resultant production of high-density, charge clusters (HDCC). The transmutation of radioactive waste uses the HDCC process by the immediate and direct production of HDCC.

Th21

New Type Of Radioactivity

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It is well known, that many books and reviews about the experemental data of "Cold Fussion" (CF) [1] and "Cold Transmutation" (CT) [2] were publshed. Existing theoretical models do not explain the data, no theoretical foundations of CF and CT success even in quavalitativily describing of the experemental results. Here we presented the new theoretical model.

Let us restrict to CT. Experemental data of CT has many common properties independing of external forces used to induce CT: 1. CT are the exothermal process. 2. The cross section of CT has exibit the resonance and threshold character. 3. Synthesized nuclei by CT are stable, ...

Observed properties of CT may be explaned qualitatively by the resonance synchronization principle [3] and new natural radioactivity [4]. The resonance principle is responsible for the increasing of the cros sections of CT, when the frequansies of external fields are commensurable with the frequansies of nuclei, which participated in the nuclear syntheses. Authors [5] suggested to use for CT the bound – state β^- decay of fully ionized atoms. In such case the acceleration of β^- decay may be up to many orders (up to 20 orders) [6,7]. Bound-state β^- decay is a weak interaction decay mode, in which the decay electron remains in a bound atomic state, the antineutrino carries the total decay energy. The number Z of protons increases (Z+1) and the number N of neutrons decreases (N-1): $X_Z^A \to (Y_{Z+1}^A + e^-)_{bound} + \tilde{\nu}_e$. This is the transmutation of nuclei by a weak interaction.

This idea [4] was generalized to the different multistep photonuclear reactions, for example:

$$\gamma + X_Z^A \to (e^+ + e^-)_v + X_Z^A \to (Y_{Z+1}^A + e^-)_{bound} + \tilde{\nu}_e, \quad (1)$$

$$\gamma + X_Z^A \to (e^+ + e^-)_v + X_Z^A \to Y_{Z+1}^A + e^- + \tilde{\nu}_e, \quad (2)$$

$$\gamma + X_Z^A \to X_Z^{A*} \to (Y_{Z+1}^A + e^-)_{bound} + \tilde{\nu}_e, \quad (3)$$

$$\gamma + X_Z^A \to X_Z^{A*} \to Y_{Z+1}^A + e^- + \tilde{\nu}_e. \quad (4)$$

Where symbol $(e^+ + e^-)$ means that electron-positron pair is virtual. These processes can give essential contribution to stellar nucleosynthesis of heavy nuclei. The capture reactions (1) of virtual positrons by nuclei in strongly ionized atoms are a new type of natural radioactivity which is a responsible for which is a responsible for the asymmetry of matter and antimatter distribution in Universe.

It is well known that the fluid - dynamic flows in the Earth crust are followed by high ampere currents in the natural magnetic field of the Earth. Krivizskiy V.A. [8] acted on lead with short pulse current in a high-power magnetic field. He synthesized a new nuclei depending on the current intensity and impulse duration. This is the transmutation of nuclei by the electromagnetic fields.

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We11

Thermal to Electric Energy Conversion -- Basics, Limits, and Potential

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Several groups in the field are working toward the development of devices that would generate power for commercial applications. Some of these applications involve the conversion of heat to electricity. This motivates a brief consideration of the problem of thermal to electric energy conversion.

The efficiency for thermal to electric energy conversion is ultimately limited by thermodynamic considerations. In an ideal converter, no entropy would be generated in the conversion process, and the conversion efficiency that results is the Carnot limit -- $(T_{hot} - T_{cold})/T_{hot}$.

No practical thermal to electric conversion system works at or near this ideal limit. Commercial thermoelectric systems convert with efficiencies that are on the order of 20% of the Carnot limit. New thermoelectrics that are under development in the lab will result in higher efficiencies on the order of 30% of the Carnot limit. Other approaches are expected to lead to higher conversion efficiencies. We review a variety of approaches to the problem. It is likely that conversion efficiencies greater than 40% of the Carnot limit will emerge from research efforts presently under way.

The implications of this for electric power generation from excess heat production in metal deuterides and metal hydrides is considered. Excess thermal power produced in aqueous electrochemical systems that operate below 100 C will be converted to electrical power inefficiently. A thermal to electrical power gain on the order of 10 is required for a self-sustaining system. Devices that produce excess heat at elevated temperatures will be most interesting for application involving electrical power generation.

Models For Tunneling Through The Coulomb Barrier

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There has been a great deal of discussion over the years on the problem of two deuterons tunneling together in molecular deuterium and in metal deuterides. We have examined this problem in some detail over the years, and it seems appropriate to summarize some of the results that we have obtained.

The basic problem as understood from conventional solid state and nuclear physics involves tunneling and Golden Rule reaction rate estimates for the resulting fusion reaction when the two deuterons approach within a few fermis. There has been much discussion of possible enhancements of the tunneling effect due to screening effects. We have examined various aspects of this problem, including site effects and dielectric effects. We conclude that screening in the case of TiD is probably similar to the case of molecular deuterium.

We consider how tunneling would be modified if a resonant nuclear state were present. We find mathematical solutions that correspond to a greatly enhanced tunneling rate. However, a consideration of dephasing effects indicates that there would be no possibility of obtaining such enhancements in a real metal deuteride.

The phonon-coupled SU(N) models that we have been studying recently appear to describe coherence effects associated with tunneling through the Coulomb barrier. We consider this model in terms of the associated matrix elements, and the implications of experimental results on anomalies in metal deuterides on the associated rates that are predicted.

Fr11

On the New Electronic Journal

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Plans to initiate a new electronic journal for people working in this area were discussed at ICCF9. Since that time, much progress has been made. It is hoped that the journal will be ready to begin taking contributed and invited manuscripts for consideration for electronic publication by the time of the ICCF10 conference.

The new journal (*Condensed Matter Nuclear Science*) will receive papers electronically for review, and then papers will be assigned to an appropriate Associate Editor who will arrange for manuscript review under rules similar to those used by the American Physical Society in the case of the various *Physical Review* journals. Authors of accepted papers will be expected to provide a version of their paper that is close to being in final form according to the journal format. The journal will provide some copy-editing assistance to assure that the final version of accepted papers are publication quality. Accepted papers will be published electronically in the journal repository, where they will be made available free of charge to the scientific community.

One project of immediate interest for the new journal is to arrange for review papers from individuals or from groups who have been active in the area since 1989, in order that their work, which might not have been otherwise published in a peer-reviewed journal, would not be lost or forgotten. Such papers that review the activities and progress of a single group or individual, will be arranged for by invitation from the journal. Those interested in developing such papers are encouraged to communicate with the Editorial Staff of the journal in order to make their interest known.

The journal will encourage contributed papers from authors that are well-written and focused on a single topic. Experiments should be reported so as to allow for them to reproduced by others, and with clear discussions of the purpose and results. Theory papers would hopefully concern themselves with a well defined and focused topic, and make very clear what material is speculative. As the scope of the journal includes a range of topics that are multidisciplinary in nature, we expect papers on a wide range of relevant topics. Acceptance of a particular paper will be based on the quality of the science and of the work reported, and not on whether a particular result is positive or negative.

Tu09

Unified Phonon-Coupled SU(N) Models For Anomalies In Metal Deuterides

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We have generalized the resonating group method for nuclear reactions in vacuum to include explicitly a description of the solid-state environment in the entrance and exit channels. The new model includes the vacuum nuclear description as a subset of a more general picture.

First-order reactions within the new model do not change significantly from the vacuum description. Phonon exchange effects constitute the predominant new physical mechanism that is absent in the vacuum description. Phonon exchange can produce a modification of the vacuum microscopic selection rules, similar to the atomic case where phonon emission in a solid can replace photon emission in vacuum.

New site-other-site reactions are predicted when reactions at different sites exchange phonons with a common highly excited phonon mode. This picture allows for an understanding of the fast alpha emission reported by Chambers and colleagues at NRL in 1990, and of other unusual fast ion emissions from metal deuterides.

The specific site-other-site reaction in metal deuterides that is predicted to be fastest is the null reaction, in which two deuterons form helium at one site, and a helium dissociates to produce two deuterons at another site. The two deuterons produced from helium dissociation are predicted to have difficulty tunneling apart, raising the possibility of detecting the process using nuclear collisions. This motivates us to revisit the Kasagi experiment in which three deuterons appear to react to give fast alphas and fast protons.

We have studied two-site models and many-site models in which deuterons in molecular states combine to form localized two-nucleus states, which make transitions to the helium ground state, in all cases with phonon exchange. We have demonstrated that these models can lead to efficient exchange of nuclear energy for phonon energy when the phonon excitation is sufficiently strong to contribute on the order of 20 units of angular momentum to the localized states (which stabilizes them against fusion and other decays). Within the model, the process of tunneling from the molecular states to the localized states appears as a coherent process with Dicke enhancement.

Analysis of Calorimetric Data Obtained Using Fleischmann/Pons Type Electrochemical Cells to Determine Excess Heat

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We have developed special approaches to the analysis of F/P cell calorimetric data. These procedures make use of previous work in the field, statistical methods of analysis, and some unique physical modeling. They depend heavily on extensive computational capabilities, so simply available these days, and powerful graphical techniques. Not only are the results useful for analyzing calorimetric data obtained using F/P type cells, but they demonstrate how the cells and methodology can be useful more generally for other calorimetric purposes. For example, it is shown that the cells can be accurately analyzed for "well stirred" cells, not so well stirred cells, and cells not stirred at all. Also at one time it was thought that heat pulses could not be used to calibrate the calorimetric units. This has been shown to be false. It has been shown that the use of calibration pulses for calibration is both valid and needed to find the "local" cell "constants" under the current conditions. On the other hand it has been shown that the cell's calorimetric characteristics are not really constant, but change appreciably with electrolyte level, cell temperature, and cell current. Fortunately they are constant enough for the cells to be useful. But the concept of fixed heat transfer coefficients, cell heat capacity, and even cell temperature must be modified. They are replaced by the concept of "effective" values because they change somewhat over location and time. Of course this is why more sophisticated (and much more complicated) calorimeters have been designed. But the F/P systems are easily made, and have been used in many-cell sets. Also these days we can use complicated calculations easily and effectively when they are needed. Complicated algorithms, once in place are simple to use over and over. Thus F/P type calorimeters have their place.

We will first show the analysis of some F/P cell systems we have made and used and how we interpret the data quickly and accurately. We will then show our analysis of some experimental data taken by others, viz the New Hydrogen Energy (NHE) Laboratory, Sapporo, Japan where excess energy was looked for.

We wish to thank Dr. Melvin H. Miles, a participant in those experiments for permission to use the data.

Replication Of MHI Transmutation Experiment By D_2 Gas Permeation Through Pd Complex

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Unusual nuclear transmutation reaction was reported by Mitsubishi Heavy Industries (MHI) for the experiment of permeating D_2 gas through Pd complexes which were consisted of a thin Pd layer, alternating CaO and Pd layers and bulk Pd.[1)] When they used samples of Pd complexes with additional Cs on the surface, Pr emerged on the surface while Cs decreased after the Pd complex was subjected to D_2 gas permeation at 343K and 1atm for about one week. The elemental analysis was performed using an X-ray photoelectron spectroscopy (XPS). This phenomenon was reproduced qualitatively by the present replication experiment.

We performed D-permeation experiments three times similarly to the MHI's experiment[1)] and confirmed production of Pr. The surface of the thin Pd layer of Pd complex sample provided by MHI was washed to remove hydrocarbon by electrolysis before depositing Cs. The depositing of Cs atoms was made by applying weak electric field to 1 mM $CsNO_3$ solution. We made D_2 gas permeated through the Pd complexes at 343K and 1atm for about 5 days. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was performed to analyze the existence of the elements (Cs and Pr) and mass distribution. The results showed the existence of Pr. And we also confirmed the existence of Pr by using Neutron Activation Analysis (NAA) at Japan Atomic Energy Research Institute (FNS).

As a result, we confirmed that the nuclear transmutation reaction, from ^{133}Cs to ^{141}Pr, was occurred. This transmutation suggests that mass number and atomic number increase 8 and 4, respectively. It is considered that the model of multi-body resonance fusion of deuterons proposed by A. Takahashi[2)] can explain this mass-8-and-charge-4 increased transmutation, as follows:

(Primary reaction) : $8D \rightarrow {}^{16}O^* \rightarrow {}^{8}Be^* + {}^{8}Be^* + 95.2$ (MeV)

(Secondary reaction) : ${}^{133}Cs + {}^{8}Be$ (47.6 MeV) $\rightarrow {}^{141}Pr^*$ (50.47 MeV)

or ${}^{8}Be^* \rightarrow {}^{4}He + {}^{4}He$

If the phenomena occur following this model, ^4He should also come up. So we are trying to detect ^4He.

1. Y. Iwamura *et al.* : observation of low energy nuclear reactions by D_2 gas permeation through Pd complexes, *Proc. ICCF 9,* May 19-23, 2002, Beijing, China (in press)
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We02

Report on Several On-Going Low Energy Nuclear Reaction Projects at NRL

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The Surface Modification Branch at NRL has pursued low energy nuclear reaction (LENR) research for several years with small amounts of funding from laboratory funds. Our interest is to repeat or clarify experiments already in the literature or those conveyed to us by private communication, rather than to perform new experiments in LENR. Experiments examined are of two classes. The first consists of experiments that entail very low counting rates; specifically a.) duplication and extension of proposed d-d-d fusion by Kasagi et al., and b.) duplication of d-d fusion events recently reported by Keeney-Jones at a fall APS meeting. The second includes the examination of material from an experiment that generated heat. NRL is modifying its unique trace element accelerator mass spectrometry (TEAMS) system to search for isotope shifts in Pd and impurities in the Pd. Progress on these investigations will be reported.

Tu15

Low Energy Nuclear Transmutation in Condensed Matter induced by D_2 Gas Permeation through Pd Complexes: Correlation between Deuterium Flux and Nuclear Products

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Correlation between deuterium flux and Pr is described, which is a transmuted product by low energy nuclear reactions in condensed matter induced D_2 gas permeation through Pd complexes (Pd/CaO/Pd). The Pd complex is composed of Pd and CaO thin film and Pd substrate. It was made by Ar ion beam sputtering method. An addition of Cs on the surface of the thin Pd film was performed by the Cs ion injection or an electrochemical method. The Cs added Pd complex was introduced in the vacuum chamber. The Cs added side of Pd complex was subjected to D_2 gas and the other side was evacuated by the turbo molecular pump. D_2 gas permeated through the Pd complex and an elemental change occurred on the Cs side surface of Pd complex after several days' D_2 gas permeation. The experimental set-ups and the procedures are basically the same in the reference [1] and [2]. However, the following points are improved or changed compared with presentation at ICCF-9.

1) Estimation of deuterium flux through Pd complexes becomes available.
2) Quantitative analysis of Pr becomes possible using ICP-MS (Inductively coupled plasma mass spectrometry).
3) Estimation of cross section for the transmutation of Cs into Pr was performed based on "an ultra-low energy D beam model".
4) Cs ion injection into Pd complexes instead of electrochemical method was performed. Pr was also observed in the case of Cs ion injection method.
5) Depth profile and surface distribution of Cs and Pr was obtained by TOF-SIMS (Time of Flight Secondary Ion Mass Spectrometry).
6) Replications of our D_2 gas permeation experiment have been performed or planning in some universities or institutes. The paper on replication study will be presented at ICCF-10 by Prof. Takahashi's group in Osaka University.

With above improvements, we noticed that quantity of Pr was proportional to deuterium flux through Pd complex. This fact suggests us that D_2 gas permeation through Pd complex could correspond to an ultra-low energy D beam irradiation on the Pd complex.

The authors also noticed that very thin surface region up to 100 angstrom was active transmutation zone by the analysis of depth profile of Pr.

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Mo01

Evidence for Charged Particles Emanating from Deuterided Metal Foils

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Innovative experiments for initiating low-temperature fusion were developed by Particle Physics Research Co., which led to in-depth experiments with highly-sensitive detectors conducted at Brigham Young University beginning early 1997. Partially-deuterided titanium foils (TiD_x) were positioned between two ion-implanted silicon detectors mounted in a vacuum chamber. A dual-coincidence requirement along with a cosmic-ray veto counter reduced background to very low levels so that even low yields from very thin TiD_x foils could be detected. In one series of experiments, we observed charged-particle coincidence rates from two to five times the background rates (from TiH foils) in the energy regions of interest. The statistical significance is approximately seven standard deviations. A striking advance is that the repeatability from these dual-coincidence charged-particle experiments is currently greater than 70%. A second experiment, using a photo-multiplier tube with plastic and glass scintillators and TiD_x foils under non-equilibrium conditions, registered charged-particle emissions at 2,171 ± 93 counts/hr, over 400 times the background. Moreover, these particles were identified as protons having 2.6 MeV after exiting the TiD_x foil. Our experimental results provide strong evidence for nuclear reactions occurring in the deuterided metals and are consistent with proton and triton production from the reaction:

d + d ÷ t (1.01 MeV) + p (3.02 MeV).

Refer to the website www.particlephysicslab.com for more details.

Mo05

Increase Of The Output Of Neutrons In Relation To Background Deuterium Containing Electrolit At Their Electrochemical Decomposition By Superelectrolys

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Superelectrolys - new type of electrochemistry.

