The 7th Meeting of Japan CF-Research Society

JCF7 ABSTRACTS

April 27-28, 2006

Kagoshima University

Japan CF-Research Society

Program of JCF7 Meeting
(Japan CF-Research Society)

Date and Place: April 27-28, 2006, at The Inamori Memorial Hall, Korimoto campus,
Kagoshima University, Kagoshima, Japan

Paper presentation: oral Presentation 20 min. + discussion 5 min.,
Language= English or Japanese

Abstract: only available at JCF home page

April 27, (Thu), 2006

9:00-9:50   **Registration**

9:50-10:00   **Opening Address** (Y. Takeuchi, Kagoshima U.)

Theory-1 (chairman: A. Takahashi, Osaka U.)

10:00-10:25   **JCF7-1**   S. Sasabe (Tokyo Metropolitan U.): Possibility of Control on Coulomb Potential

10:25-10:50   **JCF7-2**   K. Tsuchiya (Tokyo N. C. T.): Mechanism of Nuclear Reaction and Bose-Einstein Condensation in Solids

10:50-11:15   **JCF7-3**   T. Sawada (Nihon U.): Why an exotic particle is needed in understanding the nuclear cold fusion

11:15-11:40   **JCF7-4**   T. Sawada (Nihon U.): Extension of the Nuclear Physics to Include the Magnetic Monopole

-----**lunch**(11:40-13:00)-----

Experiment-1 (chairman: A. Kitamura, Kobe U.)

13:00-13:25   **JCF7-5**   K. Iizumi et al. (Yokohama N. U.): Energy Output and Material Balance During Plasma Electrolysis of Water

13:25-13:50   **JCF7-6**   H. Numata (Tokyo Institute of Tech.) et al. : Microscopic Structural Change during Repeated Cathodic and Anodic Electrolysis in Glycerin and Phosphoric Acid

13:50-14:15   **JCF7-7**   Y. Toriyabe et al. (Hokkaido U.): Analysis of Nuclear Transmutation Yields for Pd-H Systems by SCS Model

14:15-14:40   **JCF7-8**   H. Kagiyama et al. (Kagoshima U.): Analysis for Accuracy and Precision of Ultrasound Pulse-Echo Method for Measurement of H2O Contamination in D2O and Its Improvement

-----**break** (20 min)-----

Theory-2 (chairman: T. Sawada, Nihon U.)

15:00-15:25   **JCF7-9**   A. Takahashi (Osaka U.) et al. : Brief Review on Fusion Rates of Bosonized Condensates   Part-I: Basic Theory

15:25-15:50   **JCF7-10**   A. Takahashi (Osaka U.) et al. : Brief Review on Fusion Rates of Bosonized Condensates   Part-II: Example-EQPET/TSC Model

15:50-16:15   **JCF7-11**   M. Fukuhara (Tohoku U.): Possible Origin of Nitrogen in Earth's Atmosphere (II)

16:15-16:40   **JCF7-12**   A. Takahashi (Osaka U.) et al. : Comments on Role of CaO-Layer in Iwamura Cold Transmutation

16:40-18:00   **JCF Annual Meeting**

18:00-20:00   **Reception**

April 28 (Fri), 2006

Theory-3 (chairman: E. Yamaguchi, Doshisha U.)

10:00-10:25   **JCF7-13**   H. Miura: Formation of Tetrahedral, Octahedral or Hexahedral Symmetric Condensation by Hopping of Alkali or Alkaline-earth Metal Ion

10:25-10:50   **JCF7-14**   N. Yabuuchi (High Sci. Res. Lab.): Tetrahedral and Cubic Forms   and Condensate Nuclear Fusion

-----**break** (20 min)-----

Experiment-2 (chairman: K. Ohta, Yokohama N. U.)

11:10-11:35   **JCF7-15**   H. Iwai et al. (Kobe U.): Reproduction of Nuclear Transmutation in CaO/Sr/Pd Samples by Deuterium Gas Permeation

11:35-12:00   **JCF7-16**   H. Yamada et al. (Iwate U.): Producing an Element of Mass Number 137 on Multi-layered Pd Sample by Deuterium Permeation

12:00-12:25   **JCF7-17**   S. Narita et al. (Iwate U.): Possibility of Inducing Selective Transmutation in Discharge Experiment

Adjourn

Possibility of Control on Coulomb Potential

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P.A.M. Dirac established the equation of motion for a radiating charged particle in 1938, which is called Lorentz-Dirac equation. Nobody doubts the validity of his equation in the present day. The nonrelativistic form of L-D eq. is known as Abraham-Lorentz equation.

A-L equation was introduced into quantum mechanics by present author. It was found that point electron behaves as an extended charged particle due to self-field bound to the electron.[1]

Applying the self-field method to the system of two electrons interacting each other on Coulomb potential, the effective Coulomb potential working between two electrons was obtained:[2]

$$U(r) = \frac{e^2}{4\pi r}\Big[1 - \exp(-\frac{r}{2R})\cos\frac{r}{2R}\Big]$$

Characteristic length $R = \sqrt{r_c\lambda/2}$ is geometric mean value of Classical electron radius r_c and Compton wavelength λ of electron.

Virtually extended charge density of the electron was also obtained.[3]

$$\varrho(r) = \frac{e}{4\pi\sqrt{2}\,R^3}\frac{\sin\eta}{\eta}\exp(-\eta)\,, \qquad \eta = \frac{r}{\sqrt{2}\,R}$$

It was proved that above virtual charge density works not only Coulomb potential but also any arbitrary electric potential.[4]

These results imply the possibility of control on Coulomb potential.

References

[1] S. Sasabe; Finite Mass Change of Electron in Altered Self-Field Approach.,
J. Phys. Soc. Jpn, Vol.59, pp.449-454 (1990).

[2] S. Sasabe; Coulomb Potential Weakened by Self-Field of Electron, J. Phys. Soc.
Jpn, Vol.61, pp.812-815 (1992).

[3] S. Sasabe; Virtual Charge Distribution of Nonrelativistic Electron with Bound
Self-Field, J. Phys. Soc. Jpn, Vol.64, pp.1034-1035 (1995).

[4] 奥永雄治、笹部　薫、新井真人；自己場を伴った電子に見られる仮想的電荷分布、
電気学会論文誌Ａ, Vol.115-A, pp.1105-1113 (1995).

(Y.Okunaga, S.Sasabe, M.Arai; Virtual Charge Distribution of The Electron with Its
Self-Field, Trans. IEEE of Japan, Vol.115-A, No.11, pp.1105-1113 (1995)

Mechanism of Nuclear Reaction and Bose-Einstein Condensation in Solids

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Abstract

Many deuterons trapped at void in solids may reach Bose-Einstein condensation (BEC) and nuclear reaction. This study shows mechanism of the cooperative relationship between BEC and nuclear reaction in solid. In this theory, the transition temperature of BEC is calculated from the density of deuterons trapped at voids. [1] The nuclear reaction rate is also calculated from the wave function of condensed deuterons. [2] In the local space of deuteron storing metal, BEC induces nuclear reaction, and nuclear reaction restrains BEC. The static reactions can be explained by this cooperation.

References

1   Y.E.Kim and A.L.Zubarev, " *Nuclear Fusion for Bose Nuclei Confined in Ion Trap* ",
    Fusion Technology, **37**(2000)151

2   K.Tsuchiya, " *Quantum States of Deuterons in Pd* ",
    International Journal of Hydrogen Energy, **29**(2004)1513

Why an exotic particle is needed in understanding the nuclear cold fusion.

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The most important achievement of the physics in the 20th century is the discovery of the quantum mechanics and its extension to the quantum field theory. These theories are essential in describing the atomic and also the subatomic systems. The prediction of the quantum theory agrees with the experiments excellently. For example, the g-factor g of the electron, which is the proportional coefficient between the magnetic moment $\vec{\mu}$ and the angular momentum $\vec{j}$ defined by $\vec{\mu} = g(e/2m)\vec{j}$. When $\vec{j}$ is the spin angular momentum, $g = 2$ according to the Dirac equation. However quantum electrodynamics (QED) predicts small deviation of g from 2, namely $g - 2 = 1159652176.41 \times 10^{-12}$. On the other hand, the experimental value is $g - 2 = 1159652188.4(\pm4.3) \times 10^{-12}$. It is amazing that the leading eight digits of these values coincide. Therefore slight change of the quantum rule may destroy the agreement. So we cannot adopt the first way to understand the cold nuclear fusion reaction where the quantum rules are altered to explain a single phenomenon — cold fusion.

As the nuclear physicists point out, the nuclear fusion reaction of the low energy cannot occur because of the repulsive Coulomb barrier. Moreover the idea to shield the positive charge of the nucleus by the electron cloud does not work, either. Since the required size Δr of the electron cloud is around 1pm., from the uncertainty principle $\Delta p \sim \hbar/\Delta r$, the kinetic energy $(\Delta p)^2/2m_e$ becomes around 100 keV.. In order to prevent the spread of the electron cloud, the confining potential much higher than 100keV. is required. However the chemical energy cannot provide such large energy.

There is the third way to understand the cold nuclear fusion. When we apply the time-honored equation $-i\hbar\partial_t\Psi = H\Psi$ to a quantum system, we must specify the system namely specify the hamiltonian H. In the case of the second way, mentioned above, the ingredients of the system are the ordinary particles namely protons, neutrons and electrons. On the other hand, in our case of the third way is to include a rare particle X as the additional ingredient. The particle X is expected to play the role as the catalyzer of the low energy nuclear fusion reaction. When X is exotic and floating with extremely low density in our environment, the occurrence of the fusion reaction must be sporadic. This is because in order to start the fusion reaction, X must come into and stop in the reaction region. Since X must attract the fuel nuclei (p, n, d, t, ^3He) and repel the product nucleus ^4He, we can pin-down the catalyzer X. If X is a particle with large negative charge, it attracts ^4He as well as the fuel nuclei, contrary to our expectation. On the other hand, if we choose a magnetically charged particle as X, it will do the expected job. This is because the fuel nuclei (p, n, d, t, ^3He) have the magnetic moments $\vec{\mu}$ and they are attracted to the magnetic monopole when the spins of the nuclei orient properly, whereas the charged particle of spin zero such as ^4He is repelled by the monopole. Therefore the magnetic monopole $^\star e$ is the most important candidate of the catalyzer particle X. Our next task is to construct the world of the nuclei plus the magnetic monopole, and to see whether the magnetic monopole behaves as the catalyzer of nuclear fusion reaction. We shall see the speed of the nuclear fusion reaction is increased appreciably when it occurs in the neighborhood of the magnetic monopole.