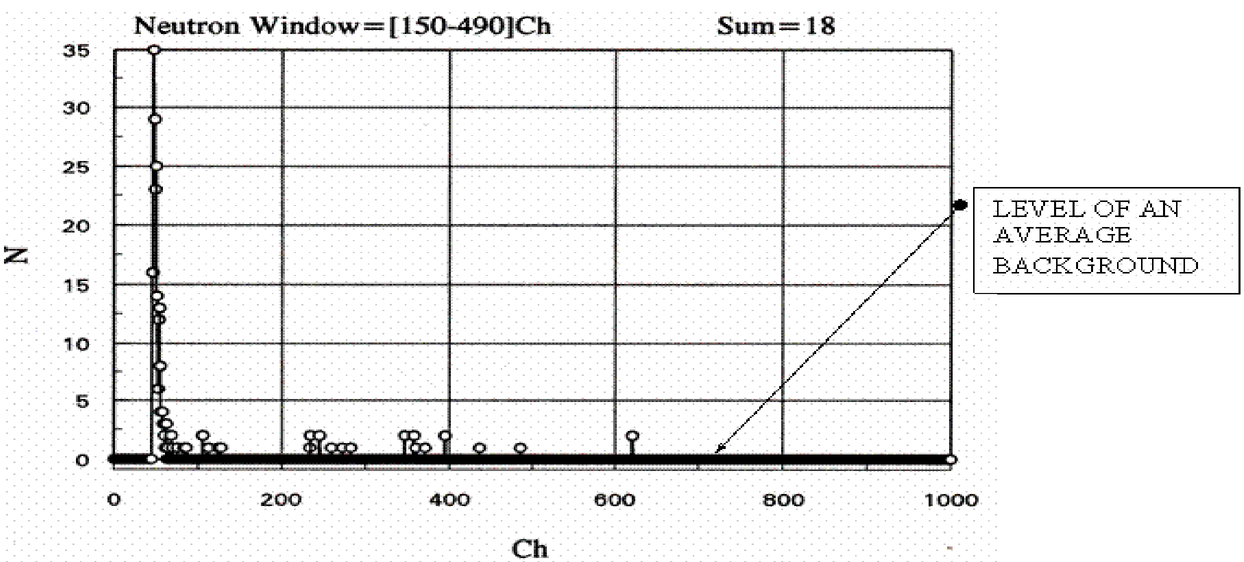
On it electrochemical processes proceed on 10 - 20 orders of size faster, i.e. do not depend both from diffusional kinetic, thus and on thermodynamics. The essence consists that superelectrolys as the method can be realized only due to superpolarization of border an electrode - electrolit(1 - 5 and higher volt). In this created intensity of electric fields in a firm phase reaches sizes, sufficient for issue electrons without electrochemical stages. In size of intensity of fields in a firm phase issue electrons in electrolit with various energy varies, than is reached CF and transformation of chemical elements, i.e. original solid state the accelerator - reactor. For example in deuterium containing electrolit on a basis ^{14}N nuclear reactions it is possible to write down according to dineutron theories

1) $d^{+} + e^{-} \rightarrow ch^{0} + n_{0} \quad + 0.113\ Mev_{n,}$ (ch – dineutron)

2) $^{14}N + ch \rightarrow {}^{15}N + n \quad + 7.714\ Mev_{N\text{-}n,}$

3) $^{1}H + n \rightarrow {}^{2}H + g \quad + 2.224\ Mev_{g}$

The part of the data on registration of neutrons with use of a method superelectrolys on an example of a monocrystal of cubic sodium - tungstic bronze $Na_{0.9}WO_3$ is shown below.



Experiment CFL29

Th29

Experimental Research into Characteristics of X-ray Emission from Solid-state Cathode Medium of High-current Glow Discharge

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X-ray emission with intensity up to 100 R/s was registered when researching a possible mechanism of initiating nuclear transmutation reactions in the solid-state cathode medium of high-current glow discharge. The experiments were carried out on the high-current glow discharge device [1] 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.

X-ray emission registration was carried out using thermo-luminescent detectors (TLD) based on Al_2O_3 crystal, camera-obscura (objective diameter is 0.3mm) with fixing the X-ray emission onto the X-ray film and nuclear emulsion, as well as with the use of scintillating detectors provided with photo- multipliers for registering time response characteristics. All the detectors were covered with a protective screen made of Be having the thickness of 15µm.

The X-ray emission energy was estimated using both TLD and scintillating detectors with the multipliers covered with Be foil having various thickness (15µm, 30µm, 60µm, 105µm, 165µm, 225µm and 300µm). The data on the thickness of half x-ray absorption for Be was used as well [2].

The average energy of the X-ray emission (TLD results) was equal to1.0 - 1.3keV. The estimations of the maximal energy gave the values from 1.5keV for Al and up to 1.8 keV for Ta.

The images obtained using the camera-obscura showed that the central cathode part had the largest luminosity.

Two emission modes were revealed under the experiments:

1 - Diffusion X-rays was 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 in the distance of 100 mm from the cathode was equal to 5 - 10 µm, angular divergence was up to 10^{-4}. The x-ray laser beams were absorbed when passing through the multilayer metal screens, but they had an anomalous high penetrative quality in the continuous metal media. The X-ray intensity in the mode of diffusion bursts changed in dependence on the distance under the 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 obtained results were the direct experimental evidence of existing the excited metastable energy levels with the energy of 1.2-2.5keV in the solid of the cathode sample. Hypothetically, the mechanism of forming the metastable energy levels with the energy of 1.2-2.5keV 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.

$$D^{+*} + Pd \rightarrow Pd^{*} + D^{+}$$

Then the energy redistribution to the higher levels took place like the mechanism of "P. Hagelstein phonon laser". Hypothetically, the inverse medium population with the energy of 1-5KeV 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 $\tau = 3 \cdot 10^{-13} - 3 \cdot 10^{-14}$ sec, the separate beam power must be $10^7 - 10^8$ W.

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Experimental Research into Secondary Penetrating Radiation when Interacting X-ray Beams of Solid Laser with Various Materials Targets

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The penetrating radiation was registered outside the walls of the discharge chamber under the experiments with a high-current glow discharge before [1]. The experiments showed that it was a secondary radiation arising when interacting primary X-ray beams from the solid-state cathode medium with the material of the chamber walls as well as with the construction elements. The created 100% reproducible technology of generating X-ray laser beams allowed to carry out the research into the characteristics of the secondary radiation.

The experiments were carried out on the high-current glow discharge device [] using H2, D2 , 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 with the pulse duration of the discharge current of t = 0.3 - 1.0 ms and the period of T = 1.0 - 100 ms was used. The targets in the form of the shields made a foil of various materials (Al, Ti, Ni, Nb, Zr, Mo, Pd, Yb, Ta, W, Pb) with thickness of 10 -30 μm or 1 - 3 mm were arranged at the distance of 200 mm from the cathode. The scintillating detector provided with photo-multipliers was use for registering the secondary radiation. Under the experiments the registration of temporal radiation spectra was carried out during the period between trailing and leading edges of the discharge current (discharge current free).

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 turning off.
The secondary X-rays of two types was observed.
1-The emission with a continuos temporal spectrum in the form of separate bursts with intensity up to 10^6 photon a burst. This emission began in o.5 - 1.0 ms after the discharge current turning off.
2-The emission with a discrete temporal spectrum and emission rate up to 10^9 photon a burst. The bursts distribution of this emission with time was defined by the target material.

The third kind of penetrating radiation was observed also. This emission was registered immediately by photo-multipliers placed behind of a target with thickness of 10 -30 μm without a scintillator.

The obtained experimental results show that in a solid the creation optically active medium with long-lived metastable levels with 1 -5 keV energy and higher is possible.

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Production of Excess Heat Power and Impurity Elements with Changed Natural Ratio of Isotopes at Forming Exited Long-lived Atomic Levels with the Energy more than 1 keV in the Solid Cathode Medium of High-current Glow Discharge

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The results of the experiments with a high-current glow discharge are given. The device consisted of a water-cooled vacuum chamber, cathode and anode assemblies, and it was a complete flow calorimeter. The precision system of measuring input power of an electric discharge and heat output power was used. The discharge was carried out in H_2, D_2, Ar, Xe, Kr at pressure up to 10Torr,current up to 500mA and discharge voltage of 500-2500V. The cathode samples made of Sc, Ti, Ni, Nb, Zn, Pd, Ta, W were used.

The excess heat power up to 10 –15W and efficiency up to 150 % was 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 deuterated Pd cathode samples in Xe, Kr discharges. At the same time the excess heat power was not observed for pure Pd cathode samples in Xe, Kr discharges.

The production of the impurity nuclides with the efficiency up to 10^{13} atoms/sec was registered. The main impurity nuclides (with the content more than 1%) were ^{7}Li, ^{13}C, ^{15}N, ^{20}Ne, ^{29}Si, ^{44}Ca, ^{48}Ca, ^{56}Fe, ^{57}Fe, ^{59}Co, ^{64}Zn, ^{66}Zn, ^{75}As, ^{107}Ag, ^{109}Ag, ^{110}Cg, ^{111}Cg, ^{112}Cg, ^{114}Cg, ^{115}In. Changing the natural ratio of the isotopes by some tens of times was registered for some impurity elements (Ca, Ti, Fe, Ni, Ge and others). In this case some basic (with large % content in nature) isotopes of the elements impurities were observed to be absent. The following isotopes ^{58}Ni, ^{70}Ge, ^{73}Ge, ^{74}Ge, ^{113}Cd, ^{116}Cd were registered being absent completely.

Emission of 3MeV protons and 14MeV α-particles with the intensity up to 10-15 s^{-1} was registered using CR-39 plastic track detectors (up to 250 tracks /cm^2 of the detector area were registered).

The soft X-ray radiation from the solid-state cathode medium with the intensity up to100 R/s was registered under the experiments with the discharge in H_2, D_2, Ar, Xe, Kr. The X-ray radiation was observed as bursts (up to 10^6 photons in a burst and up to 10^5 bursts a second) during discharge burning and within 100 msec after the discharge current turning off. X-ray energy considerably exceeded possible ion energy (discharge voltage). All the experimental results were of 100 % reproducibility.

The results of the X-ray radiation registration showed that the exited energy levels having the lifetime up to 100 msec and more and the energy of 1.0 - 3.0keV existed in the solid medium. Hypothetically, under these conditions it was possible to carry out the nuclear transmutation reactions in the solid medium with producing the excess heat power and the nuclear reactions products. The probability of such reactions proceeding is defined by the characteristic temperature, excited energy levels density and life time of excited levels. These nuclear reactions can be called non-equilibrium nuclear reactions.

The obtained results allowed creating a demonstration source of heat power. The technology of multi-element cathode fuel elements with plasma anodes was developed. The demonstration reactor with input electrical power of 10 kW and output heat power of 15 kW will have the dimensions of 20×20×20 cm^3.

New nuclear power plants can be designed on the base of non-equilibrium nuclear transmutation reactions in the solid medium. It is "Third way" of the advanced nuclear power devices in comparison with the plants on the base of uranium fission and thermonuclear fusion.

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Low-Energy Nuclear Fusion Reactions In Metals

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In order to clarify the mechanism of cold fusion, it is very important to investigate the interplay between nuclei and their metal surroundings. Using deuteron beams with energies lower than 80 keV, we have studied deuteron induced fusion reactions in metals systematically. So far, the following measurements have been carried out: (1) Reaction rates of the D(d,p)T reactions as a function of the deuteron energy in various metals. Up to the present, metals examined as hosts for the DD reaction with bombarding energies below 11 keV are Be, Ti, Fe, Ni, Cu, Pd, PdO, Sm, Pt and Au. (2) Reaction rates of the $^{6,7}Li(d,\alpha)^{4,5}He$ reactions as a function of the deuteron energy in Pd and Au for bombarding energies between 30 and 75 keV. (3) Branching ratios
$R = Y(DD \rightarrow n+{}^3He)/Y(DD \rightarrow p+T)$ of DD fusions in metals at bombarding energies below 12 keV.

The results of these measurements clearly showed that both the D+D and Li+D reactions are strongly affected by the environments surrounding the nuclei.

As already reported, reaction rates depend on the metal host very strongly. The enhancement can be parameterized by introducing the screening energy. For the DD reaction, the most enhanced reaction so far observed is in PdO; the screening energy of about 600 eV. In Pd and Fe, the DD reaction is enhanced but not so large as in PdO; the screening energy of 200〜300 eV. In other metals the DD reaction is not enhanced or slightly enhanced; the screening energy of about 100 eV or less.

For the LiD fusion reaction, the Pd metal also provides strong enhancement on the reaction rate and the screening energy is about 1600 eV. On the other hand, it is not enhanced in Au at all; the screening energy of about 60 eV.

The large values of the screening energy for the DD and LiD fusion reactions cannot be explained by the screening due to the conduction electrons in metal, and, thus, strongly suggest the existence of another important mechanism to enhance the fusion reactions in metal. We suggest the possibility of a dynamic screening mechanism during the deuteron bombardment and penetration into the host wherein the fluidity of deuterons must play a decisive role.

The branching ratio of the DD reaction was deduced in various hosts, ant it turned out that the ratio also depends on the kind of host metals, although the amount of the change is very small. A possible origin of the dependence will be discussed.

Tu124

Experimental Test of Bose-Einstein Condensation Mechanism for Low Energy Nuclear Reaction in Nanoscale Atomic Clusters

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Bose-Einstein condensation of Bose Nuclei was suggested as a possible mechanism for ultra low-energy nuclear reaction in 1998 [1]. Recently, theoretical studies of the Bose-Einstein condensation mechanism have been carried out by solving approximately many-body Schroedinger equation for a system of *N* identical charged integer-spin nuclei ("Bose" nuclei) confined in ion traps [2-4]. The 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.

These theoretical formulae yield two main predictions. The first prediction is that the Coulomb interaction between two charged bosons is suppressed for the large *N* case and hence the conventional Gamow factor is absent. This is consistent with the conjecture made by Dirac [5] that each interacting neutral boson behaves as an independent particle in a common average background for the large *N* case. The second prediction is that the fusion rate depends on the probability of the Bose-Einstein condensate (BEC) ground state instead of the conventional Gamow factor. This implies that the fusion rate will increase as the temperature of the system is lowered since the probability of the BEC state is larger at lower temperatures.

With these theoretical considerations in mind, a series of experiments have been devised and performed with the intention of detecting low energy nuclear reactions at both room temperature and liquid nitrogen temperature under similar conditions used by Arata and Zhang [6] and others [7]. Stainless steel cells were loaded with palladium nanoparticles in the range of 80 – 180 nanometers in diameter. Deuterium gas was loaded into the cells at pressures ranging between 1,000 – 20,000 p.s.i. The heat of deuterium absorption into the nanoparticles was observed. The pressurized cell was then thermally isolated in a calorimeter along with an identical control cell lacking both deuterium and palladium. Fusion reactions occurring within the cell can be measured by a relative temperature difference detected by a Lakeshore silicon diode with sensitivity of 0.03 °C on the outer surface of the cell. A heater was placed inside the control cell to calibrate the system.

Two experiments have been completed at room temperature. In both of these, the active cell and control cell were both encased in insulating foam to offer thermal isolation. The first was conducted with 2.59 grams of palladium at a deuterium pressure of 1600 p.s.i. and yielded a limit of 11 ± 220 μW/gram of palladium of heat production. The second was conducted with 3.18 grams of palladium at a deuterium pressure of 17,000 p.s.i. and yielded a limit of 176 ± 186 μW/gram. An additional low temperature experiment was performed, in which the pressurized cell and control cell were placed in a sealed vacuum chamber held at liquid nitrogen temperature. This experiment used 2.51 grams of palladium at a deuterium pressure of 19,250 p.s.i. and yielded an upper fusion limit of 79.68 μW/gram. Further improvements have been made to the experimental setup of the low temperature calorimeter, and recent measurements with a control cell using an artificial heater have indicated that the detection sensitivity for further experiments will now be below 8.0 μW.

Plans of future experiments will be presented as well as their theoretical implications.

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Tu124

Quantum Many-Body Theory of Low Energy Nuclear Reaction Induced by Acoustic Cavitation in Deuterated Liquid

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Recently, a theoretical model of low-energy nuclear reaction in a quantum many-body system was developed to describe the anomalous ultra low energy nuclear reaction [1-3]. Approximate ground-state solutions of many-body Schroedinger equation for a system of *N* identical charged integer-spin nuclei ("Bose" nuclei) in a harmonic trap were obtained by the recently developed equivalent linear two-body (ELTB) method [4,5]. The ELTB method [5] is based on an approximate reduction of the many-body Schroedinger equation by the use of a variational method. The solution is expected to be accurate for the large *N* system. The solution is used to derive theoretical formulae for estimating the probability and rate of nuclear fusion for *N* identical Bose nuclei confined in a trap.

These theoretical formulae yield two main predictions. The first prediction is that the Coulomb interaction between two charged bosons is suppressed for the large *N* case and hence the conventional Gamow factor is absent. This is consistent with the conjecture made by Dirac [6] that each interacting neutral boson behaves as an independent particle in a common average background for the large *N* case. The second prediction is that the fusion rate depends on the probability of the Bose-Einstein condensate (BEC) ground state instead of the conventional Gamow factor. This implies that the fusion rate will increase as the temperature of the system is lowered since the probability of the BEC state is larger at lower temperatures.

With these considerations in mind, we propose a number of key improvement to acoustic cavitation experiments to check these predictions as well as the results of other experiments [7,8]. One of the major criticisms of these experiments has been the use of a pulsed neutron generator to induce the production of large radius cavitation bubbles. Because the fusion signal is also based on the observation of neutrons, questions have been raised about the die away time of the generator neutrons within the experimental area due to neutron reflections off materials within the room. Typical die away times range between 100 and 200 microseconds. We propose to replace the pulsed neutron generator system with an associated particle neutron generator to induce the cavitation bubbles. This type of generator has the advantage that the time of production and the neutron flight direction are known. We propose to conduct the experiment in a low mass environment in a large experimental area with modeled and measured neutron die away time of 50 microseconds or less. By running the generator at a neutron production rate of approximated 1 neutron per die away time, criticisms of generator neutron over lap with possible fusion neutron observation will be eliminated. Because the associated particle neutron generator produces neutron uniformly and not pulsed, the associated backgrounds are reduced by the ratio of the pulsed time to total cycle time. Another advantage is that the neutrons are produced uniformly over the entire acoustic cycle with a precisely known phase within the acoustic cycle. In this way, out of phase neutrons serve as a control sample to establish and understand background issues in the experiment during the data collection process. If fusion neutrons are produced during the cavitation collapse then they will show up only for these neutrons induced events with the correct phase and have generator neutrons pointing at the cavitation bubble. Cosmic ray induced events are eliminated because they will not have a generator neutron associated with them. This technique is especially well suited for high pressure deuterated liquid phase experiments.

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Calculations Of Nuclear Reactions Probability In A Crystal Lattice Of Titanium Deuteride

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For calculations of probability of nuclear reactions of hydrogen isotopes in the crystal lattice of titanium deuteride the model offered earlier for palladium deuteride was used [1-2]. The hydrogen isotopes predominantly occupy tetrahedral sites in the face-centered cubic lattice of titanium hydride. A symmetrical position of deuterium atoms concerning the edge connecting two adjacent tetrahedral sites in titanium was selected as initial conditions for a series of experiments. In a series of experiments the probability of D-D approach for random initial conditions was calculated, when initial energies of approaching deuterons were set in the range of energies 0.01-0.51 eV (the potential barrier for diffusion of deuterium atoms in titanium is 0.51 eV). For each experimental value of D-D approach the reaction rate was calculated on the shifted Coulomb potential with the shift energy, which equals to the energy of screening [1-2].