Extension of the nuclear physics to include the magnetic monopole.

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In 1960's the nuclear physics was extended to include the hyperon such as Λ or Σ as the new ingredient in addition to the proton and the neutron. Today we are familiar with the hypernuclei. Since the interactions between the hyperon and the nucleon as well as the nuclear potential are known, we can construct world of the hypernuclei from the first principle as long as the baryon number A of the system is not large ($A \leq 10$ say). Our proposal is to extend the nuclear physics to the different direction, namely to extend to include the magnetic monopole $^\star e$ as a new ingredient instead. Since the smallest electric charge e and magnetic charge $^\star e$ satisfy Dirac's charge quantization condition $^\star ee/\hbar c = 1/2$, the Coulomb interaction between the monopoles becomes super-strong. This is because the smallness of the fine structure constant $e^2/\hbar c = 1/137$ implies the largeness of the magnetic counterpart of the "fine structure constant" $^\star e^2/\hbar c = 137/4$. Therefore the monopole accompanies very strong magnetic Coulomb field $^\star e\hat{r}/r^2$, and when a nucleus with the magnetic moment $\kappa_{tot}e/2m_p$ comes into the magnetic Coulomb field, the interaction energy becomes $|\kappa_{tot}|/4m_p r^2$. For the proton and the neutron, the interaction energies are 14.5 and 9.93 MeV. respectively at the separation of 1.41fm., which is the Compton wave length of the charged pion. Since these values and nuclear potential at the same separation are nearly the same, we can expect to extend the nuclear system, namely the (p, n) system, smoothly to the ($^\star e$, p, n) system. If we take the mass of the monopole infinity for simplicity, the Hamiltonian of the nucleon is

$$ H = \frac{1}{2m_N}(-i\vec{\nabla} - Ze\vec{A})^2 - \kappa_{tot}\frac{^\star ee}{2m_p r^2}(\vec{\sigma}\cdot\hat{r})F(r) $$

, where $\vec{A}$ is the vector potential whose rotation is the Coulomb field, and $F(r)$ arises from the form factor of the nucleon magnetic moment, which has the form $F(r) = 1 - e^{-ar}(1 + ar + a^2 r^2/2)$ with $a = 6.04\mu_\pi$ as determined by the experiment of the electron-nucleon scattering. By including the nuclear potential term, we can treat the ($^\star e$, p, n) system and whose Hamiltonian is $H_{tot} = \sum_i H_i + \sum_{i>j} V_{i,j}$.

Since the hamiltonian is known, the construction of the ($^\star e$, p, n) system is the typical few-particle problem. However it is instructive to study first the easier one-body problem. Not only the ($^\star e$, p) or ($^\star e$, n) but also ($^\star e$, t), ($^\star e$, ^3He) or ($^\star e$, ^4He) can be treated approximately as one-body problems as long as deformations of the nuclei in the magnetic Coulomb field are small. The nucleus with the magnetic moment has the bound state with the monopole, while the spin 0 charged particle such as ^4He cannot form the bound state with the monopole. The size and the binding energy of such bound states are few fm. and around 1MeV. respectively. It is not difficult for the monopole to form the bound state with two nuclei, this is because when the first nucleus is trapped by the monopole, the potential felt by the approaching second nucleus is the sum of the Coulomb repulsion plus the attraction of the strong (magnetic moment)-monopole interaction. If we start from the bound state with two deuterons $|(d, \,^\star e, d) >$, because of the rearrangement, $|(t, \,^\star e, p) >$, $|(^3He, \,^\star e, n) >$ and $|^4He, \,^\star e >$ states appear and oscillate among these states. However it end up with the emission of ^4He, because it cannot form the bound state with the monopole. Therefore the monopole placed in the region, where the density of the deuteron is high, acts as a source of the α-particle. When we construct the ($^\star e$, p, n) world by solving the few-particle problem mentioned above, we may expect to see other novel phenomena which are not expected in the ordinary nuclear physics.

ENERGY OUTPUT AND MATERIAL BALANCE DURING PLASMA ELECTROLYSIS OF WATER

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An excess heat and an excess hydrogen generation during plasma electrolysis were reported [1, 2]. An accurate determination of energy balance during electrolyses should count the sum of latent and sensible heat is required. However, it is very difficult to measure the output energy for a plasma electrolysis. In this study, in order to obtain an accurate heat balance, we developed a flow calorimetry system using a flow cell system, and measured the energy balance during plasma electrolysis.

The anode was a 2 cm diameter hollow cylindrical platinum mesh. The cathode was a 1.5 mm diameter tungsten rod and it was placed at the center of the cylindrical anode. The electrolyte was 0.3 mol dm^{-3} Na$_2$CO$_3$ light water solution and it was circulated in this system passing through a reservoir. The temperature difference between inlet and outlet of the electrolyte was measured by the Pt resistance thermometers. Hydrogen and oxygen that generated during electrolysis were collected in the reservoir and measured the rate of gas generation.