The series consists of 34660 experimental values. The mean distance of D-D approach on all series equals 0.97 angstroms, that exceeds the mean distance in a molecule D-D. However, more than 14% of all experimental values show an approach of deuterons for a distance less than 0.1 angstroms. If one considers the reaction rate at each case of approach, and then averages as a whole on the entire sample, the general reaction rate for the given set of the initial conditions will make $10^{1.91}$ DD^{-1} s^{-1}. It is 4 orders of magnitude less, than the analogous rate calculated earlier for palladium deuteride [2]. For optimization of calculations the most favorable initial conditions were selected. As a result the rate of the reaction calculated according to the above model should be additionally multiplied by a correction factor, which allows for the probability of the occurrence of these favourable conditions. In our case it equals 10^{-16} - 10^{-18}. Thus, the rate of the nuclear fusion reaction of deuterons in titanium deuteride should be 3-4 orders lower, than the earlier calculated rate for palladium deuteride [2] and equals 10^{-14} - 10^{-16} DD^{-1} s^{-1}.

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Mo07

D(d,p)t Reaction Rate Enhancement in a Mixed Layer of Au and Pd

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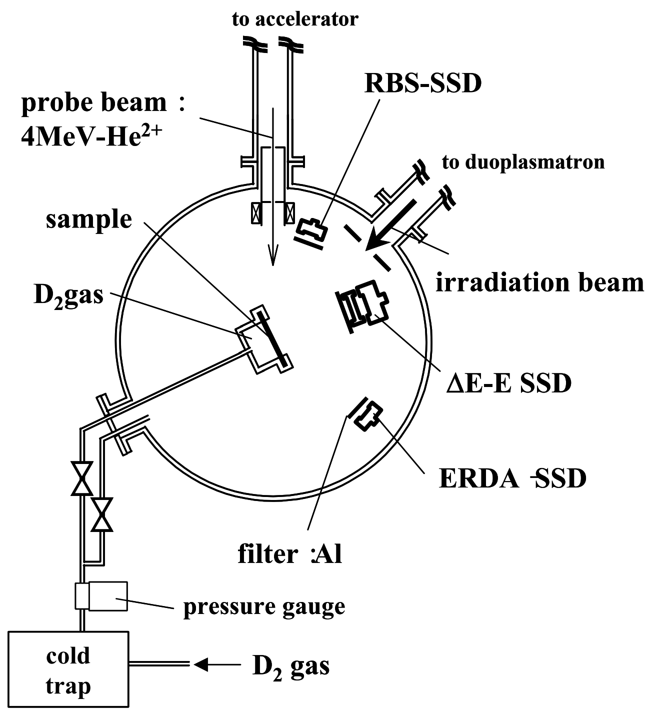
A variety of deuterium-induced reaction in metal deuterides with some yield anomaly has been reported in recent years. Three-body reactions, *i.e.*, DD(d,^{4}He)pn, DD(d,^{4}He)d and DD(d,^{3}He)t, have been claimed to take place with great enhancements of the reaction rate in TiD_x [1-3]. Nuclear transmutations in a variety of samples have also been reported by many authors, which includes experiments on forced permeation of D through a multi-layered film of Pd and Cs [4].

To investigate possible anomaly in nuclear reactions in solids, deuterium ion irradiation of deuterated Au/Pd samples has been performed with extensive measurements of reaction products and simultaneous characterization of the samples including ERDA and RBS.

The deuterium density in the sample with a modified composition under 15 - 25 keV D_2^+ irradiation has been found to reach the maximum value, sometimes greater than that in $PdD_{0.86}$, around the mixed layer of Au and Pd. Moreover, the D(d,p)t reaction rates have been found to become two orders of magnitude greater than the calculated ones. We speculate that the formation of the Au/Pd-mixed layer retaining the high deuterium density induces the enhancement of the reaction rate.



Experimental system

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Th41

Experimental Observation Of Fusion Of Precious Metals In Growing Microbiological Associations

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The problem of synthesis of heavy precious metals in growing microbiological cultures was investigated. We have studied the reaction $W^{186} + Be^{9} = Pt^{195}$ of nuclear transmutation in pure water containing salts of W and Be and special microbiological associations. The result of expected reaction is the formation of Pt^{195} isotope of precious metal platinum.

This reaction is energy favourable ($\Delta E > 0$, $\Delta E = 1.65$ MeV). The Pt^{2+} and Fe^{2+} iones are chemically alike and have the same ionic radiuses of divalent state ($R_{Pt} = 0.8\text{-}0.83$ A, $R_{Fe} = 075\text{-}0.83$ A). Substituted element Fe is among several vitally necessary elements. Ions of created Pt^{2+} can substitute ions Fe^{2+} while microbiological cultures are growing. Expected Pt^{2+} can be formed in a volume of growing culture by nuclear transmutation at the presence of the active forms of W and Be.

In the experiments with the use of pure microbiological cultures (for example, culture ***Saccharomyces cerevisiae)*** carried out beforehand it was shown, that the efficiency of such response is very small and couldn't be observed by a mass-spectrometer. Low effectiveness of the reaction is the result of strong negative influence of salts W and Be on a process of growth of microbiologycal culture.

Nuclear transmutation of biology unfavorable elements W and Be by the special "microbial catalyst-transmutator" has been studied. The "microbial catalyst-transmutator" is represented by special granules that include: concentrated biomass of metabolically active microorganisms, sources of necessary nutrient elements, gluing substances which keep all components stable in the form of granules in water solutions for a long period of time [1,2]. In "microbial catalyst-transmutator" adjustable (directed) microbial metabolism and microbial of communities (associations) adapted to a wide spectrum xenobiotics (aggressive environments, heavy metals and radionuclides) are used. This "microbial catalyst-transmutator" is able to grow, for example, in water with pH =2, while ordinary "clean" cultures die in such environment very rapidly.

In our experiments we have observed the process of transmutation of W^{186} and Be^{9} to Pt^{195} during 15 days of growing and development of microbiological associations in pure distillated water with salt of W and Be at $T=25^{0}C$. Coefficient of transmutation equals $\lambda \approx 10^{-9}$ (synthesized Pt^{195} nuclei per s and per pair of W^{186} and Be^{9} nuclei).

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Th42

Cold Fusion Messages from Teachers

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A selection of Internet messages about LENR-CANR phenomena from physics teachers. The sampled messages were originally posted on the discussion list, Phys-L, which has about 650 subscribers, or emailed to me in private. They illustrate a wide range of opinion. Phys-L messages can be fetched from the searchable list archive at http://lists.nau.edu/archives/phys-l.html.

Fr06

CF-Matter and the Cold Fusion Phenomenon

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The working concept "the cf-matter" is defined as "neutron drops in a thin neutron liquid." This is used to explain complex events in the CFP. It became clear through a semi-quantitative investigation [1,2] that the cf-matter is spread over CF materials in general. At boundary and surface regions of samples used in CF experiments, the cf-matter contains high-density neutron drops in surface/boundary regions while in the volume it contains only a few of them, in accordance with experimental data.

Even if the excited neutron states in lattice nuclei are unstable, neutrons that entered into the neutron band instantaneously form the cf-matter, including neutron drops in the boundary/surface regions and become stable and accumulate there. These neutron drops in a thin neutron gas may interact with extraneous nuclides there to induce new types of nuclear reactions in the boundary region that may be observed in phenomena such as the cold fusion phenomenon, i.e. nuclear reactions and accompanying events occurring in solids with high densities of hydrogen isotopes in ambient radiation, in fcc and hcp transition-metal hydrides and deuterides and in proton conductors.

The neutron drop ${}^{A}_{Z}\triangle$ interacts with a nucleus ${}^{A'}_{Z'}X$ to accelerate the decay process of ${}^{A'}_{Z'}X$ if it is unstable, or to give ν neutrons and ν' protons to ${}^{A'}_{Z'}X$ (ν, ν' = 0, 1, 2, ---) thus inducing nuclear transmutations (NT). Especially, an explanation of mass spectra of nuclear products in the nuclear transmutation by fission, NT_F, observed in CFP (e.g. Bockris 1995, Mizuno 1995, Miley 1996) can be explained as fission products of unstable nuclides ${}^{A'+\nu+\nu'}_{Z'+\nu'}X'$ formed by the above process as done by Fisher using hypothetical polyneutrons.[3]

Several examples of experimental results show nuclear transmutation by absorption, NT_A; production of Cr in a Ti/D/S system (Kopecek 1996), production of Pb in Pd/Li/D system (Mizuno 1996), production of Pr and Mo in a Pd/D_2 system with Cs and Sr on the surface of Pd (Iwamura 2002), production of Ba and Pb in a Pd/D/Na/Pt system (Arapi 2002, Yamada 2002).

The production of Fe is often observed in electrolytic experiments (Bockris 1995, Miley 1996, Ohmori 1997, Hanawa 2000, etc.), in arcing between carbon rods (Sundaresan 1994), and others might be explained by transmutation of a neutron drop ${}^{A}_{Z}\triangle$ into a stable nucleus ${}^{A}_{Z}Fe$ and others. In this case, we can expect the abundance of the generated isotopes to be similar to the natural one of the element.

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Tu01

Laser Stimulation of Deuterated Palladium: Past and Present

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A brief history of the discovery and early results of the laser stimulation effect is given; cathode fabrication methods are discussed and results from three independent calorimetry methods are presented. The calorimetry methods discussed are: isoperabolic on a benchtop, isoperabolic in a temperature-regulated enclosure and flow calorimetry.

The apparent importance of laser wavelength and beam polarization are also discussed; a crude physical model used to compute resonant laser wavelengths is presented.

Characteristics and Effects of Ball Lightning

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Ball lightning is the name of a natural phenomenon that sometimes exhibits much power and strange characteristics, as when they blow up or bore holes through solid walls and windows. The connection between cold fusion and transmutation at low energies and ball lightning is that there is a state of existence of material and energy that is like that of natural ball lightning and cold fusion processes happen when substances are in this state. In particular, materials and liquids may enter a BL-like state during stresses such as electrolysis and sound induced cavitation, and the atoms in this state behave like BL – that is they may explode, form microscopic BL, emit particles or transmute to other elements(1).

Atoms in this state have the characteristics of unusual fluidity and the propensity to form bigger clumps such as larger atoms and microscopic BL. B. Franklin described the apparent heatless melting of metal objects struck by lightning, and more recently Ken Shoulders(2) has described his research of micrometer-sized EVs which are microscopic ball lightning causing metals around them to flow without any noticeable heat effects. Atoms in this state also are more prone to forming larger clumps and to transmute. And BL causes atoms to undergo atomic reactions as described by G. Dijkhuis(3), and by reports of radioactive deposits left by natural BL, and by the research of Matsumoto and Shoulders.

I would like to suggest an arena of research for cold fusion and transmutation researchers. Search your apparatus for signs of this unusual atomic behavior and microscopic BL. In my microscopic investigation of electrolysis cells that were used in G. Miley's laboratory at the U. of Illinois in the mid 1990s, I found visual evidence of the effects of microscopic ball lightning in the ring patterns, the microscopic groves and the pits in the electrodes and plastic casings(4,5). Ken Shoulders has examined some of these cells and electrolysis cells from other research groups and after further study with his own equipment also believes that there is significant evidence of the role of these objects which he calls EVs in the transmutation process. I've seen evidence of both the fluid-like atomic flow and the boring and grooving of electrodes in published photographs of electrodes, and both Matsumoto and K. Shoulders furnished further evidence by correlating the location of the BL markings and the transmuted atoms using chemical analysis equipment. As Matsumoto did, try to set up targets such as plastic sheets in and around your apparatus. BL can travel through glass and plastic. I believe that when researchers understand the characteristics and effects of the microscopic ball lightning phenomenon they will be better able to understand the role of BL in this process.

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Cold Fusion May be Part of a Scientific Revolution

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Every 80 years or so(1), there have been scientific revolutions in the field of physics of the kind described by Thomas Kuhn in his book, *The Structure of Scientific Revolutions*(2). In my opinion, the various kinds of experimental phenomena called "cold fusion" are a part of a crisis period(2) in physics. The phenomena of cold fusion, together with anomalies of ball lightning, superconductivity, sonoluminescence and cavitation are a part of a basis for a revolution in physics theory, and the revolution is following the 80 year pattern of the past.

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. There have been five successive paradigm shifts in physics:

the Galilean, about 1593;
the Newtonian, 1664;
the Fluid paradigm originally formulated by Franklin, about 1745;
the Classical Field theory paradigm, rudimentarily formulated by Faraday in 1820 and developed by Maxwell;
and the Quantum Mechanics and Relativity theory paradigm formulated by Einstein about 1905.

Just before such a revolution in physics, there is a 10 or 20 year period of crisis in physics, as Kuhn described in his book. He called these periods, "crisis periods." It seems to me that there was a crisis period in physics starting in the middle of the 1970s, and that the confusion and disagreement both in this field and in the field of physics as a whole is simply evidence of the basic contradiction of basic Q.M. and Relativity theory ideas. What is needed is a new general theory that will resolve the anomalies in a simple theory with a few simple basic assumptions.

What determines the timing in the development of physics paradigms? Two limiting factors are involved; they concern the ability of people to learn physics- or technology-related ideas:

(1) Older, more experienced people learn new ideas slowly or not at all, especially when the ideas are very different from their own. I call this constraint the *inhibition of apprehension*.
(2) Theoreticians are not usually the best experimenters or technicians, and vice versa. I call this constraint *the difference between theoreticians and technicians.*

Both of these ideas have been observed for centuries. Kuhn discussed them in his books(2,3).

We can expect therefore, if physics continues to develop as it has in the past, if it is God's will, that a general theory will emerge that is accepted by young people, who will develop the paradigm and thus enable the development of lots of new technology within a few decades. One can expect that the theory will not be accepted by the older, established physicists who already believe Q.M. The theory itself will start out as rudimentary hypotheses, and then be embellished and developed over time.

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Progress in Gas-Loading D/Pd System, —The feasibility of a self-sustaining heat generator—

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A great progress in experiment has been made after 14 year pursuing in the gas-loading D/Pd system. 6 watts of "excess heat" was generated in a gas-loading D/Pd system for 9 hours continuously. This experiment has been repeated 6 times already in various configurations. The "excess power" density in the Pd film is more than 100 W per cubic centimeter, which is about the power density in a fuel rod of a thermal neutron fission reactor.

In ICCF-9, the correlation between deuterium flux and heat flow was first reported [1] after 16 repetitions in a high precision Calvet calorimeter (C-80D). A new gas-loading D/Pd system was built to make use of this correlation in order to build a self-sustaining heat generator. Two improvements were made in order to keep the excess heat continuously.

(1) A constant deuterium gas supply to keep the pressure difference across the Pd thin film.
(2) An electrical heater is use to heat the Pd film, and for the calorimetric calibration.

The key issue is the anomalous behavior of the deuterium flux. Usually, the deuterium flux permeating the Pd film is considered as a monotonic function of the temperature (T_{Pd}). The deuterium flux is supposed to increase dramatically with the temperature. However, it was discovered that at certain temperature, T_r, the deuterium flux showed a peak behavior. In other word, the deuterium flux drops in an anomalous way when temperature is just higher than T_r. This drop in deuterium flux is accompanied by a drop in heat flow according to the correlation between heat flow and the deuterium flux [1]. Consequently, a negative feed-back mechanism is established in Pd film when the temperature reaches the higher temperature side of the flux peak at T_r, i.e. when $T_{Pd} > T_r$, the heat flow drops; hence, the T_{Pd} drops back until T_{Pd} reaches a steady state.

When we heat the circumference of a round Pd film only, the temperature gradient points to the direction of the radius; i.e. the temperature at edge is higher than that in the center of the Pd film. Once the temperature approaches T_r, a heat source appears first at the edge of the palladium film which "ignites" the Pd film from the edge to the center. As a result, the temperature gradient reverses its direction suddenly; i.e. the temperature at center is higher than that at edge. Due to the negative feed-back mechanism, this new distribution of the temperature is quite stubborn. Even if the heating power is reduced to lower the temperature at edge of Pd film, the temperature at center keeps higher than T_r .

This behavior implies a possibility of having a self-sustaining heat generator, if we might generate enough "excess power" in the Pd film, and if we are able to have a good insulation to keep this temperature distribution at zero heating power. We shall report the updated result along this direction.

Right now we have obtained that the amount of energy released from each deuterium atom is in the order of 4 keV, which can not be explained in terms of any existing chemical reactions.

This similar phenomenon has been observed in a long thin Pd wire (250 cm × ϕ0.034 cm) as a "pumping effect"[2], a thin wall Pd tube (2.5 cm× ϕ0.4 cm × 0.01 cm) as a correlation between heat flow and the deuterium flux[1], and now in a thin Pd film (ϕ2 cm × 0.01cm) as a continuous heat source.

This phenomenon is discovered in a gas-loading system, because the T_r is greater than the boiling point of the heavy water.

This anomalous deuterium flux revealed that the deuteron inside the palladium might be describe by a single wave function as suggested by Martin Fleischmann[3], and Del Giudice[4]. The related theoretical and experimental work will be presented in other 4 papers in ICCF-10.

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Neutron Yield on the Electric Breakdown of Cavitation Bubbles in Deuterium-Containing Matter

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Recently, R Taleyarkhan et al [1] reported nuclear emissions (neutrons and tritium) during acoustic cavitation in dielectric deuterated liquid (D-acetone). Although this work appears to be controversial in terms of the detailed neutron [2] and tritium detection, it claims the first observation of nuclear effects in cavitation experiment with a deuterated liquid. However, in 1990 researchers of Institute of Physical Chemistry The Russian Academy of Sciences (including myself) published an article titled "Observation of neutrons under cavitation effect on deuterium containing media" in Russian Technical Physics Letters [3]. In this paper acoustic multi-bubble cavitation was created by a titanium vibrator, operating with frequency 20 kHz in a glass vessel containing D_2O, we reported a weak, but statistically significant fast neutron emission (0.5-1.0 n/s).