Figure 1 shows the current efficiencies for gaseous evolutions during normal and plasma electrolyses. The cell voltage of h 7 and 8 were 95 V, and that of h 9 and h 10 were 105 V. These four runs were plasma electrolyses. The cell voltage of h 11 was 25 V without plasma. The current efficiencies of the plasma electrolyses were 115 ~ 125 % and these of normal electrolysis were 93 ~ 94 %. The excess gases of 15 ~ 25 % were generated during plasma electrolyses and they could not be explained by the electrolytic current. The excess gas might be generated by the plasma process.

Figure 2 shows the energy balances during normal and plasma electrolyses. The energy balances of the plasma electrolyses were 98 ~ 101 % and these of normal electrolyses was 98 ~ 99 %. A clear excess energy was not observed in this study.

Fig. 1 Current efficiencies during normal and plasma electrolyses in 0.3 M Na$_2$CO$_3$ light water solution.
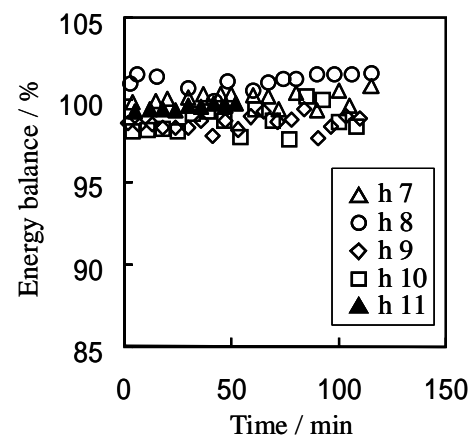
Fig. 2 Energy balances during normal and plasma electrolyses in 0.3 M Na$_2$CO$_3$ light water solution.

Reference

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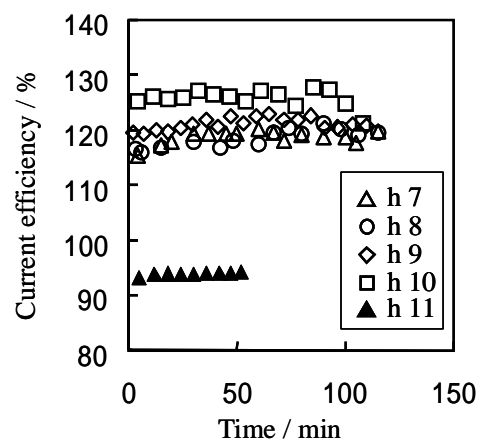2) T. Mizuno, T. Akimoto, K. Azumi, T. Ohmori, *Jpn J. Appl. Phys.*, **44**, 396 (2005).

Microscopic structural change during repeated cathodic and anodic electrolysis in glycerin and phosphoric acid

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Electrochemical electrolysis for well annealed Pd rod (2.0 mm   ) in glycerin and phosphoric acid was performed. The physico-chemical properties of hydrogen (essentially same as deuterium) in Pd have been studied by *in situ* potentiometric, resistance and dilatometric measurements of repeated hydrogen absorption/desorption electrolysis (x<0.02).

Results and Discussion: The resistance increased with an increase in the H/Pd ratio and the electrode potential of the 1st through 4th absorption cycles exhibited the Nernstian behavior. For all the absorption cycles except 1st one, an induction period of the dilation was appeared, which is attributed to the disorder-order transformation.[1] However, the former explanation with respect to the induction period was inconsistent with the view that the absorption/desoption might cause no deterioration of the matrixes due to the low level of the H/Pd ratio. The disorder-order transformation is bulky non-steady state phenomenon. Alternatively, the separation of the sub-surface layer and the bulk of the Pd rod provide comprehensive solution for such the unusual induction period. During the induction period the hydrogen ingress proceeds in the sub-surface layer, which is characterized like imperfect metal. If such region contains much defects, vacancies and tangled dislocations, a certain amount of hydrogen ingresses do not produce the dilation, while the existence of hydrogen among Pd atoms causes the resistance increase. As a result, the set of the resistance and the dilation changes is well agreed with the experimental data. The potential change with the H/Pd ratio is also explained taking into account hydrogen absorption in the sub-surface layer. The measurement of the hydrogen/deuterium loading behavior of the Pd-H (D) system revealed the micro structural model inside the solid (N-cycle reaction model[2]), which improves reproducibility of cold fusion related phenomena. Further discussion will be presented in connection with N-cycle model.

1) H. Numata and I. Ohno, Proc.of the 6th Int. Conf. on Cold Fusion, "Prog.in New Hydrogen Energy", Toya Japan, 13 Oct., 1996, Vol.1, p.213, NEDO, The Inst.of Appl. Energy, (1997).

2) H. Numata et al., Neutron Emission and Surface Observation during a Long-term Evolution of Deuterium on Pd in 0.1M LiOD, Conf.Proc.Vol.33 of ACCF2, "The Science of Cold Fusion", p.71-79 (1991)

Analysis of Nuclear Transmutation Yields for Pd-H Systems by SCS Model

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Anomalous nuclear reactions are occurred in not only deuterium but also hydrogen loaded metals. We have already conducted a number of light water electrolysis experiments with several electrodes and some elements that could not be detected before the experiments and nowhere in the cell as contamination were detected on the cathode surface after the experiments[1, 2]. The results strongly suggest these elements were signs that unknown nuclear reactions can be occurred in the solid state.

Several models have been proposed to explain the fission-like products. In this study we assumed the detected elements could be fission products of Pd electrode, and compared the experimental results with a theoretical value estimated by an innovative model to predict the fission yield. This model is referred to as Selective Channel Scission model, having been developed by Takahashi and Ohta with a concept of channel dependant fission barriers for all fission channels[3, 4]. We improved the SCS model at some points fully based on their model and applied this to the transmutation process in the Pd-H systems.

In this study, following points are improved to estimate more proper yields. The channel dependant fission barriers are calculated by not the deformed shape of the Pd nucleus, but an energy balance between surface energy and coulomb energy, namely macro-terms in a nucleus. A narrow part in the middle of the deformed nucleus is approximated as a hyperbolic curve. An excited nucleus would be split into two FPs when the energy balance is equal to the 1.0 under the constant volume condition. At first, this approach was applied to the U fission, and confirmed a better agreement with the evaluated nuclear data library[5]. Therefore this estimation should be more suitable for the numerical simulation in the Pd-H system.

The fission yields for natural Pd were calculated in two cases, neutron-excited case and photon-excited case, and compared with the experimental results[1, 6]. The difference between two cases is excitation levels. Although photons excite all kinds of Pd isotopes up to the same level, the excitation level by neutron incident depends on each Pd isotopes. In the case of photon excitation, SCS model can explain the observation frequency of transmutation products qualitatively. Thus, the excitation source is considered very likely to be not neutron but photons at this moment.

The yield, however, cannot agree quantitatively. In particular, the SCS Model cannot predict the strong Fe peak that was detected from all cathode samples. In most cases the other fragment, Ca, was not observed. Therefore the reaction occurred in the Pd-H system were not only the normal nuclear fission. We conjecture that there might be an unknown mechanism to enhance a certain channel reaction that is unique in the solid state nuclear reaction.

1. Y. Toriyabe et al., *Proceedings of ICCF12*, 2006
2. T. Mizuno et al., *Proceedings of ICCF12*, 2006
3. A. Takahashi et al., *Jpn. J. Appl. Phys.*, **40**, 7031, 2001
4. M. Ohta and A. Takahashi, *Proceedings of JCF5*, 79, 2003
5. Y. Toriyabe et al., *Abstracts for 23rd Meeting of Atomic Energy Society of Hokkaido*, 4, 2005
6. G. H. Miley, *Proceedings of ICCF12*, 2006

Analysis for Accuracy and Precision of Ultrasound pulse-Echo Method for
Measurement of H20 Contamination in D2O and Its Improvement

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In our prior conference we proposed a simple and comprehensive method to measure H20 Contamination in D2O for CF study, by means of sound speed measurement and comparison with pure H2O, by ultrasound pulse-echo method (1). In such measurement, variety of error source must be taken account. In our latest study error sources are located as follows.

Errors related to oscilloscopic time domain measurement of echo pulse locations

Errors related to temperature of measurement environment to determine sound speed

Errors related to accuracy of test chamber wall-to-wall physical distance

Errors related to signal to noise ratio of the electronic system including A/D conversion.

Possible historical negligence of hidden error in reported sound speed of D2O.

In reality of our laboratory environment mostly big problem was, ironically, measurement chamber size uncertainity. Including such problem we will address a gross view for this method in terms of improving the accuracy, and the method to realize it.

(1) M. Koda et.al., JCF6-7 (2005)

Brief Review on Fusion Rates of Bosonized Condensates
Part-I: Basic Theory

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Abstract: In Part-I, theoretical basis for formulating fusion rates in condensed matter is summarized. Nuclear strong interaction, S-matrix, T-matrix, fusion rate for steady state dd molecule, and fusion rate formula for collision process are briefly given[1].

Useful quantum-mechanical formulas are summarized for extending more practical theoretical models for possible fusion (or in general nuclear) reactions under ordering (self-organization or lattice constraint) in condensed matter.

The condensed matter nuclear effects can be treated adiabatically, namely based on Oppenheimer-Phillips approximation in quantum mechanics, for several steps of multi-particle interactions; 1) The first process to form deuteron (or p-d mixed) cluster in condensed matter as electromagnetic interaction of deuterons (or plus protons) as dynamic motions under constraints as for instance periodical Bloch potentials, 2) the second process to form an adiabatic quasi-molecular state by "bosonization" of electrons, and 3) the third process to make strong nuclear interactions within extremely short ranges of inter-nuclear distances for which we introduced reaction rate formulas based on the global optical potential.

Basic formulas are derived for the second and the third process. Example of application is given in Part-II[2].