In contrast to [1] to explain this observation we did not assume super-high temperature (10^7 K) for the bubble implosion, but proposed an accelerating mechanism, when deuterons accelerated by an electric field generated during the bubble's breakdown bombarded the surface of the deuterated Ti-vibrator and/or surrounding heavy water. Taking into account that measured temperature of single-bubble implosions in the Sonoluminescence (SL) never exceeds 10^5 K and the fact that in [1] there was no direct time correlation measurement of the individual SL burst (duration ~ 10^{-10} s) with neutron pulses, a similar accelerating mechanism could also be applied to their study.

Here we showed that neutron emission detected in cavitation bubbles seeded by 14-MeV neutron pulse generator in deuterated acetone [1,2] as well as our previous results [3] can be quantitatively explained in terms of accelerating model suggesting electric breakdown of deuterium in caviation bubbles. The calculated neutron yield for C_3D_6O experiments is strongly depends on bubbles radius and found to be in the range of 10^2-10^6 n/s in 4 π ster. for the large bubble radii varied within 0.3-0.7 mm [1]. During cavitation with Ti-vibrator in D_2O [3], the bubble radius is much smaller (0.05-0.01 mm). In this case the detected neutron yield (≤ 1.0 n/s) totally determined by a large enhancement of DD-reaction (about 5 orders of magnitude at E_d =1.3 keV), corresponding to deuteron screening potential U_e ~ 600 eV that was deduced from the enhancement data obtained from high current low energy deuteron bombardment of Ti target in glow discharge [4].

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Th26

Strong Enhancement of DD-reaction Accompanied by X-ray Generation in a Pulsed Low Voltage High-Current Deuterium Glow Discharge with a Ti-Cathode

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We have performed a systematic study of DD-reactions and X-ray emission yields during a very low energy deuteron loading (the energy range of $0.8 < E_d < 2.45$ keV) into Ti and Pd cathodes using a pulsed high-current glow discharge (GD). The yields of 3.0 MeV protons (from DD-reactions) and soft X-ray photons emitted in this GD were measured using electronic noiseless solid state track (CR-39) and Al_2O_3:C thermo-luminescent (TLD) detectors. The GD operates at low discharge voltages (ranging of 0.8-2.5 kV) and high current density (300 – 600 mA/cm^2), with short pulse duration ($\Delta\tau \sim$ 200-400 μs). Ti or Pd cathodes were used with D2 or H2 pressure in the range of 2.0-10 mm Hg. The thick target yield for 3.0 MeV protons with the Ti-cathode demonstrates an unusually high DD-reaction enhancement (about 9 orders of magnitude larger at $E_d = 1.0$ keV) compared to extrapolation of the standard Bosch & Halle approximation of the DD-reaction cross-section to lower energies. The screening potential value deduced from the experimental enhancement is found to be a $U_S = 610 \pm 140$ eV. This value is much larger that that extrapolated from accelerator data at higher deuteron energies ($E_{lab} \geq 2.5$ keV) and much lower beam current (50- 400 μA) [1,2]. Data from Pd cathode is still under analysis.

X-ray measurements performed with a moving anode geometry showed that emission from the cathode surface gives a main contribution in the soft X-ray flux. The quantum yield of X-ray emission with a mean energy of quantum about 1.3 – 1.5 keV for the Ti and Pd cathodes was found to be as large as $I_x = 10^{12}$-10^{14} s^{-1}-cm^{-2} of cathode. Measurement were made of the X-ray dose absorbed in a TLD for different discharge currents varying from 100 – 270 mA corresponding to voltages from 1.0-1.8 kV at constant D_2 pressures p=6.0 and 4.2 mm Hg. Results show an exponential increase of yield I_x with an increase in effective discharge electric power P*=UJQ (where Q = 0.15 is the constant pulse on-to-off time ratio). Since the temperature over the subsurface layer of the Ti-cathode is proportional to P*, the diffusivity of deuterium in this layer should be also proportional to the discharge power. Thus, it appears that, as might be expected, the X-ray emission intensity increases with an increase in diffusivity of deuterium in the cathode.

The proximity of the deuteron screening potentials U_s deduced from these experiments and the energy levels of inner shells of the metal targets (e.g., the L_{II} electron shell energy in Ti-atom is consistent with the measured $U_s = 610 \pm 140$ eV) strongly suggests a correlation between the mechanism for deuteron screening and X-ray generation in the Ti-cathode.

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Triggering A Deuterium Flux In Pd Wire Using Electromagnetic Field

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During ICCF-9, Del Giudice, De Ninno and their group showed that an electrical potential along the palladium wire is important to load the deuterium into the Pd [1]. The pattern of their successful cathode shows that it is also important to increase the resistance of the palladium wire in order to reduce the Joule heating effect while a large electrical voltage is applied onto the palladium wire. However, there may be another way to generate an electrical potential without the strong Joule heating. That is to use the electromagnetic field instead of a DC current.

We believe also that this AC voltage on the palladium wire would generate a deuteron flux along the palladium wire and a deuteron flux across the surface of the palladium wire. These fluxes might generate a heat flow based on the correlation between deuterium flux and heat flow.[2] Twins of apparatuses were built to test this idea.

A copper coil is used to generate an electromagnetic field in a glass vessel. A Pd coil which works as a secondary winding of a transformer, is put into this glass vessel. When a high frequency AC voltage is applied on the copper coil, it induces an electrical potential in the Pd coil. However, the circuit of the secondary winding is open; hence, there is no strong Joule heat effect. Then, we are able to watch any temperature rising when any tiny heat effects appears in the Pd coil. When the deuterium gas was filled into the glass vessel, a temperature rising was observed. This temperature rising was correlated with the AC voltage clearly.

A twin system is made in order to exclude any side-effects such as the possible Joule heating due to the eddy current, the disturbance of AC signal in the Pt thermistor… In one of these twins, Pd wire coil is replaced by a similar copper coil. The preliminary comparison between these twins shows that there might be a net heat effect in the D/Pd system. We will report the updated result in ICCF-10.

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Mo09

Enhancement of nuclear reactions due to screening effects of core electrons

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Abstract

Recent progress in understanding the screening effects of core level atomic electrons is summarized in this paper. Some preliminary results on core electron screening were reported before [1]. The studies focus on two types of nuclear reactions in some metal lattices: fusion between deuterons and also proton capture by medium and heavy lattice nuclei. In both reactions the energy of the light nuclear species, proton or deuteron, is on the KeV (1000 electron volts) scale, while that of heavy nuclei is essentially zero. The elevated energy of the light species can be attributed either to excitation by a plasma or a coherent oscillation developed in the lattice when excited by suitable combination of loading, ion flow, and external forces. A standard atomic code is used to obtain the core electron charge density and the potential profile in the metal atom. This Hartree-Fock-Slater type code was originally written by Herman and Skillman [2] and later modified by others and available online [3]. For the D-D reaction, the charge density obtained then gives an estimate on the screening length. The corresponding enhancement in Coulomb barrier tunneling can be obtained from this data. For the proton capture reaction, an ion dynamic code [4] written to simulate the motion of KeV protons in Pd/Ni lattice, CLAIRE, was modified to take into account the realistic atomic potential, including core electron contributions. In both cases, our result shows a significant nuclear reaction enhancement. The reaction rate calculated roughly matches the scale of excess heat observed in some metal hydride/deuteride [5] experiments.

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Tu18

First-principles studies of ionic and electronic transport in palladium hydride/deuteride

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Abstract

The transport properties of palladium hydride/deuteride are investigated using state-of-the-art density functional computational tools. This aspect of loaded hydride is important in that that the resistance-loading curve is often used as a diagnostic in experiments to estimate the loading ratio. Understanding transport provides other important insights into some features of the nuclear reaction mechanism. Also, achievement of a minimum current flow (i.e. transport) is considered to be a key requirement for excess heat production. This research involves both ionic and electronic degrees of freedom. For the ionic part, the focus is on the charge state of hydrogen/deuteron, in both a static and a dynamic (hopping) situation. Experiments show that hydrogen hops as fractional-charged positive ion in Pd lattice [1,2] while previous band structure calculations [3-5] always gave a negatively charged H in the ground state. This discrepancy is addressed in the current research and some results are already published [6]. The collective motion of ions is studied in the phonon structure and electron-phonon coupling constant using a perturbation density functional theory. The electronic part focuses on the density of state and the Fermi surface, which when combined with the electron-phonon coupling constant, determine the temperature and the H/D loading dependant resistivity curves. Our numerical results [7] qualitatively match experimental trends but systematically produce a slightly smaller resistivity. This discrepancy is thought to be due to additional scattering mechanism associated with alloying disorder, a phenomenon that is not considered in the present model. The possible connections between this transport theory/mechanism and the non-equilibrium conditions required for excess heat are discussed.

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Th39

LENR and "Cold Fusion" Excess Heat: Their Relation to Other Anomalous Microphysical Energy Experiments and Emerging New Energy Technologies

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During the past 15 years, indisputable experimental evidence has built up for substantial excess heat (far beyond ordinary chemical energy) and low-energy nuclear reaction phenomena in specialized heavy hydrogen and ordinary hydrogen-containing systems.[1] The primary theorists in the field that is properly designated Cold Fusion/LENR have generally assumed that the excess heat phenomena is commensurate with nuclear ash (such as helium), whether already identified or presumed to be present but not yet found. That was an excellent initial hypothesis. However, the commensurate nuclear ash hypothesis has not been proved, and appears to be approximately correct in only a few experiments. During this same period, compelling evidence—although not as *broadly* verified as data from cold fusion/LENR—has also emerged for other microphysical sources of energy that were previously unexpected by accepted physics. The exemplar of this has been the "hydrino" physics work of Dr. Randell Mills and his colleagues at BlackLight Power Corporation, which was a radical outgrowth from the cold fusion field that emerged publicly in May 1991.[2] Even more far-reaching is the work in vacuum energy extraction pioneered by Dr. Paulo and Alexandra Correa, which first became public in 1996.[3] This vacuum energy experimentation began in the early 1980s and has been reduced to prototype technological devices, such as the patented PAGD™ (pulsed abnormal glow discharge) electric power generator, as well as many published experiments that can be performed in table-top fashion to verify the Correa "Aetherometry" (*non-luminiferous* aether measurement) science.[4] In an era when mainstream science and its media is all agog about "dark matter" and "dark energy" composing the vast bulk of the universe, there is a great need to reconcile, if possible, the significant bodies of evidence from these three major experimental and theoretical streams: cold fusion/LENR, hydrino physics, and Aetherometry. The aim of the present paper is to compare the substantial features of each field of investigation and to suggest how to move forward for the benefit of all with openness and a minimum of preconceptions.

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Mo04

Evidence Of Cold Fusion In Palladium Exposed To Atomic Deuterium

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Abstract

In experiments to investigate the application of gas phase as a medium for cold fusion, a Pd vessel was exposed to deuterium gas, dissociated in an electric discharge at between –10 and –20 degrees C. After absorption had proceeded for eight hours, neutrons were detected at levels approaching the full scale on the recording equipment. This lasted for three hours before falling to zero.

The gas remaining in the Pd was removed by exposing it to oxygen dissociated by the electric discharge. Water produced was collected in a cold trap and tested for beta radiation as evidence for tritium formation. The level of radiation found was over 6000counts/min. This was 20 fold above the background since a similar sized sample of heavy water made from the deuterium gave a reading of 300c/min.

Further attempts to perform similar experiments were unsuccessful. At the time this was puzzling, however recent insights into solid phase gas fusion may shed light on possible causes for this failure and it is worth pursuing this approach as the gas phase presents certain advantages over methods currently used.

This work was carried out in 1990

Tu03

The need for Triggering in Cold Fusion reactions

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It has long been recognized that initiation of the cold fusion heat effect observed in heavy water electrolysis at palladium cathodes requires simultaneous attainment of three conditions: (i) high loading or chemical potential of D within the Pd lattice; (ii) an initiation time at least ten times larger than the D diffusional time constant; (iii) a minimum or threshold electrochemical surface current or current density that is not correlated to the bulk D loading [1-3]. In 1995 a fourth condition was added with the recognition [4] that (iv) deuterium flux plays an important role in determining the excess heat power density.

With the emergence of better phenomenological understanding and predictive theory we can begin to associate the features of the observed causes and effects with the requirements of a solid state nuclear effect that gives rise to heat and associated He-4. We now understand that the production of significant excess heat from a solid target requires Thermodynamic preconditioning (i and ii) and suitable Triggering (iii and iv). Electrochemistry provides a convenient means of loading but it is energetically expensive to maintain the electrochemical current density just to preserve loading during the initiation period if alternative means are available. More importantly, triggering by means of a high-density electrochemical current flux is an inefficient way to achieve the favorable energy balance necessary to demonstrate commercial potential of the effect.

We will discuss how in practice to separate the steps of loading, initiation and triggering, what these processes are, why they are necessary, and what their associated energy input costs are. We will demonstrate results recently obtained to confirm that means more practical than sustained electrochemical current flux can be used to trigger the excess heat effect in suitably prepared PdD cathodes. We will discuss also the extension of these concepts to potentially more useful structures.

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A Calorimetric Investigation Of The Pd / B System

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The measurements discussed in this presentation were made by one of us (M.H.L.) during his stay in the laboratories of the New Hydrogen Energy Group, Sapporo, Japan using an ICARUS-1 Calorimeter (1) coupled to an ICARUS-2 polarisation and measurement system (2). The Pd-0.5% B electrodes were prepared by one of us (M.A.I.) at the Naval Research Laboratories in Washington D.C.

It is shown that in contrast to the measurements on the Pt / D_2O "blank" system (see (3)) the "lower bound" heat transfer coefficients vary markedly within each measurement cycle and with the progression of these cycles from Day 1 to Day 68 spanning the experiment duration. This shows the presence of a markedly varying rate of excess enthalpy generation and, in consequence, the evaluation has had to be restricted to the "robust" estimates of $(k_R')_1$ and $(k_R')_2$ and the differential heat transfer coefficients $(k_R')_{11}$ and $(k_R')_{12}$ (compare (3), (4)).

It is shown that the experiment described in this paper suffers from a number of deficiencies. In the first place, the power delivered to the calibration heater was incorrectly quoted so that $(k_R')_2$ has had to be estimated from the maximum value of the "lower bound" heat transfer coefficient (compare (5)). Secondly, some of the samples of D_2O used to replenish the electrolyte (to make up for losses due to the combined effects of electrolysis and evaporation) were evidently contaminated by HDO causing marked increases of the "lower bound" heat transfer coefficient following such replenishments. Thirdly, the range of current densities used in the experiment (and the protocol) was restricted in view of the dimensions of the electrode so that this was maintained in the region for the onset of "positive feedback" (which could be detected throughout the experiment duration) (compare (6), (7)). Nevertheless, the rates of excess enthalpy generation observed in time regions free from such complicating factors agree with those observed in the initial investigation (8). This is perhaps not very surprising because an essential step in the preparation of these electrodes was the melting of the palladium in the presence of calcium boride (so as to maintain the oxygen activity at an adequate low level).

The experiment also demonstrated the phenomenon of "Heat-after-Death" (5), (9). The rate of excess enthalpy production increased markedly on Day 68 of the experiment, so much so that the cell contents "boiled to dryness" (5), (9). It can be seen that all the phenomena to which we have previously drawn attention can be demonstrated using just a single experiment provided this is carried out in an adequately comprehensive manner, over a sufficient duration, and provided the experiment is subjected to a complete evaluation.

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Mo15

Correlation Of Excess Enthalpy And Helium-4 Production: A Review

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Three different sets of experiments conducted in the Navy laboratory (NAWCWD) at China Lake, California clearly established that helium-4 is the main fusion product in the Pd/D_2O+LiOD electrolysis system. The first set of 15 experiments (1990-1991) used glass flasks (500 mL) to collect the electrolysis gases. These samples were sent to the University of Texas (Ben Bush) for helium analysis (1). When excess enthalpy was measured, 8 out of 9 samples showed excess helium-4. Furthermore, the helium production rates were 10^{10}-10^{12} ^{4}He s^{-1} W^{-1}, which is the correct magnitude for typical fusion reactions that yield helium as a product (2). When no excess heat was measured, all 6 samples showed no excess helium-4.

The second set of 3 experiments (1991-1992) also used glass flasks to collect the electrolysis gases, but Rockwell International Corporation (Brian Oliver) performed very accurate helium analysis ($\pm 0.01 \times 10^{14}$ atoms/500 mL or ±0.1 ppb) (3). Furthermore, the rate of atmospheric helium diffusion into these flasks was measured and extrapolated back to the time of collecting the gas samples. These three experiments produced different amounts of excess power and similar differences in the amounts of helium-4 were measured (3). The rate of helium production in these 3 experiments was 2, 2, and 5×10^{11} ^{4}He s^{-1} W^{-1}. During these experiments neither Rockwell International nor the China Lake laboratory knew both the excess power and helium measurements until after the study was completed and all results were reported to a third party (3).

The final set of 15 China Lake experiments (1993-1994) employed metal flasks to collect the electrolysis gas samples (4, 5). The helium analysis was performed by the U.S. Bureau of Mines laboratory in Amarillo, Texas. When excess enthalpy was measured, 7 out of 9 samples registered excess helium-4. When no excess heat was present, all 6 samples showed no excess helium-4. One of these samples producing excess heat and correlated helium-4 production used the novel Pd-B material produced by Dr. Imam at the Naval Research Laboratory (6). The rate of helium production for these experiments using metal flasks ranged from 7.0×10^{10} to 2.5×10^{11} ^{4}He s^{-1} W^{-1} (5).

Combining these three different sets of experiments shows a correlation between the measurements of excess enthalpy and excess helium-4 in 18 out of 21 experiments. Furthermore, a rational explanation for the three exceptions can be made (5). Thus 30 out of 33 experiments conducted in the Navy laboratory at China Lake agree with the hypothesis that the excess enthalpy is correlated with helium-4 production: $D + D \rightarrow {}^4He + 23.8$ MeV. The theoretical rate of helium production for this reaction is 2.6×10^{11} ^{4}He s^{-1} W^{-1} (3). A statistical treatment shows that the probability is only one in 750,000 that the China Lake set of heat and helium measurements could be this well correlated due to random experimental errors (5). Furthermore, the rate of helium-4 production was always in the appropriate range of 10^{10}-10^{12} atoms per second per watt of excess power.