Reference:
1) A. Takahashi: Fusion Rate Formulas for Bosonized Condensates, ppt-slides for Sunday Tutorial Class of ICCF12, downloadable from ICCF12 at http://www.iscmns.org/
2) A. Takahashi, N. Yabuuchi: Brief Review on Fusion Rates of Bosonized Condensates, Part-II: Example- EQPET/TSC Model, this JCF7 meeting

Brief Review on Fusion Rates of Bosonized Condensates
Part-II: Example-EQPET/TSC Model

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Abstract: In Part-II, application for TSC-induced fusion is summarized. Fusion rate formulas for adiabatic approach in EQPET theory are summarized. Final state interaction is briefly discussed. Time-dependent approach for TSC squeezing motion is briefly introduced[1-3]. Basic theoretical background is given in Part-I[4].

An example of theoretical modeling (EQPET/TSC) for fusion rates of bosonized condensates is summarized based on Oppenheimer-Phillips approximation in quantum mechanics, for three steps of multi-particle interactions;

1) The first process is to form deuteron (or p-d mixed) cluster in condensed matter as electromagnetic interaction of deuterons (or plus protons) as dynamic motions under constraints as, for instance, in periodical Bloch potentials.

2) The second process is to form a transient Platonic polyhedral cluster as TSC (tetrahedral symmetric condensate for 4 deuterons and 4 electrons) which can be analyzed as synthesis of adiabatic quasi-molecular states by "bosonization" of electrons and their shielded Coulomb potentials are derived and numerically estimated.

3) The third process is to make strong nuclear interactions for Platonic polyhedral multi-body configurations within extremely short ranges of inter-nuclear distances. Intermediate compound states and final state interactions leading to multiple outgoing channels with branching ratios are discussed.

References:

1) A. Takahashi: Deuteron cluster fusion and related nuclear reactions in metal-deuterium/hydrogen systems, *Recent Res. Devel. Physics*, 6(2005)pp.1-28, ISBN: 81-7895-171-1

2) A. Takahashi: Brief Theoretical Summary of Condensed Matter Nuclear Effects, Acta Physica et Chemica, Debrecen, Hungary, Vol.38-39, (2005)341-356

3) A. Takahashi: Time-dependent EQPET analysis of TSC, Proc. ICCF12, Yokohama 2005

4) A. Takahashi, N. Yabuuchi: Brief Review on Fusion Rates of Bosonized Condensates, Part-I: Basic Theory, this JCF7 meeting

Possible origin of nitrogen in Earth's atmosphere (II)

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Abstract

The significant question on the origin of nitrogen abundance in the Earth has not been entirely resolved, and has been overlooked without consensus. An attempt to give a possible answer to the question was interpreted to be the result of endothermic nuclear transmutation of carbon and oxygen atom pairs in carbonate lattice of upper mantle containing crust [1],

$$^{12}C + ^{16}O + 2e^{*} + 2\nu \rightarrow 2\ ^{14}N + ^{4}He,$$
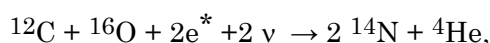
with help of electropionic attraction effect due to the excited electron capture and neutral pion catalysis [2-4]. The excited electrons were generated by rapid fracture or sliding of carbonate crystals due to volcanic earthquake, and plenty of neutrinos were derived from young sun. In this study, we propose three possible formation models of nitrogen by dynamic interaction among carbon and oxygen atoms: The CO_3 anions resolved in deep seawater were hydrostatistically compressed and the C-O distance attains at critical distance for nitrogen transmutation at 10250 m below the sea level, corresponding to Mariana basin. The second model is due to volcanic earthquake-induced fracto-nuclear transmutation in (Ca,D) CO_3 lattice under high temperature and high pressure in crust of the Earth. The third possibility is dynamic interaction between C and O atoms occurring during diamond formation in mantle under high pressure above 58 GPa and high temperature above 2520 K.

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JCF7 abstract 3

Comments on Role of CaO-Layer in Iwamura Cold Transmutation

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We have proposed a model on nuclear transmutation reaction of 4d/TSC plus metal nucleus system in PdDx surface and lattice focal points[1,2]. Formation of minimum-size "neutral" pseudo-particle of 4d/TSC with about 10 fm diameter is expected to be a seed of nuclear transmutation reaction with host and added metal nuclei. Quantitative estimation of reaction rates are given by the STTBA approximation. Selective transmutations with (mass-8, charge-4), (mass-4, charge-2), (mass-12, charge-6), etc can be treated by the model.

However the role of CaO layer in the Iwamura cold transmutation experiments[3-5] is of open question.

This paper gives a model of TSC formation by combination of two dde*(2,2) EQPET molecules[1,2] which would be generated by Cooper pairs (bosonized electron pairs) born at the interface of CaO/Pd layers. Gap of Fermi-levels between CaO and Pd generates "free electrons" from CaO layer with low work-function. These free electrons with momentums may enter the conduction band of Pd layer and form "transient" Cooper pairs e*(2,2). EQPET molecules dde*(2,2) will be then formed at around the interface.

Combination of two dde*(2,2) molecules as transient motion will be happening with some probability there to produce 4d/TSC transient clusters. Transmuted elements, Pr for instance will diffuse to surface for about 20 nm movement in the MHI Pd-complex samples.