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Mo12

Fluidized Bed Experiments Using Platinum And Palladium Particles In Heavy Water

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These experiments were designed to give dynamic electrolysis conditions by using small palladium particles that maintain electrical contact. The movement of these particles due to the D_2 gas evolution produces continuously changing surfaces for the cathodic reaction. Platinum particles were tested in Cell A as a control while palladium particles were investigated in Cell B. The platinum and palladium particles were actually miniature cylindrical rods that had the same dimension, i.e., 0.6-0.65 mm diameter and 0.65-0.7 mm length. The stated purity was 99.99% for both metals.

The China Lake calorimetric cells were the same as reported previously (1) except that the secondary compartment outside each cell was filled with copper granules rather than aluminum foil. The bottom of each electrochemical cell was filled to a level of 3-4 mm with the small Pt or Pd particles. A platinum wire sealed in shrink Teflon with only a small tip exposed was used to make electrical contact to the metal particles at the bottom of the cell. A platinum coil anode was positioned about 0.5 cm above the bed of metal particles. Each cell was then filled with 18.0 cm^3 of 0.1 M LiOD. Thermistors T_1 and T_6 were fixed in position on the outside surface of Cell A (Pt particles) while thermistors T_3 and T_4 were similarly placed on the outside surface of Cell B (Pd particles). The thermistor positions were 1.9 cm above the bottom of each cell (T_1, T_3) and 4.5 cm above the bottom of the opposite side of each cell (T_6, T_4).

Both direct current electrolysis and pulse power electrolysis methods were used with these cells. The initial cell current of 0.100 A was increased to 0.300 A after one day. For the direct current electrolysis, these cells were typically run at 0.300 to 0.400 A. The pulse power electrolysis method used a pulse width of 1.0 µs, a pulse frequency of 5 kHZ, and a peak voltage of nearly 100 V. The average current was only 0.012 A under the pulse conditions. The excess power observed using palladium particles (Cell B) was 90 mW for direct current electrolysis and 250 mW for pulse electrolysis (2). No excess power was observed for similar experiments using platinum particles (Cell A).

These novel fluidized bed experiments provide dynamic conditions that are believed to be important for the observation of excess enthalpy in cold fusion experiments. The small metal particles jostle about during electrolysis, hence new surface areas are continually exposed to the top portion of the metal/electrolyte interface. The many tiny metal particles give a large effective surface area and make these experiments more independent of the metallurgical properties of any particular palladium sample (2).

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Th06

Review of Transmutation Reactions in Highly Loaded Lattice

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Transmutation reactions involving lattice atoms have been reported by a number of research groups [1]. Results fall into two broad categories of reactions: one or more products from direct H/D-lattice interactions and a multiple array of products from fission of compound nuclei involving multibody H/D-lattice interactions. These various studies will be briefly summarized and common systematics (key "signatures") will be noted.

Earlier work by Miley and Patterson studied hydrogen loaded multi-layer thin-film Ni/Pd using an electrolytic technique [2]. A distinctive characteristic was a product yield curve vs. mass with four high yield peaks. Higher yield elements occurred in quantities well above maximum impurity limits, while certain non-natural isotopic distributions were observed. Recent CR-39 track detector measurements reveal low-level emission of protons and alpha particles from similar thin-film electrodes [3].

Experiments in other laboratories have employed a variety of electrode materials ranging from Carbon, Palladium, Nickel, to Uranium. They also used various loading methods, e.g., a plasma discharge [4] high-current plasma electrolysis [5], low-current electrolysis [6], and laser irradiation [7]. Transmutations involving Uranium have also been of strong interest for possible radioactive waste management [8,9]. Other recent experiments have focused on "single element" transmutations; e.g. Iwamura et al. [10] recently reported transmutation of a surface layer of Sr-88 into Mo-96, using diffusion of deuterium through a multi-layer thin-film Pd/CaO substrate. Cs-133 was also transmuted into Pr-141.

Products systematics from these various studies will be discussed relative to the frequency that various elements have been observed, deviation from natural abundance, product mass relative to electrode atomic mass and implications of reaction energetics. A comprehensive theory to explain these varied results is the objective of several theoretical projects. While a detailed theory is not yet available, the different classes of reactions involved appear to be closely associated with loaded lattice configurational conditions [11]

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Generation Of Heat And Products During Plasma Electrolysis

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Abstract

We have already reported anomalous heat generation during plasma electrolysis. Some researchers have attempted to replicate the phenomenon. However, they have found it is difficult to generate a large amount of excess heat. Usually, the plasma state can be easily be triggered when input voltage is increased up to 140V at a high electrolyte temperature, above 65ºC. Researchers trying to replicate tend to increase input voltage very high, to several hundred volts. Yet they may observe no excess heat even when they kept the voltage this high. In this condition, a great deal of hydrogen gas is released from the cell, making it difficult to calibrate and to determine the exact heat balance. It is especially difficult because not only is a great deal of electrolysis effluent gas produced, additional "excess" gas is released by pyrolysis. When the excess gas leaves the system it carries off excess heat that cannot be accounted for with most calorimeters. In this paper, we show some techniques we have used to measure all gas and enthalpy during plasma electrolysis. A researcher who wishes to replicate must pay close attention to both the electrolysis conditions and these techniques.

The amount of hydrogen and the oxygen generated by electrolysis is predicted by Faraday's law. At extraordinarily high temperatures, above 4000ºC, direct pyrolysis of the gas begins to release significant amounts of hydrogen. These high temperatures and the generation of hydrogen in excess of Faraday's law is observed when the conditions such as electrolyte temperature, current density, input voltage and electrode surface are suitable. In this paper we show that the enthalpy carried off by the excess hydrogen reaches more than 30% of input energy. So, it is necessary to estimate the enthalpy of this hydrogen generation to calculate the heat balance.

We also show that anomalous element deposition sometimes occurs when excess heat is generated.

Th09

Metallic Transmutations Induced By Acetic Acid

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Abstract.

Experimental evidence for Biological Transmutations has been widely shown by L. Kervran (www.lowenergytransmutations.org).

We could then suppose that transmutation can occur as a result of organic chemical reaction.

During the preparation of the components for the transmutations into stable elements of Thorium and Uranium, Vinegar is used to wash Mercury. If this preparation is followed by further washing in Acetic Acid and final dissolution in Nitric Acid, the Mercury spikes up beautiful Gold crystals.

This experiment, in our opinion, shows that Lavoisier's statement about the intransmutability of Mercury into Gold is experimentally groundless.

Probably other metallic transmutations induced by Acetic Acid are possible.

Fr07

Neutrons, Polyneutrons, Super Heavy Stable Elements (SHSE)

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Abstract.

Consequently to the Periodic Table of the Elements which follows from the Alpha Extended Model of the Atom (www.lowenergytransmutations.org) any Element is made up of Polyneutrons and can be made by composing properly a certain group of Polyneutrons.

Low Energy Transmutations from one Element to another are possible. We are able to prepare peculiar isomeric configurations of Polyneutrons (Elements)which are suitable for Transmutations.

The first example is the Transmutation of Mercury into Gold. After a peculiar treatment with Acetic Acid, followed by dissolution in Nitric Acid, the Mercury spikes up beautiful Gold crystals, widely shown in the paper (a video tape is also available).

A second example is the Transmutation of Lead, Mercury, Copper. We are able to prepare peculiar isomeric configurations of Lead, Mercury, Copper, which, after ignition with Nitrates, Carbon, Sulfur, transmute into Platinates, Gold, Silver.

A third example is the possibility, during the previous Transmutations, to cause the Transmutation of unstable elements, like Thorium and Uranium, into stable elements, by simply adding them in the form of oxides and nitrates, to the mixture for the transmutation of Lead, Mercury, Copper.

There is the possibility, tested in previous experiments, that during the ignition process Super Heavy Stable Elements are produced, endowed with peculiar catalytic properties, which cause the proliferation of Noble Metals in the compound. The existence of these Super Heavy Stable Elements has been recently shown by Adamenko (http:www.arxiv.org/pdf/nucl-ex/0307011).

In our opinion the discovery of the Tetraneutron and the discovery of Super Heavy Stable Elements, are experimental evidence for the Alpha Extended Model of the Atom.

The Technology of Low Energy Transmutations is now applied, on industrial basis, by Monti America Corporaion, for the transmutation of radioactive waste into stable elements.

Tu12

Energetics Of Defects And Isotropic Strain In Palladium

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The question of whether the electrolytic cells, and their relatively large electrodes in cold fusion experiments, can function as energy storage devices like batteries, has hounded the field from its earliest days. As recently as April of this year, a letter to the editor of New Scientist asserted that there is a "simple and known explanation of the extra heat given off by metal hydrides, such as palladium deuteride. The extra energy comes from elastic relaxation."(1). The question of energy storage has two parts: (a) whether or not the annihilation of pre-existing defects or strains during an electrolysis experiment can release significant energy, and (b) whether or not energy stored in an electrode during hydriding or deuteriding can be released later, and be mistaken for excess power. The purpose of this paper is to address the first part of the question by summarizing the energetics of palladium containing defects and isotropic strain (prior to hydriding or deuteriding). We focus on palladium because of the importance of palladium-cathode experiments in the field.

The energies in the starting material can be organized according to the dimensionality of the defect structure, namely 0-D point defects (vacancies, interstitials and substitutionals), 1-D line defects (dislocations), 2-D planar defects (grain boundaries) and 3-D elastic distortion (strain). For extreme concentrations of each of these defects, and a high isotropic linear elastic deformation of 1%, we computed the energy densities per cubic centimeter, which are given in the following table.

Defect or Condition	Assumption	Joules/(cm) exp(3)
Vacancies	T = 500^0 C, so Vacancy Fraction = 10 exp(-10)	1.1 x 10 exp (-6)
Interstitials	Part per thousand impurity, i. e., "3 9s pure.	<11
Substitutionals	Part per thousand impurity, i. e., "3 9s pure.	11
Dislocations	Heavy Cold Work = 10 exp(16)m per m exp(3)	22
Grain Boundaries	Micrometer Size Grains	3
Isotropic Deformation	1% linear deformation in the lattice constant	1 x exp (-2)

Voids are not generally present in electrodes in high concentrations (volume fractions), and cracks are known to defeat the desired high loading, so energies for both of these types of defects were not calculated. Shear strains are likely to be unimportant. The values in the table show that total annihilation of the initial defects in a cold fusion experiment would yield, at most, about 50 W for 1 sec, 5 W for 10 sec, 500 mW for 100 sec, 50 mW for 1000 sec or 5 mW for 10K sec for a Pd cathode 1 cm^3 in volume, under these extreme assumptions of defect densities and deformation. That is, the energies stored in defects within the starting material are generally insufficient to account for observed excess energies in many cold fusion experiments, even if those energies were entirely released by defect destruction during the process of hydriding or deuteriding.

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Gamma Ray Detection and Surface Analysis on Palladium Electrode in DC Glow-like Discharge Experiment

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The possibility of inducing low-energy nuclear reaction in electric discharge method using Pd electrode has been widely investigated for several years. Previously, we observed low energy gamma ray emissions in 70-110keV region during DC glow discharge in ~3Torrs of deuterium gas[1]. In this study, we carried out the similar discharge experiment with deuterated (hydrated) Pd foil cathode (10x10x0.1mm in size, >99.95% in purity) but increasing the pressure of atmospheric deuterium (hydrogen) gas to ~1atm. This discharge condition was called "glow-like". The discharge test cell used in this experiment was made of Pyrex glass and it has a cylindrical shape with volume of ~1000cm^3, which consists of two parts adhered to each other by silicone grease. After setting the Pd deuteride (hydride) sample as a cathode, the cell was closed up and evacuated to 10^{-2}-10^{-3}Torr. Then, the deuterium (hydrogen) gas was filled until the pressure inside the cell became ~1atm. Then the DC power was applied and the sample was exposed to discharge with currents of 2-4mA, voltage of 4000-6000V for duration time of 60min. The NaI scintillation counter was perpendicularly placed ~10mm away from the side of the cell for detecting gamma rays emitted from the sample. The anomalous signals in the gamma ray spectra with energy 80-230keV were sometimes observed during the discharge using deuterated Pd cathode in deuterium atmosphere. It was supposed that these signals could not be noise introduced by the electric discharges and that a nuclear reaction, producing the radioactive source, took place during the experiment. One of the possible ideas to explain the formation of radio isotopes with short lifetime in such discharge condition is low-energy photofission[2]. Part of energies of gamma rays detected agrees with ones from some radio isotopes predicted to be produced in the model. For the experiments exposing hydrated Pd in hydrogen atmosphere or no-loading Pd to the discharge, such anomalous signals were not observed at all. Therefore, the deuterium probably played an important role to induce the reaction.

The elemental analysis can give us information to understand the phenomena. In this study, we also investigated the surface composition of Pd by Time-of-Flight secondary ion mass spectrometry. Using Pyrex glass cell comparing with metal one has an advantage to minimize possibilities for Pd samples to be contaminated during sputtering process by discharge, so that we can detect small quantity of nuclear products on the sample. We will discuss the possible transmutation processes considering both energy of gamma rays detected and the results of surface analysis.

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Analysis Of Nuclear Transmutation Induced From Metal Plus Multibody-Fusion-Products Reaction

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Nuclear transmutation phenomena have been analyzed by multi-photon induced fission (MPIF) and selective channel scission (SCS) models [1]. MPIF model is assumed the nuclear excitation to E1 giant resonance region by low-energy photons. SCS model is one that estimates fission processes and products from the excited nucleus.

Recently, the mass-8 and Z-4 increased transmutation was reported by Y. Iwamura et al [2]. This phenomenon is probably related to $^{8}Be^{*}$ produced by a certain reaction, judging from the increase in mass and Z with a specific number.

Multibody Fusion model has been developed over 10 years [3]. This model assumes that deuterons are condensed to octahedral- or tetrahedral-sites simultaneously under a transient condition and make fusion because of the enhancement of the screening of Coulomb barrier and the symmetry property of nuclear force. Reactions concerning with the mass-8 and Z-4 increased transmutation phenomenon are picked up as follows:

$$4\text{ D} \rightarrow {}^{8}\text{Be}^{*} \rightarrow 2\,{}^{4}\text{He} + 47.6\text{ MeV},$$
$$8\text{ D} \rightarrow {}^{16}\text{O}^{*} \rightarrow 2\,{}^{8}\text{Be} + 95.2\text{ MeV}.$$

The ^{8}Be produced by these reactions must induce the mass-8 and Z-4 increased transmutation.

And based on these reactions, fissions can also occur as secondary reactions by fusions that the sample metal M (Pd etc.) plus major products (^{4}He or ^{8}Be) because these excitation energies are enough high to induce fission reactions; for example, the excitation energies are 26.7 MeV for $^{106}Pd + {}^{4}He$ and 53.2 MeV for $^{106}Pd + {}^{8}Be$, respectively.

$$\text{M} + {}^{4}\text{He (or } {}^{8}\text{Be)} \rightarrow \text{Fission product 1} + \text{Fission product 2.}$$

The distributions of these fission products (FPs) can be calculated by SCS model in the same way as the previous MPIF analysis or neutron-induced fissions of ^{235}U in spite of the difference in target nuclei and the excitation energies.

The distribution of FPs analyzed by SCS model will be presented with comparison to the experimental results reported by T. Mizuno et al [1]. Also, γ-ray emissions in decay process of fission fragments will be discussed in detail.

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Fr03

Detection of Energetic Charged Particles During Electrolysis

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By the use of CR-39 particle track detectors immersed in the electrolyte, we confirm that a nuclear reaction of as-yet unknown nature can take place during electrolysis. With Li_2SO_4 dissolved in D_2O or H_2O and either Pd or Ni as cathodes, a very large statistical difference in nuclear track generation is found between detector chips immersed during electrolysis and the control chips immersed in similar solutions not subjected to electrolysis. The probability that the electrolysis tracks and the control tracks could have by chance arisen from a common population is 2.5×10^{-5}, 1.2×10^{-6}, and 5.8×10^{-4} for the systems Pd/D_2O, Pd/H_2O, and Ni/D_2O, respectively. We conclude that there is a causal relationship between electrolysis and energetic charged particles and that neither Pd nor D_2O is essential for the generation of a nuclear reaction. Some implications for theoretical considerations are presented.

Fr05

Energetic Charged Particles Detected in the Vapor in Electrolysis Cells

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Electrolysis of $H_2O/Li2SO_4$ solutions using either nickel or palladium as cathodes produces tracks in CR-39 particle track detectors suspended in the gas above the electrolyte. The plastic detector chips are held edge down above a nickel disc that nearly fills the cross-sectional area of the electrolysis cell. The disc decreases the carry-over of liquid droplets from the electrolyte, and maintaining at about 70°C the section of the cell body that contains the chips decreases condensation of water vapor upon them.

The number density of tracks produced upon detector chips (the actives) held in the vapor of operating electrolysis cells is compared to that on control chips. The probability that the number densities on the actives and those on the controls belong to a common population is 1.0×10^{-6}. The fact that the tracks can be produced only by charged particles with energies much larger than can be generated by chemical reactions leads to the inescapable conclusion that electrolysis can cause a nuclear reaction to take place in the gas phase.

Occasionally, extremely large number densities of nuclear tracks are produced on the detector chips. The distribution of number density over the area of the chip and analysis of the spatial orientation of the tracks permit an estimation of the location in the gas of the nuclear reaction that generated the tracks. The present observations can be rationalized only by the theory developed by Fisher.

Pd-110/Pd-108 Isotope Abundance Ratio Variations in Pd Exposed to High Pressure Deuterium Gas in the Hollow Cathodes of Arata/ Zhang

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Significant variations in the Pd-110/Pd-108 ratio appear to have been created by long term exposure to high pressure deuterium gas in the hollow space in an Arata-Zhang special cathode. The variation is in the range of 10% for the most extreme case between three active samples and the virgin material. The sample showing the most extreme variation also showed the highest relative increase in the zinc-64 content relative to the virgin material (a factor of 14). The variations show a depletion of Pd-108 relative to that of Pd-110 in all three active samples relative to the virgin material. One might speculate that Pd-108 is more easily fissioned to Zn-64 than Pd-110 or transformed to Ag-109 by a (d,n) reaction. No information was possible under the conditions available to us for neutron activation analysis (NAA) on the other isotopes of palladium, even though minor changes would have allowed including Pd-102 in the analysis. It is possible that errors in NAA could be due to small variations in the precise geometry of the samples vs the germanium gamma ray detector. However we have addressed this possibility by averaging over several different counts and using the ratios of several different pairs of gamma rays for which such variations should differ. Use of the virgin powdered Pd as the baseline prevented our being fooled by variations in the Pd isotope abundance ratios naturally present on the earth.

Attempts to measure the isotopic ratio of the increased zinc concentration were thwarted by the short half life of Zn-69m and its occlusion by gammas from the Pd isotopes (to acquire the Zn-64/Zn-68 ratio). A measurement using time of flight secondary ion mass spectroscopy (TOF-SIMS) showed significant differences from natural zinc. However, we could not eliminate the possibility that the variations were due to differences in metal hydrogen (multiple atom) ions. One would expect that if zinc had been produced by fission of Pd-108, that its isotopic abundance ratio would significantly differ from natural zinc. With the cooperation of Graham Hubler of the Naval Research Laboratory, the ratios of the two silver isotopes, Ag-107 and Ag-109 (Ag-109 is also observed by NAA to increase in the active vs the virgin material) is currently being attempted by accelerator mass spectroscopy, a method mostly immune to complications due to multiple atom ions. If available by the time of the conference, this data will be presented. The extremely long half life of Ag-108m (127 years) prevented our observing it by NAA using short time, low flux irradiations available at the University of Texas reactor.

Mo14

Observations Of A Porous Packed Bed Gaseous Deuterium Filled Mini-Reactor

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Microcrystalline palladium powder formed in and around diatomaceous earth particles was packed in a glass tube (ID = 9 mm, OD = 14mm, bed depth = 1.0 cm) and compressed using machined brass end plugs fitted with o-rings. Deuterium gas was introduced at pressures from 0 – 3 bar in a cul-de-sac configuration, while a voltage and current was applied to the Pd bed via the brass plugs, and the power input to the bed continuously monitored. Three thermocouples attached to the outside of the glass tube simultaneously monitored temperature produced by resistive heating. Correlation coefficients of > 0.997 were routinely observed when power v. temperature (average of the three thermocouples) analyses was made for the bed filled with air at atmospheric pressure.

Subsequent D2 flushing and pressurization produced temperatures higher than predicted from the air filled control, with excess heat calculated 30 – 40% above that expected from pure resistive heating.

Th20

Positrons Annihilation And Possible P + D Nuclear Reactions

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ABSTRACT

The research of interaction of hydrogen isotopes with metals in conditions of thermal activation is carried out and at influence on metals of the accelerated ions from plasma of the glow discharge. Registration of hydrogen complexes with help of the mass - spectrometers formed at interaction of the glow discharge plasma with metals, shows presence of the deuterium generation. The assumption is stated, that the plenty excess heat received in experiments on sorption-desorption of hydrogen isotopes in metals, at acceleration of hydrogen isotopes in the glow discharge suffices, can be connected to deuterium formation on the nuclear mechanism.

The positrons generation investigated on registration of gamma - radiation arising from positrons annihilation with electrons. The essential difference in gamma - spectra, for not working installation and at inclusion of the glow discharge on a natural mix of hydrogen isotopes, is not noticed and corresponds to size of a deviation, at measurement of so small size of radiation, namely about ± 50%, for intensity of gamma - quantums with energy 511 keV, equal 40 quantum /s.

The deuterium and tritium generation, arising at interaction of the accelerated isotopes of hydrogen with metals in plasma of the glow discharge, and also absence in products of reaction of neutrons and positrons, allow to make a conclusion about absence of thermonuclear reactions at low energy interaction of hydrogen isotopes with metals. We believe, that the basic reaction can be:

$$P + e + P \rightarrow D\ (\sim 2\ \text{keV}) + \nu\ (\sim 1{,}95\ \text{MeV}).$$

The registered power of this reaction is lower three order, than majority of thermonuclear reactions. The same reaction can serve a source, rather, high-energy deuterons for reaction:

$$P + e + D \rightarrow T\ (\sim 6\ \text{keV}) + \nu\ (\sim 5{,}98\ \text{MeV}).$$

So, the increase of deuterium concentration in a mix of isotopes approximately on three order, in conditions of the glow discharge and magnetic field, has resulted in increase of the tritium generation rate everything, from several tens percents, for molybdenum and tungsten, up to four-seven times, for niobium and tantalum. Thus, the tritium generation under the specified condition can occur and in pure protium, without impurity of deuterium. The truth, speed of secondary nuclear reactions has factor within the limits of 10^{-5} – 10^{-7}.

The similar reaction can result in formation helium-4:

$$P + e + T \rightarrow {}^{4}H\ (\sim 15\ \text{keV}) + \nu(\sim 19{,}8\ \text{MeV})$$
$$\downarrow$$
$${}^{4}He\ (\sim 15\ \text{eV}) + \beta^{-}\ (\sim 15\ \text{keV})$$

We12

Prospects Of Intensity Increase Of Nuclear Reactions At Low Energy Interaction Of Hydrogen Isotopes And Possible Areas Of Their Application

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ABSTRACT

The research of tritium generation, arising at bombardment by the accelerated ions of mixes hydrogen isotopes from low energy plasma of the glow discharge for surfaces of various metals.

It is shown, that it is possible to operate by tritium generation rate and, accordingly, both speed of nuclear reactions and generation of heat, at use of optimum materials for the cathode - target - anvil, increase both of energy and current in the discharge and correct use of a magnetic field. The revealed laws allow to project discharge devices with tritium generation rate about 10^{11}-10^{12} atom/s, at planned efficiency about 10^{7}-10^{8} atom/J. Such characteristics are sufficient for reception of excess heat of a nuclear nature at a level from some hundreds, up to several thousand Watt.

The revealed laws allow to approve, that the new direction of nuclear researches on a basis of low energy interaction for hydrogen isotopes with metals is already generated, the decision of which problems is a urgent scientific and technical task. Such features of offered nuclear reactions arising at low energy interaction of hydrogen isotopes with metals, as overwhelming advantage of reactions with participation only of protons, and from radioactive products presence only of low - active tritium, allow to plan the basic directions of their practical use:

-Power.

On the basis of use for offered intensive proton - electronic reactions the development of manufacturing technological processes for stationary, mobile and transport power installations with increased ecological compatibility is possible.

-Storage and processing wastes.
A) Processing wastes with tritium.
B) Processing high intensity, heavy wastes.

For destruction of high intensity, heavy wastes we offer to make combined reactors of nuclear fusion using as reactions arising at low energy interaction, as and known of thermo-nuclear reactions.

-Production of rare isotopes.
-Development of new materials.
-Development of isotope light sources and energy.
-Development of economic generators of coherent radiation (Lasers).

Fr01

Tritium Generation At Low Energy Interaction Of Hydrogen Isotopes With Metals

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ABSTRACT

The research of tritium generation, arising at bombardment by the accelerated ions of mixes hydrogen isotopes from low energy plasma of the glow discharge for the surfaces of various metals.

It is shown, that the tritium generation at influence on metals of hydrogen isotopes in conditions of thermal activation, on size, is close to background quantity. At interaction of mixes hydrogen isotopes with a surface of various metals, under action of positive ions from plasma of the glow discharge, the speed of tritium generation could be increased by two order, in comparison with reference background values. At imposing on a surface metals of the magnetic field, perpendicular to a surface, with an induction 0,002-0,02 T, the speed of tritium generation was more increased, exceeding background quantity by three - four order.

Using the original technique distinguished by increased of value energy of colliding atoms and density of current, we have reached of steady tritium generation rate at a level about 10^9-10^{10} atom/s. Thus an error of measurement of the tritium contents in tests did not exceed ±50%.

Nuclear character of the tritium generation at interaction of hydrogen isotopes with a metals surface in plasma of the glow discharge specify the following features which have been found out in similar experiments:

1. The tritium generation does not depend on temperature.
2. The tritium generation depends basically on parameters of experiment describing power interaction of hydrogen isotopes.
3. The tritium generation rate has precise dependence on nuclear number of the bombarded material by ions of hydrogen isotopes from plasma of the glow discharge.
4. At transfusion of hydrogen isotopes through a metal wall in conditions of the discharge, contrary to diffusion isotope effect, the heavy tritium collects behind a membrane, instead of before it.
5. The tritium output from a sample - cathode of the glow discharge at the expense of electro-migration is insignificant, as in metals, used by us, the hydrogen was in partially ionized condition, with a positive charge.

Fr10

The LENR-CANR.ORG Website, Its Past And Future

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The LENR-CANR-org website has proven to be a popular source of information about cold fusion. This site has distributed more full text papers about LENR than any other source. In addition, it contains many features that allow easy search and insertion of the discovered references into a document. Now the site will allow access to a new journal that will focus on the subject of low energy nuclear reactions.

Mo06

Nuclear emissions from materials, including hydrogen and deuterium, induced by laser beam

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The emission of nuclear particles (protons, deuterons, neutrons and α-particles) was detected as a result of irradiation of different targets, including hydrogen and deuterium (TiH_x, TiD_x, CH_2), by powerful laser beam. Charged particle emission was measured by plastic track detector CR-39 with filters of different thickness. Activation detectors based on In were used for the measurement of neutron emission.

The measurements with the targets including H(D) shown, that the proton (deuteron) emission is anisotropic and may be caused by acceleration of the particles of plasma, produced on the target surface as a result of laser beam influence. It was shown, that the main part of particles ($\sim 10^{11}$ sr^{-1} per one impulse) accelerated up to the energies less than 0.8 MeV.

The protons with the energy 3 MeV and neutrons ($\sim 10^4$ per one impulse into 4π sr), which may be the products of dd-fusion, were detected in the case of TiD_x target.

The emission of α-particles with the energies $E_\alpha > 10$ MeV ($\sim 10^4$ sr^{-1} per one impulse) was observed for the crystal targets (TiH_x, TiD_x). This emission was not detected in the case of CH_2 target.

The emission of ions with $A > 4$ ($\sim 10^4$-10^5 sr^{-1} per one impulse) was also detected. The energy of this ions, estimated by the filter thickness, $\sim E_i > 3$ MeV/nucleon.

The mechanism of the charged particle emission may be explain by the acceleration of plasma particles on the target surface resulted from the influence of the laser beam.

Mo03

Phenomenon of an Energetic Charged Particle Emission From Hydrogen/Deuterium Loaded Metals

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The new phenomenon of energetic alpha (up to 16.0 MeV) and proton (~1.7 MeV) emissions has been discovered from a metal surface possessing a large affinity for hydrogen and loaded/excited by electrolysis, glow discharge or powerful laser [1,2]. Earlier we employed dE-E SSB detectors and showed that the alphas with energy ranging 8-14.0 MeV are emitted during exothermic deuterium/hydrogen desorption from Au/Pd/PdO:H(D) samples [1]. New insight was recently obtained from the use of CR-39 track detectors to the study energetic particle emissions from the surface of Pd/Ti loaded with hydrogen/deuterium [2]. Experimental runs with CR-39 to detect long-range alpha-particles *in-situ* during electrolysis of Pd/dielectric substrate cathodes showed energetic alphas ($9.0 < E_\alpha < 16.0$ MeV) yield $N_\alpha \sim (2\text{-}5)\times10^{-4}$ s^{-1}-cm^{-2} Pd in 4π-ster. accompanied by emission of ~ 1.7 MeV protons.

Recently, more powerful excitation conditions were employed in experiments with Ti and Pd foils during glow discharge deuterium/hydrogen implantation and also with picosecond laser irradiation of H/D-loaded metal targets. The yields of charged particles (DD-reaction products and energetic α-particles) were studied in a pulsed deuterium glow discharge with a Ti-cathode at a low discharge voltage (range 0.8-2.5 kV) and a high current density (300 – 600 mA/cm^2). Long-range alphas with energy E > 10.0 MeV along with protons/deuterons (E ~1.5-2.0/2-2.8 MeV) were observed, very similar to the emission found in electrolysis runs. The yield of the alpha-emission ($N_\alpha \sim 0.2$ s^{-1}-cm^2 Ti in 4π-ster.) in the glow discharge was found to be 3 orders of magnitude lager than that in the electrolysis runs with a Pd cathode.

The emission of nuclear particles (protons, deuterons, neutrons and alphas) was also detected during irradiation of 30 μm-thick TiH_x and TiD_x foils with a powerful picosecond laser beam ($I= 2.0\text{x}10^{18}$ W/cm^2, λ=1.053 μm). Note that various cover foils were employed with the CR-39 to distinguish alphas from the other electrostatically accelerated charged particles also generated in laser shots. The main component of emitted particles consisted of protons/deuterons ($N_p \sim 10^{11}$ sr^{-1} per pulse) accelerated up to the energy $E_p \leq 1.0$ MeV. The emission of α-particles ($10 < E_\alpha < 16$ MeV, $N_\alpha \sim 10^4$ sr^{-1} per pulse) was detected in TiH_x, and TiD_x foils. Such emission had not been observed in the experiments with solid (non metal-hydride) targets.

These various experiments on charged particle detection show a remarkable feature, namely all exhibit a similar specific energy yield of long-range alphas (1 alpha particle per 10-15 eV input energy/Pd(Ti) target atom) independent of the excitation power of delivering method (electrolysis, glow discharge or laser irradiation). This result suggests the mechanism of energy transfer causing the energetic particle emissions in hydrogen loaded metal targets is similar despite the seemingly dissimilar excitation techniques.

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Transmutation Effects In Glow Discharge Hydrogen Experiments

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The possibility of chemical and isotope structure change of the materials by low energy glow discharge ions on the cathode was studding during 1989-2003. The different mass-spectrometry methods (SIMS, SNMS, ITMS) and EDS were used with various depth and arias of analyses. Mainly results were made on Pd and its alloys.

The increase of impurity elements quantity of in tens and hundreds times was observed. The general addition of impurity elements achieved from 0.1at. % into ~5 at. %.

Maximal addition of the impurity elements quantity was observed for Ag and Cd, as elements with close nuclear numbers (up to several percents). Smaller increasing was observed in Sn, Ti, Fe, Br, Sr, and Tc/1,2/. The changes of isotope natural ratios in the material structure were from several percents up to tens and hundred times /2/.

The enormous disparity in the isotope ratios was observed by TIMS for such elements as Mg, Si, K, S, Ca, Fe (Table 1) after deuterium glow discharge in Pd. It is necessary to note that C, Mg, Si, S, Sc, Co, Co, Sn, Cd, Ba, Cs were not detected in the Pd before experiments (< 10 ppm).

Mass	Element	Natural abun, %	Pd cont, Puls./sec	Pd after Puls/sec	Natural ratio	Experimental ratio	Disparity	Δ, Pulses/ second
1	2	3	4	5	6	7	8	
24	Mg	78.99	0	50/800	24/25/26 ~ 8/1/1	24/25/26 =12/1/0.5	> into~ 1.5 times 24 Mass; > 26 into~ 2 times	+800
25	Mg	10	0	0/67	25/26			+676
26	Mg	11	0	0/38				+38
28	Si	92.23	0	100/>100	28/29~20	28/29~0.16	< into 125 times	+100
29	Si	4.67	0	630/1 000				+1000
30	Si	3.1	0	220/500	28/30~30	28/30~0.5	<into 60 times	+500
40	Ca	96.86		1 000 000	Ca40/44= 50	40/44=5	< into 10 times	
42	Ca	0.6	3000	200 000	Ca44/42~ 3	44/42=0.025	< into 100 times	+197000
43	Ca	0.15	200	~4 000	Ca44/42 ~13.3	44/42= 1.25	< into ~10 times	+3800
44	Ca	2.0	1000	~5 000				+4000
45	Sc	100	0	200			0 background	+200
46	Ti	8	65	1300	46/48~1/10	46/48~1/5	< into ~2 times	+1235
47	Ti	7.3	95	0				-95
48	Ti,	73.8	1000	7 000				+6000
56	Fe	91.7	2800	4 500	56/57~50	56/57~18	< into ~3 times	+1800
57	Fe	2.2	50	250				+200
59	Co	100	0	1500				+1500

The maximum of isotope ratios disparity after experiments with using TIMS analysis was for Si (28/29, 28/30 into 60-120 times), for Mg 24/25/26 into 10-20 times, for Ca 40/44 into 10 times, for Ca 44/42 into 10times, for Ga 69/71.5 to 5 times. The Ag, Cd, Sn, Sc, Co, Sr, Te, Mg, Si were observed for mostly experiments.
H.Hora and G.Miley in predicted the maximal Mg, Si, Ag and Cd production /3/.
An attempt to explain the nuclear transformation (transmutation) as reaction of fusion and fission, which are going simultaneously, were made. The balance of impurity elements in such kind reactions:

$d + {}_{46}Pd^{108} \rightarrow {}_{12}Mg^{27*} + {}_{34}Se^{82} + p + 11.5$ MeV; ${}_{12}Mn^{27*} \rightarrow$ 9.45M: β^{+}1.75, 1.59:· ε:·γ 843.8, 1014.4 $\rightarrow {}_{13}A^{27}$

$d + {}_{46}Pd^{105} \rightarrow {}_{14}Si^{27*} + {}_{33}As^{80*} + 8.86$ MeV; ${}_{14}Si^{27*} \rightarrow$ 4.14 S: β^{+} 3.85:γ 665.9 $\rightarrow {}_{13}Al^{27}$;

$d + {}_{46}Pd^{110} \rightarrow {}_{12}Mg^{28*} + {}_{33}As^{80} + \alpha + 9.15$ MeV; $d + {}_{46}Pd^{106} \rightarrow {}_{14}Si^{28*} + {}_{33}As^{80*} + 16.5$ MeV;

$\alpha + {}_{46}Pd^{108} \rightarrow {}_{14}Si^{30} + {}_{34}Se^{82} + 14.9$ MeV was made. But it was impossible to explain all additional elements by this way.

So, the transmutation or transformation of nucleus under stimulation by low energy electromagnetic, magnetic fields or under any gradient (stress, voltage…) are going always for solid state in the not equilibrium systems .

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Th08

Low Voltage Nuclear Transmutation

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Work is progressing to demonstrate nuclear transmutation of solid material at low voltages by using EVs in a small reactor. Monitoring with an ion trap mass spectrometer follows the course of the reactions produced. The mass spectrometer used is very simple to make and operate and the details of both it and the reactor will be shown.