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Formation of Tetrahedral, Octahedral or Hexahedral Symmetric Condensation by Hopping of Alkali or Alkaline-earth Metal Ion

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Tetrahedral Symmetric Condensate / Octahedral Symmetric Condensate / Hexahedral Symmetric Condensate (TSC/OSC/HSC) model of protons/deuterons by Takahashi can explain consistently the major experimental results of light/heavy water electrolysis, deuterium permeation and other experiments.

We have studied how and where TSC/OSC/HSC is formed, and have obtained very consistent and simple scenario about the formation of TSC/OSC/HSC that the alkali or alkaline-earth metal ions infiltrating into the host metal surface layers make cavities there when they hop into the other sites of the crystal lattice of the host metal, and then condensation of protons or deuterons is caused in the cavities:

When hydrogen/deuterium (H/D) atoms enter into interstitial sites in a transition metal they expand slightly the interatomic distances of the metal lattice by forming hydrides/deuterides. In the fcc lattice of the host metal, the H/D atoms which entered into the interstitial sites form TS (tetrahedral symmetry), OS (octahedral symmetry) or HS (hexahedral symmetry) centered in by the alkali or alkaline-earth metal ion entering into the other interstitial sites or vacancies. The H/D atoms which constitute polyhedron symmetry are pushed out slightly on the outside from the usual positions due to the alkali or alkaline-earth metal ion of the center of polyhedron symmetry.

The probability that alkali or alkaline-earth metal ions diffuse into the other interstitial sites or vacancies overcoming the repulsion potential barrier of the host metal increases, if it is changed by outer electrical potentials, electromagnetic impulses, etc. When one of the alkali or alkaline-earth metal ions exchange the position with one of the H/D atoms which constitute TS, OS or HS, the other ones are also put back into the inside of the polyhedron symmetry by a reaction.

Exchange of one phonon of the host metal lattice generates an electron transition from the inside of H/D-Fermi sheet into that of host metal-Fermi sheet, which compose a pair of symmetrical positions of TS, OS or HS in the real space, and then two pieces, three pieces or four pieces of electron Cooper pairs and electron hole Cooper pairs are formed respectively.

The electron Cooper pairs condense and shield the Coulomb repulsion, then H+/D+ ions squeeze, after the condensation of protons/deuterons, condensed 4d/TSC, 6d/OSC or 8d/HSC causes the cluster 4d, 6d or 8d nuclear fusion when it receives the weak recoil of the hopping-out of the alkali or alkaline-earth metal ion, and condensed 4p/d/TSC, 6p/d/OSC or 8p/d/HSC causes various nuclear fusions, transmutations or fissions when it receives the strong recoil.

Tetrahedral and cubic forms and condensate nuclear fusion

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When the wave-motion function in the coordinate representation for a dynamical system composed of *n* particles is taken to be $(q_1 s_1 \quad q_2 s_2 \ldots q_N s_N, t)$, its Schrîdinger representation is as follows:

$$ i \frac{}{t} \left\{ \sum_{j=1}^{N} H_{(q)} + \sum_{j \ k}^{M} W(q_i, q_k) \right\} \tag{1} $$

$H(q_i) = {}_j^2/2m + U(q_j)$ is the energy operator for the *j*th particle.

For $U(q_i)$, refer to Brief Review on Fusion Rates of Bosonized Condensates Parts I and II (JCF7).

Here, W indicates the potential of strong interaction, and U indicates the potential of electromagnetic or Coulomb interaction.

Deuterium, having a compound nucleus composed of a proton and a neutron, is a boson, and absorption of it in large amounts in a hydrogen-occlusion alloy may lead to Bose-Einstein condensation. Further, a mass of deuterium condensed near the thin-film layer boundary of the metal may exist in a cluster configuration. Wave motion having the property to arrange the deuterium into a tetrahedral or cubic regular polyhedron forms this configuration. This wave motion acts to arrange the deuterium existing in the wave motion into tetrahedral and cubic regular polyhedra. (In Greek philosophy, a substance which is matter formed into a uniform configuration is termed a "form.")

A deuteron is composed of one proton and one neutron, and is believed to exist in a state in which one proton and one neutron are missing from the four nucleons of helium arranged in a tetrahedral form having four apices. When this is expressed as an equation, the regular tetrahedral structure is inscribed within and circumscribed about a sphere, and $_T$, taken to be the spherical coordinate, is believed to experience the force of $U(q_j)$ and external force and to create a strong mutual interaction with the tetrahedral form (wherein q_1 is the proton and q_2 is the neutron):

$$ _T = {}_T(q_{n_1 l_1 m_1 s_1}, q_{n_2 l_2 m_2 s_2}, o, o, t) \tag{2} $$

Although this exists within the probability waves of both the proton and the neutron, t at a given time t is believe to yield both $_{T1}$ and $_{T2}$:

$$ _{T1} = {}_{T1}(q_1 s^{1\!/\!2} q_2 s^{1\!/\!2} o, o, \quad t), \quad _{T2} = (o, o, q_3 s^{-1\!/\!2} q_4 s^{-1\!/\!2} \quad t) \tag{3} $$

Here, q_3 represents the proton and q_4 the neutron.