Th16

Analysis of Ni-Hydride Thin Film after Surface Plasmons Generation by Laser Technique

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Abstract

A nickel-hydride thin film was studied by the Attenuated Total Reflection (ATR) method: when a light wave, under certain conditions, propagates along a layered structure containing a metal layer, a reflectance minimum could be observed instead of total reflection. The reason is the coupling between the light wave and the electronic surface plasma of the metal, giving rise to the surface plasmon resonance. The differences between a "black" film and a pure nickel film (blank)" behaviour are showed. The black Ni-hydride film has been obtained by a short electrolysis with 1 M Li_2SO_4 electrolyte in light water. A shift in the minimum of the observed reflected light occurs, together with a change in the minimum shape, i.e. its half-height width increases. This two phenomenon are due to the change in the electronic band structure of the metal induced by the electron added in the lattice by hydrogen. The charging of the electronic structure, revealed by the laser coupling conditions, leads to consider that an hydride phase was created. The specimen was taken under He-Ne laser beam at the reflectance minimum angle for about three hours.

A SIMS analysis was also implemented to reveal differences between the blank and black films.

Th15

How to Make A Cheap and Effective Seebeck Calorimeter

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ABSTRACT

The Seebeck calorimeter is very effective in measuring heat generation over a wide range of power and with high sensitivity. Such a device can be constructed cheaply and easily, although with considerable investment of time. A successful example is described.

Tu04

Use of a very sensitive Seebeck calorimeter to study the Pons-Fleischmann and Letts Effects

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Characteristics of a commercial Seebeck calorimeter are described. This very stable instrument is applied to a study of the Pons-Fleischmann effect using a palladium anode and a platinum cathode (sic). The use of a laser to stimulate anomalous heat production (The Letts Effect) is also described. Positive results were obtained for both effects and these reveal important aspects of the nuclear-active-environment.

Mo17

What are the conditions required to initiate the LENR Effect?

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Accumulating evidence indicates that previous understanding of the environment in which the P-F effect occurs is wrong. The environment is not highly loaded beta-PdD. Instead, it is a complex alloy that may or may not contain palladium. In addition, the size of the domain in which the nuclear reaction takes place is critically important. This new insight requires different explanations and experimental approaches than have been previously used.

Fr08

Cavitation And Fusion

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Taking advantage of the natural cavitation phenomena, we have adapted it to initiate DD fusion events. The transient cavitation bubble, TCB, has been harnessed to produce high energy densities, 10^{24} D/cc. An acoustically driven piezo device filled with D2O produces TCBs that act like micro accelerators implanting deuterons into a target foil producing ^{4}He from the Pd foil and T from the Ti foil. As a tangent technology to emergent sonoluminsecence technology, it gives us an environmental probe into the bubble contents. (Sonoluminescence studies center on the pulses of photons coupled to the irradiating acoustic field emanating from an oscillating single stable cavitation bubble, SSCB.)[1] The generation of these photons relates to the conditions that produce ^{4}He and T in our piezo reactors. We are studying the effects of frequency on multi TCB sonoluminescence conditions that produce fusion. This process, the experiments, and the analytical methods have concentrated on the mass spectroscopy of reactor gases, calorimetry of the reactor and power supply, and the scanning electron microscope photographs of target foils [2]. The results from many experiments produce a plausible path for the TCB that terminates with deuterons implanting into a target with the resulting fusion events.

TCB sonoluminescence is used as a tool indicating the presence of the bubble content dissociation during its adiabatic collapse process. It is of importance for the bubble contents in this transient environment to be dissociated as a high density, low energy plasma. If a condition exits for photon production during the collapse process, then fusion events from the implanting jet will follow.

The jet t accelerates (launched from the TCB collapse) toward the target foil as a plasma and is compressed as the z-pinch of the plasma electrons and sheath electrons, further increasing the jet density. The number of deuterons in the jet plasma is in the order of 10^{9}. The lifetime of the implanting jet plasma is a few pico seconds.

Studies of multi TCBs' sonoluminescense at higher temperatures (300 –450ºK), pressures (106 – $10^{7.5}$ dynes/cm^{2}) and frequencies (.02- 1.5MHz) are proceeding in a search for better fusion environments. The results of these experiments will be presented.

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Mo13

Excess Heat from Low Electrical Conductivity Heavy Water Spiral-Wound $Pd/D_2O/Pt$ and $Pd/D_2O\text{-}PdCl_2/Pt$ Devices

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Spiral-wound palladium cathodes, similar to devices previously reported made of nickel loaded from both light (1) and heavy water (2), were immersed in low electrical conductivity D_2O [with no additional electrolyte and with 8.2 mM $PdCl_2$ in codeposition mode (3)], and electrically polarized against a platinum anode. They were examined for heat production using multiring thermal spectroscopy with joule controls (1) using different anodic and system configurations.

These devices [cathode volume ~0.47 cm^3, area ~6.4 cm^2] yield significant excess heat after full loading, with a peak excess power production circa 1.5 Watt, and a peak electrical power gain of ~2.4, depending upon loading rate, loading achieved, and confinement time. We report separate optimum operating and peak excess heat production points at which the power generated and excess heat production are each maximized, respectively, along the input electrical power axis.

The Palladium $Pd/D_2O/Pt$ devices demonstrate a critical input electrical current density circa $1.5^{+/-0.3}$ milliamperes/cm^2, and a possible activation energy of ~60.7 kilojoules/mole.

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Tu06

Photoinduced Excess Heat from Laser-Irradiated Electrically-Polarized Palladium Cathodes in Heavy Water

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The photothermoelectric response of optically-irradiated [670 nm laser, ~3.5 milliwatts] spiral-wound electrically-polarized palladium cathodes (1,2,3) in very-low electrical conductivity heavy water was examined. An incremental photoinduced excess heat of $\sim 89^{+/-16}$ milliwatts results from a ~3 milliwatt incident optical beam. This photoinduced excess heat may be a lower limit because optical path geometry, irradiated cathodic area, impact of formed bubbles, and skin depth penetration, have not been fully addressed.

The behavior of active loaded cathodes to coherent optical irradiation depends on the input electrical power and the prehistory of the cathode prior to optical irradiation. Although the system yields excess heat (1) both with, and without, optical irradiation of the cathode, photoinduced excess heat is observed only in the presence of a functioning active loaded cathode.

The power gain has a curious photothermoelectric response. Optical irradiation of the pericathodic volume and surrounding solution produces a photoinduced decrease in the Pt/D2O/Pd electrical resistance [55 Kohm to 51 Kohm]. There follows a photoinduced decrease of the power gain, which is noticeable at higher input electrical power levels (2.4 to 2.3, for 1.3 watts input). This decrease in the power gain heralds conduction/polarization pathways which lead away from some desired reactions.

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We04

Polarized D^+/Pd-D_2O System: Hot Spots and Mini-explosions

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Abstract

Two types of activities occurring within the polarized D^+/Pd-D_2O system, viz. the presence of localized heat sources (hot spots) and associated with them mini-explosions, are described. The "birth and death" of hot spots is monitored by IR imaging while the mini-explosions are displayed by the voltage spikes exhibited by a piezoelectric substrate onto which a Pd/D film was co-deposited. Processes leading to the formation of unstable domains as a precursor to the observed behavior are examined.

Tu22

Mechanism of Deuteron Cluster Fusion by EQPET Model

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The model of tetrahedral and octahedral resonance fusion under transient Bose condensation of deuteron cluster at PdDx lattice focal points was proposed[1)] at ICCF9. To make quantitative estimation for modeled reaction process, the electronic quasi-particle expansion theory (EQPET) was proposed[2)] to formulate mathematical equations and some numerical results were given. Calculated results, based on the single particle approximation for e* electronic quasi-particle states, revealed that dde*(2,2) transient molecular state had fusion rate of 10^{-20} f/s/2Dpair and 10^{-17} f/s/4D-cluster. Strong enhancement of 8D cluster fusion was also speculated by octahedral condensation. It was concluded that major reactions were 4D cluster fusion to produce two 23.8 MeV ^{4}He-particles and 8D cluster fusion to produce two 47.6 MeV ^{8}Be-particles. These high energy charged particles would make secondary transmutation reactions[3)], including fission, with metal elements and heavier sample elements.

The present paper makes deepened modeling for the mechanism of transient Bose-type condensation for 4D and 8D clusters with electrons from Pd 4d-shell. Formation of quadruplet e*(4,4) quasi-particle and octal-coupling e*(8,8) around lattice focal points with D-clusters is modeled and discussed. Modal fusion rates which are composed of 2D, 3D, 4D and 8D fusion rates with characteristic values for mode are estimated for the tetrahedral and octahedral symmetric condensations. Based on given modal fusion rates we can estimate macroscopic cluster fusion rates (f/s/cc) by knowing time-averaged values of D-cluster densities. Several w/cc level fusion rates for 4D and 8D can be foreseen with major ash of ^{4}He and secondary transmutation, and neutron production rate by 2D fusion will be with 10-12 orders smaller magnitude than that of ^{4}He production. Neutrons are therefore hardly visible in deuteron cluster fusion in condensed matter.

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(Proceedings of JCF4 can be downloaded from http://www.eng.osaka-u.ac.jp/nuc/03/nuc03web/JCF/)

We03

Studies on 3D Fusion Reactions in TiDx under Ion Beam Implantation

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This is a review of our experimental studies for about 10 years on detection of three-body (3D) deuteron fusion in TiDx samples using low energy ion beam irradiation.

If there exits a linkage between nuclear reaction (nuclear physics) and electron behaviors in condensed matter (condensed matter physics), a new class of nuclear reactions in condensed matter may be induced under certain conditions of lattice dynamics with low particle energy. Since 1991, we have studied possible occurrence of very enhanced multi-body deuteron fusion in metal deuteride samples under low energy deuteron beam irradiation, because of our speculation that the order of atoms and electrons under transient motion around lattice focal points should enhance very much three-body fusion process, compared with random nuclear reactions.[1-3)]

With certain conditions for target-samples and beams, we could have identified specific particles (e.g., 4.75MeV tritons and ^{3}He-particles, and 15.9 MeV deuterons) from 3D fusion reactions with yield ratios [3D]/[2D] to be in the order of 1E-4 to 1E-3, in contrary to the calculated [3D]/[2D] yield ratio of 1E-30 by the conventional random nuclear reaction theory[2,3)]. The increasing trend of yield ratios in lower energy region than 100 keV for deuteron[4)], suggests that the enhanced 3D reactions were not attributed to the direct reactions with incident d-beam, but to the indirect 3D fusion out of the slowing down range of beam.

Our experimental results suggest that there exists strong screening effect on Coulomb repulsive force of d-d interaction by transient "electronic quasi-particles[5)]" to enhance very much 2D and 3D fusion reactions ,and even 4D fusion reactions.

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Tu25

Quantum States of Deuterons in Pd

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Deuteron is regarded as boson because it consists of a proton and a neutron. In 1990, Bush and Eagleton discussed the boson tendency of deuterons by hypothetical model for the deuteron clusters in Pd [1]. They assumed the attractive force, which is called symmetry force, to explain the cold fusion in Pd. In 1995, we expanded the Bush's theory to the potential field including d-d repulsion [2]. In 1996, Kuangding and Shanna discussed the effect of sudden contraction of cuboid well and Bose-Einstein condensation (BEC) in it [3]. They obtained the transition temperature of BEC as a function of the number of the condensed deuterons in the well. The possibility of cold fusion induced by BEC was examined in their study. In 2000, BEC of charged bosons are discussed in the theory of Kim and Zubarev [4]. The equivalent linear two-body (ELTB) method based on the reduction of many-body problems by the variational principle was used for the trapped deuterons in ion trap device. They assumed harmonic potential for the ion trap and obtained the solution of ELTB equation.

This study focused on the defect clusters in Pd, because they are quite similar to the ion trap device. They can trap many deuterons around the minimum point of the potential, which is regarded as the harmonic one. Cold fusion in Pd defect cluster induced by BEC has been examined here using Kim's method [4]. When deuterons in the free space enter into the Pd lattice, the potential around the deuterons suddenly changes. In order to account this effect, recent work of Kim and Zubarev for the effect of time-dependent harmonic potential [5] has also been used. Their problem is a sudden expansion of the harmonic potential, while this work treats the sudden contraction. This work shows that BEC caused by the sudden contraction of the potential induces the cold fusion in Pd.

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We05

Excess Heat In Molten Salts Of (Licl-Kcl)+(Lid+Lif) At The Titanium Anode During Electrolysis

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The electrochemical cell and technique of realization of precision calorimetric measurements is developed.

Experiments with molten salts containing of deuteride lithium are carried out. During experiments made calorimetric measurements on the titanium anode. Measurements made in an inert atmosphere of helium and in an atmosphere of deuterium at various density of a electrolysis current. It is revealed excess heat on the titanium anode in an atmosphere deuterium at electrolysis. It is made the roentgen-phase analysis of the used titanium anode. The analysis of the received results is resulted.

Th33

Possibility Of Using Of Cold Fusion For Nuclear Waste Products Transmutation

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Abstract

The possibility of using of cold fusion for nuclear waste products transmutation is investigated in this paper. In generally a method is based on saturation of the titanium by a mixture of deuterium and air. Possible nuclear fusion reactions are discussed. Their "burning out" sections, effective half-life periods and intensity of neutron beams are evaluated. Applicability of the method for a transmutation of the nuclear waste containing Cesium -137 is considered.

Search for Nuclear Ashes in Electrochemical Experiments.

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Abstract

Electrochemical experiments have been carried out in order to identify traces of nuclear processes occurring in condensed matter. The experimental activity was mainly focussed on reducing the noise by working within high cleaning condition to eliminate contamination effects. The working conditions employed allowed to obtain a clear signals from the investigated phenomena.

Neutron activation, SIMS and high resolution Mass Spectrometer analysis all produced experimental data significantly exceeding the measurement error and well above the detection limits of the instruments. The isotopic abundance has been studied for some elements and a strong difference as been observed between experimental data and natural values. In addition a correlation has been observed between the shift of the isotopic composition and a weak emission of X-rays.

This work was performed within the framework of the ongoing collaboration between ENEA and SRI to resolve outstanding issues of solid state nuclear science.

Study of Lattice Potentials on Low Energy Nuclear Processes in Condensed Matter

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The mounting evidence that soft X ray and energetic particles are revealed during experiments encouraged us consider that lattice potentials may play a significant role in the nuclear processes occurring in condensed matter at low energy. Local potentials in the order of the energy of the observed soft X ray have been considered to modify the interaction potential, between charged particles in condensed matter, for the Gamow factor calculation.

In previous works [1,2], some of the authors, on the basis of a theoretical study highlighted the possibility to have energetic ions (H and/or D) in metal lattices loaded with hydrogen isotopes; ions having energy in the order of some KeV may be considered as "shot particles".

An estimate of an effective short range screening distance for a shot proton has been carried out by comparing the Gamow factor values obtained with the modified and unmodified potentials. The results of calculation suggest a strong enhancement of the tunnelling probability and a significant proton capture reaction rate. In some cases that will be discussed, this prediction indicates an agreement with the experimental data reported in the literature.

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Successful Experiments Of Utilization Of High-Activity Waste In The Process Of Transmutation In Growing Associations Of Microbiological Cultures

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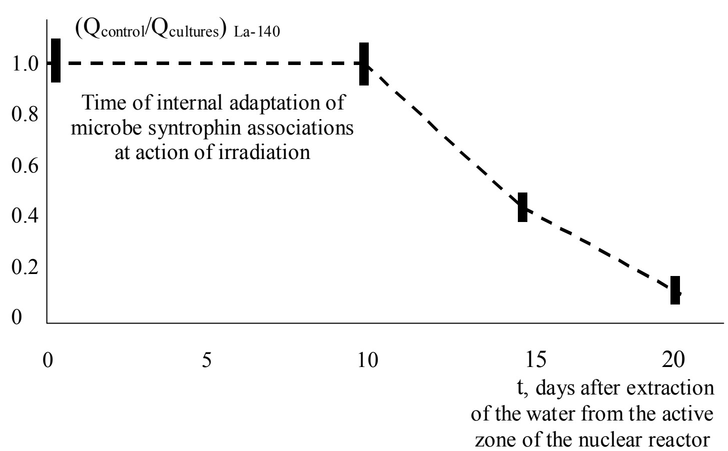
In the work for the first time has been studied the process of direct utilization of highly active waste by the way of their transmutation to non-radioactive isotopes by microbiological systems. Nuclear transmutation of several kinds of radionuclides by the special "microbial catalyst-transmutator" has been investigated. The "microbial catalyst-transmutator" represents special granules that include: concentrated biomass of metabolically active microorganisms, sources of carbon and energy, phosphorus, nitrogen, etc., and gluing substances which keep all components in the way of granules stable in water solutions for a long period of time at any external conditions.

The base of the "microbial catalyst-transmutator" are microbe syntrophin associations that contain many thousands kinds of different microorganisms that are in the state of complete symbiosis. These microorganisms appertain to different physiological groups that represent practically whole variety of the microbe metabolism and relevantly all kinds of microbe accumulation mechanisms. The state of complete symbiosis of the syntrophin associations results on the possibility of maximal adaptation of the microorganisms' association to any external conditions changes (including utmost aggressive environments and effect of highly active ionizing irradiation). Typical reaction of the association for such aggressive effects demands the existence of some time for internal adaptation. This time is necessary for mytagene change of 5-10 generations, that corresponds to several days. During this time occurs a purposeful synergy process of stimulation of the mutant formation of such microorganisms, which are maximally adapted to the changed aggressive conditions. This "microbial catalyst-transmutator" is able to develop actively, for example, in the water with very high specific activity [1], while ordinary, not radiatively stable, monocultures die in such environment very rapidly.



The research has been carried out on the basis of distilled water from first contour of water-water atomic reactor of Kiev Institute of Nuclear Research. The water with total activity about 10^{-4} Curie/L contained highly active isotopes (e.g., Na^{24}, K^{40}, Co^{60}, Sr^{91}, I^{131}, Xe^{135}, La^{140}, Ce^{141}, Np^{239}).

In our experiments "microbial catalyst-transmutator" was placed in the glass flasks with 10 ml of water from the atomic reactor.

In contol experiments the same radioactive water but without "microbial catalyst-transmutator" was used.

The cultures were grown at the temperature 25^0 C. Activity of all flasks has been measured every 5 days. For the first time we have observed fast utilization of several kinds of highly active isotopes to nonradioactive nuclei in the flasks that contained "microbial transmutator". The results of invistigation of the activity of the same reactor La^{140} isotope in the experiment on transmutation (activity is $Q_{cultures}$) and in the control one ($Q_{control}$) are presented on the figure. Initial activity of the La^{140} isotope (on 10th day after extraction from the from the active zone of the nuclear reactor) was about $Q=10^{-7}$ Curie/L. In these experiments nonexponential and oscillating decay of some isotopes (e.g., Co^{60}) during all time of investigation also was observed.

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The Theory And Experimental Investigation Of Controlled Spontaneous Conversion Nuclear Decay Of Radioactive Isotopes

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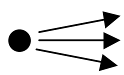
In our previous investigations the phenomenon of controlled gamma-channel of spontaneous decay was studied by the indirect methods of intensity [1] and spectral width [2] measurements of the emitted gamma-radiation and by the direct method of delayed gamma-gamma coincidence [3]. In these experiments we have discovered the change (increase) of radiative lifetime of radioactive nucleus Fe^{57*} by 10-40 % (in relation to resonant Mossbauer gamma-channel of decay) and total lifetime (including non-controlled non-Mossbauer gamma-radiation and non-controlled electron conversion channels of decay of an excited nucleus) by 1%. The outcomes of the experiment correspond to the predictions of the controlled gamma-decay theory [4].

1) Nuclear conversion decay in free space

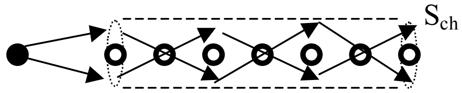
$\rho_e = (2\int d^3p \int d^3x)/V_0(2\pi\hbar)^3 = mp/4\pi^3\hbar^3$



Possible states of conversion electrons in free space

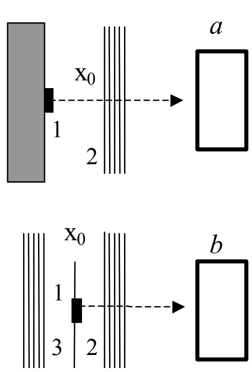
2) Nuclear conversion decay near crystal axis

$\rho_{ch} = (m/2p\hbar S_{ch}\sqrt{\pi})$



States of conversion electrons at axial channeling in crystals

The paper discusses the theory of another process (control of internal electron conversion channel of spontaneous decay of radioactive isotopes) and results of direct experimental investigation of this phenomenon. The channel of electron conversion is the main one during process of spontaneous decay of Mossbauer nuclei. For the first time we have created the theory of influence on the probability of internal electron conversion decay of radioactive isotopes. We have considered the general system, which included the excited nucleus, the system of electrons of this nucleus and the crystal matrix. The phenomenon of spontaneous nucleus decay controlling is a result of interaction of the excited nucleus with atom conversion electrons and also interaction of these fast electrons with the atoms of controlled and controlling crystal matrix during process of electron channeling and Bragg diffraction. The probability of conversion channel of nuclear decay is proportional to density of final electron states. It was shown that parameters of internal electron conversion decay greatly depend on structure of crystal matrix and on distance from excited nucleus to crystal matrix. It is the result of different density of final electron states in free space (ρ_e) and in the case of presence of crystal axis or plane (ρ_{ch}).



The aim of present experiments was to investigate the controlled internal electron conversion channel of decay of the same radioactive $Co^{57}(Fe^{57*})$ isotope. Investigated isotope source 1 was covered by very thin (thickness less 40 microns) perfect crystal 2 (not containing of Fe^{57} isotope nuclei) or was put in the space between two thin parallel perfect crystals 2 and 3 with controlled inter-crystal distance x (slot). In the experiments we have discovered inhibition of the conversion channel of nuclear decay by 7-10% and the change (increase) of total life-time of radioactive Fe^{57*} isotope by 6-9 % at optimal size x_0 of slot.

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Tu21

Excess Heat in Heavy Water--Pd/C Catalyst Cathode (Case-type) Electrolysis at the temperature near Boiling Point

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Les Case's famous Pd/C catalyst cathode electrolysis[1] was repeated in 2002, and reported in ICCF-9.[2] The huge surface area in the activated carbon catalyst generates a lot of Pd thin film on its surface. There is about 1000 square meters surface area for each gram of palladium-coating activated-carbon catalyst, and 15 grams of catalyst were used in our experiments. It is believed that this huge area of Pd surface facilitates not only the repetition of these series of experiments, but also the loading of deuterium into the Pd thin film. Usually, we need not wait a week in order to observe the "excess heat". We have observed the "excess power" is in the order of 0.15 W while the input electrical power is about 0.5-0.7 W, and the temperature of the electrolyte is about the room temperature.

We intended to enhance the "excess power" in terms of raising the temperature of the electrolyte, because we believe that at higher temperature the deuterium flux might be enhanced. The correlation[3] between the deuterium flux and the heat flow might imply a greater "excess power". This was the motivation to do the Case's experiment at higher temperature. Based on the experiment of "heat after death" and "after heat", we were supposed to observe this greater "excess power" as well.

A thermostat were used to raise the temperature of the water bath to near the boiling point of the heavy water; then, we run the Case-type Pd/C catalyst cathode electrolysis for both the heavy water and the light water. We would like to observe that the "excess power" drives the heavy water to the boiling point while the light water keeps quiet.

We have to solve the new problems related to the higher temperature electrolysis: the vaporization becomes so rapid that the water level drops, and changes the heat transfer coefficient. When we reduce the exit for gas to reduce the vaporization, the mixture of deuterium and oxygen becomes another problem. A diaphragm is used to separate the cathode and anode. Then, the temperature distribution inside the electrolysis cell becomes a new problem. Thus the first thing to do is the calibration for an inhomogeneous system. It is assumed that even if in an inhomogeneous system, there is still a constant heat transfer coefficient provided that the inhomogeneous system keeps its linearity in response to the heating power. This assumption has been confirmed by the experimental data both in the light water cell and the heavy water cell.

In the preliminary operation, we have observed the "excess power" again at higher temperature. This "excess power" is higher than that in the room temperature. The updated results will be reported.

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Tu17

Analysis by Time-of-flight Secondary Ion Mass Spectroscopy for Nuclear Products in Hydrogen Penetration through Palladium

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Mitsubishi group has reported observation of elements production in deuterium permeation experiment with a multiplayer palladium (Pd) film [1]. They showed a certain rule of nuclear transmutation, that is, 8 mass number and 4 atomic number increase in the process. This method has an advantage of minimizing contamination to the palladium sample, which is preferably used in investigating small amount of elements. We have performed the similar method to theirs using hydrogen with Pd foil and have searched for nuclear products as a result of low energy reaction.

The Pd foil sample (0.1x12.5x12.5 mm) was washed by aqua regia and set up into a holder placed between an upper and lower stream chambers. Hydrogen gas was introduced into the upper chamber with the pressure up to 1-10 atm, and it moved downstream passing through the sample. The lower stream chamber was evacuated to prevent the Pd sample from being contaminated from the atmosphere. After the hydrogen gas penetration for two weeks, the sample was taken out and the gas remained in the sample was unloaded. We have analyzed the sample surface by time-of-flight secondary ion mass spectroscopy and have compared the composition of the sample before experiment with that after experiment to search for newly produced elements during the gas penetration process

Considerable increase of the counts for Cr, Fe, and Cu were found after the experiment. Mn and Ni were also detected on deeper regions after Ga ion sputtering for 10s. We did not see significant difference in the mass spectrum for every analyzed area. In the isotopic ratio of Cr, difference from the natural one was observed in one of the three analyzed areas of a sample. While almost no change in isotopic ratio was seen for other four elements. The results have strongly suggested that all the five elements were produced by a nuclear transmutation and that the reaction could occur in hydrogen system as well as deuterium system.

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Thermal effects of hydrogen diffusion across metallic tubes

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Diffusion of hydrogen in metals and alloys is a focused subject in cold fusion studies; for example, it was found that anomalous heat and elements have been observed while hydrogen and/or deuterium diffusion across palladium, its alloys and multilayer [1,2]. However, we must exclude traditional phenomena in confirming the anomalous effects. In the paper, we will establish a model, which includes the enthalpy change in the reaction, the heat conductance, convection and temperature changes in the process, the dependence of diffusion coefficient of hydrogen on the temperature, and the self-stress effect; we will display the thermal effect while hydrogen diffusion across a metallic tube wall.

Considering a metallic tube with one end closed. At the initial time, the chemical potentials of hydrogen in the gas phase of outer and inner of tube, in the solid phase of tube wall are in equilibrated. When the outer hydrogen pressure increases suddenly, the tube will absorb hydrogen and this exothermic reaction makes the temperature of tube increase at the same time. When the diffusion flux approaches the steady state, the temperature of tube decreases slowly as shown in the figure. These results indicate that the conclusion of anomalous heat must be cautious in the hydrogen and/or deuterium diffusion experiments.

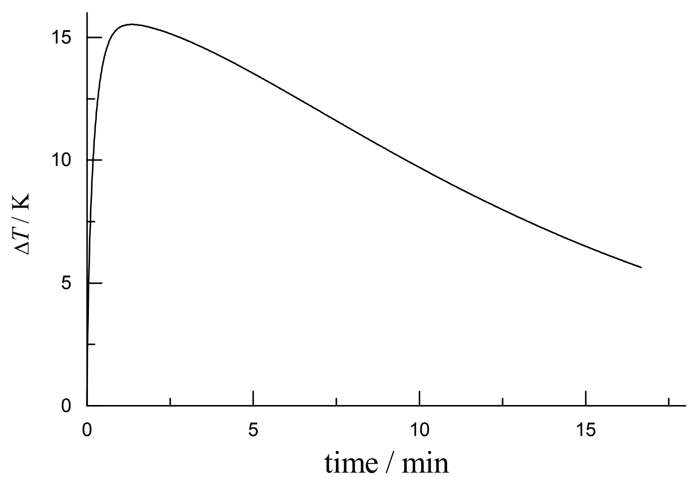

Figure. Temperature changes while hydrogen gas diffusion into a metallic tube.

This work is supported by NSFC Nos. 20103009, 10176030 & 10145006, and the Specialized Prophasic Basic Research Project (No. 2002CCD01900) of the Ministry of Science and Technology of China.

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Mo20

Anomalous heat absorption in closed Pd|D_2O electrolysis systems

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Since ICCF9, we have constricted all PTFE closed cells for Pd|D_2O electrolysis. The Pd cathode is a thin film (0.05 × 1.6 × 28 mm) or wire (ϕ0.2 × 20 mm) with the ends being point welded to Pt leads for resistance measurement, the deuterium content in the electrode was measured by resistance method using AC currents; the anode was Pt wires around the cathode, the electrolyte was 0.1 M or 1 M LiOD heavy water solution; the oxygen and deuterium gas produced during electrolysis were recombined by catalysts in the space above the electrolyte. The released heat was measured by a Calvet calorimeter as before [1,2]. The input current and voltage, Pd resistance, deuterium pressure, output power were acquired by and stored in a computer. To avoid the errors caused by the position of heater in the cell, the calorimeter was generally calibrated by reverse electrolysis.

7 runs of results are summarized in the Table. We find most of the output energies were less than the input ones as discovered before [2]. Because our system can give the heat balance in the error of 0.2% [2], so the heat absorption cannot be attributed to the measurement reasons. Although we cannot explain it up to now, it likes that the anomalous heat absorption is a general phenomena in sorts of systems [2–6]. It may be independent to the excess heat or a precursor for excess heat in Pd|D_2O systems.

No.	Pd	LiOD	Duration (second)	Input energy E_I (J)	Excess energy		
					E_E (J)	E_E/E_I	eV/atom Pd
1	film	0.1 M	68345	1,622	−60	−3.71%	−2.46
2	film	0.1 M	86860	2,495	−114	−4.58%	−4.67
3	wire	1 M	276800	6,579	−135	−2.06%	−19.7
4	wire	1 M	218750	14,143	+1	+0.007%	+0.146
5	film	1 M	742430	71,778	−1,245	−1.73%	−51.0
6	film	1 M	309440	38,563	−568	−1.47%	−23.3
7	film	1 M	896220	215,198	−3,779	−1.76%	−155

This work is supported by NSFC Nos. 20103009, 10176030 & 10145006, and the Specialized Prophasic Basic Research Project (No. 2002CCD01900) of the Ministry of Science and Technology of China. We thank Drs. Lesin, El-Boher and Tanya for their help on the construction of cell and other techniques.

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Th17

Loading ratios (H/Pd or D/Pd) monitored by the electrode potential

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Reproducibility is very important in cold fusion research. It is always caused by experimental condition, especially the working materials, which include constituent and fractions, state, and so on, during the operation. Loading ratios of hydrogen and deuterium in palladium electrode are such problems in electrolysis systems. It is the best that loading ratio could be accurately monitoring in-situ during experimental. The usual method for monitoring the ratio is the determination of relative resistance of palladium electrode. However, this measurement is always troubled in repeating the operation of the same system, because the relative resistance of palladium is irreversible during repeating measurement and there is no theoretical relationship between hydrogen concentration and relative resistance. Moreover, the measurement of relative resistance is not convenient because such technique needs four wires for working well. This technique was originally calibrated by the other, e.g. gravimetric method.

The electrode potential of palladium may be a good method for such determination. The research works about it were presented before. Most such works were still compared with the relative resistance.

The electrode potentials of palladium and the working voltages of electrolysis cell were measured during the charging and discharging processes after interruption of the water electrolysis in this work. The amount of hydrogen dissolved in palladium was determined by coulometric method during the process. It was found that the loading ratio (H/Pd or D/Pd) could be monitored with the electrode potential of palladium, even the working voltage of cell.

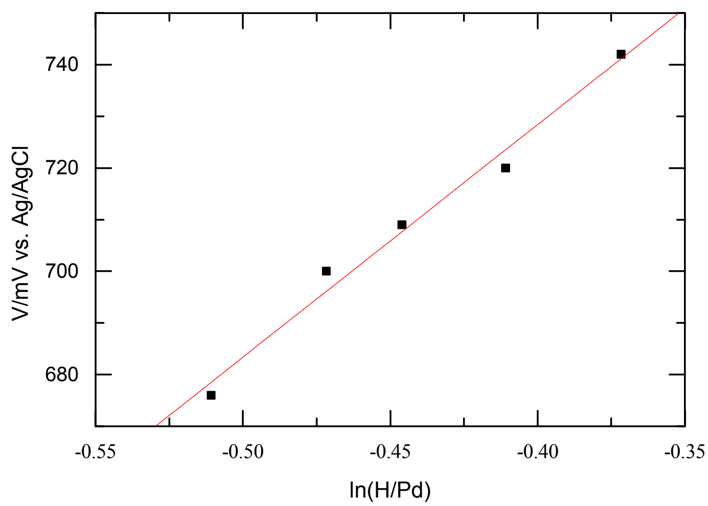

Figure. The electrode potential as function of hydrogen loading ratio

The results shown in the Figure are the electrode potential as a function of hydrogen content. We find the linear relation of electrode potential with the logarithm of loading ratio can fit these experimental data well.

This work is supported by NSFC Nos. 20103009, 10176030 & 10145006, and the Specialized Prophasic Basic Research Project (No. 2002CCD01900) of the Ministry of Science and Technology of China.

Th36

Bethe's Calculation for Solar Energy and Selective Resonant Tunneling Model

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Selective resonant tunneling model is a bridge connecting cold fusion and hot fusion. It has been successful to describe the hot fusion data in d+t fusion [1] , d+He-3 fusion and d+d fusion [2] using the selective resonant tunneling model, and it explains the "anomalous branch ratio" at low energy fusion reactions as well. We have used p+d hot fusion data to find the nuclear potential ($U_{1r}+iU_{1i}$) [3] ,and we use the same complex nuclear potential to explain the tritium production in the "sono-fusion" experiment (so called "bubble fusion" in Oak Ridge National Laboratory [4]). Now we intended to do the same study for the p+p fusion reaction.

The different point is that there is no p+p hot fusion data available for calculation of the complex nuclear potential; hence, we invoke the Bethe's theoretical calculation of solar energy[5]. In Bethe's early calculation of the solar energy, he won the Nobel prize because his calculation gave the correct power density comparable with the astrophysical observation (~2 erg/(s.g)). We may use his calculation as an indirect experimental data to fix the complex nuclear potential for p+p fusion. In Bethe's calculation, he used real nuclear potential for the strong nuclear interaction and a quantum field theoretical estimation for the weak interaction (positron emission by Fermi's theory). In the selective resonant tunneling model, an imaginary part of the nuclear potential is introduced to describe the weak interaction equivalently. Hence, we may use Bethe's calculation to fix the complex nuclear potential for p+p fusion reaction.

In Bethe's calculation, the temperature of the sun is about 2 keV, and the reaction channel is $p+p \rightarrow d+e^{+}+\nu_e$. However, in case of low energy (<< 1 eV), what would be selected by resonant tunneling for the reaction channel for p+p ?

In the Ni-H system, the tritium has been detected occasionally in the past 14 years, but we have never read any confirmed report about the 0.511 MeV gamma radiation which is necessary product of the positron annihilation ($e^{+}+e^{-} \rightarrow 2\gamma$). Therefore, we might assume that the $p+p \rightarrow {}^{2}He^{*}$ + phonon might be the dominant mechanism for the heat production in those Ni-H experiments.[6] Helium-2 might change into the deuteron through the K-capture process($p+p+e^{-} \rightarrow d$+phonon). Hence we are supposed to check the deuterium in the Ni-H system before and after the experiment.

Usually, the positron emission is faster than the K-capture process; hence, in normal cases, we expect to observe the positron emission in parallel with the K-capture process. However, selective resonant tunneling model for the low energy p+p fusion predicts that the dominant process should be the K-capture process instead of positron emission. This prediction is similar to those for d+d fusion and p+d fusion, where we did not observe any neutron and gamma radiation with the excess heat, or any neutron and gamma radiation with the tritium production.

A Kratzer potential is assume for the screened Coulomb barrier and the lattice well to facilitate the analytical calculation. The parameters for lattice well are based on the Morse potential given by S.E. Koonin[7].The Kratzer potential is connected to a square nuclear well through a shifted Coulomb barrier with a shift based on the adiabatic screening effect. [7] The complex nuclear potential is fixed based on the comparison with the Bethe's calculation. The preliminary result will be reported.

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