In equation 3, to become ^{4}He in a mutually tetrahedral form, for example by action in which

$_{T1}$ attempts to accept q_3 and q_4 from $_{T2}$, $_{T2}$ attempts to donate q_3 and q_4 to $_{T1}$, yielding:

$$\psi_{T1+2} = a^*a^* \psi_{T1}(q_1s\tfrac{1}{2}q_2s\tfrac{1}{2}o, o, \quad t) + aa \ \psi_{T2}(o, o, q_3s\text{-}\tfrac{1}{2}q_4s\text{-}\tfrac{1}{2} \quad t)$$

$$= \psi_{T1+2}(q_1s\tfrac{1}{2}q_2s\tfrac{1}{2}q_3s\text{-}\tfrac{1}{2}q_4s\text{-}\tfrac{1}{2} \quad t) \tag{4}$$

$$+ \ _T(o \quad o \quad o \quad o \quad t_o)$$

(Here, a*a* represent the acceptor operators and a a the donor operators.)

Accordingly, this yields:

$$i\ \frac{\partial \psi_{T1+2}}{\partial t} = \left\{ \sum_{=1}^{4} H(q_j) + \sum^{6} W(q_j, q\ ) \right\} \psi_{T1+2}$$

$$H(q_j) = \quad \partial^2_j/2_m + U(q_j) \qquad (Ex = 23.^8MeV) \tag{5}$$

A phenomenon similar to that in equation 4 occurs in the Bose-Einstein condensation, yielding:

$$\psi_{T3+4} = \psi_{T3+4}(q_5s\tfrac{1}{2}q_6s\ \tfrac{1}{2}q_7s\text{-}\tfrac{1}{2}q_8s\text{-}\tfrac{1}{2} \quad t)$$

$$(\quad x = 23.^8MeV) \tag{6}$$

In equations 4 and 6, in terms of the states of nuclear physics, the occurrence of group excitation results in an extremely unstable nuclear structure, causing a transition toward cubic-form ^{8}Be, which has an even higher energy value. (That is to say, ^{4}He* + He* Be*). Accordingly, this yields:

$$\psi_{C1} = \psi_{C1}(q_1s\tfrac{1}{2}q_2s\tfrac{1}{2}q_3s\text{-}\tfrac{1}{2}q_4s\text{-}\tfrac{1}{2}o, o, o, o, \quad t) \tag{7}$$

$$\psi_{C2} = \psi_{C2}(o, o, o, o, q_5s\tfrac{1}{2}q_6s\tfrac{1}{2}q_7s\text{-}\tfrac{1}{2}q_8s\text{-}\tfrac{1}{2} \quad t) \tag{8}$$

In equations 7 and 8, mutual fusion of the cubic-form $_{C1}$ and $_{C2}$ creates $_{C1+2}$, as follows:

$$\psi_{C1+2} = a^*a^*\,a^*a^* \ \psi_{C1}(q_1s\tfrac{1}{2}q_2s\tfrac{1}{2}q_3s\text{-}\tfrac{1}{2}q_4s\text{-}\tfrac{1}{2}o, o, o, o, \quad t)$$

$$+ a\,a\,a\,a \ \psi_{C2}(o, o, o, o, q_5s\tfrac{1}{2}q_6s\tfrac{1}{2}q_7s\text{-}\tfrac{1}{2}q_8s\text{-}\tfrac{1}{2} \quad t)$$

$$= \psi_{C1+2}(q_1s_o, q_2s_o, q_3s_o, q_4s_o, q_5s_o, q_6s_o, q_7s_o, q_8s_o, \quad t) \tag{9}$$

$$(Ex = 47.^6MeV)$$

However, because $_{C1+2}$ is in the group-excitation energy state of nuclear physics, it is unstable and experiences transition in which it splits into its original state of $_{T1}$ and $_{T2}$. (That is, the ^{8}Be* degenerates to two ^{4}He nuclei.) This yields the following:

$$\psi_{C1+2} \quad \psi_{T1+2} + \psi_{T3+4} =$$

$$\psi_{T1+2}(q_1s\tfrac{1}{2}q_2s\tfrac{1}{2}q_3s\text{-}\tfrac{1}{2}q_4s\text{-}\tfrac{1}{2} \quad t) + \psi_{3+4}(q_5s\tfrac{1}{2}q_6s\tfrac{1}{2}q_7s\text{-}\tfrac{1}{2}q_8s\text{-}\tfrac{1}{2} \quad t) \tag{10}$$

$$(^4He, K_E = 23.^8MeV)$$

Reproduction of Nuclear Transmutation in CaO/Sr/Pd Samples by Deuterium Gas Permeation

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It has been claimed [1,2] that forced permeation of deuterium through Cs-doped Pd/(CaO+Pd)/Pd samples induced nuclear transmutations from ^{133}Cs to ^{141}Pr, from ^{88}Sr to ^{96}Mo, from ^{138}Ba to ^{150}Sm and from ^{137}Ba to ^{149}Sm. The diagnostic methods they mainly used were XPS, TOF-SIMS and XRF. To confirm and investigate the phenomena, it is essential that the same results are obtained in different laboratories with different analytical methods.

In the present work, we have constructed an experimental system, with which accelerator analyses including PIXE, ERDA, NRA and RBS can be made *in situ* and simultaneously with gas permeation through the samples. A sample with a CaO/Sr/Pd structure on the surface is placed in a vacuum chamber, and its rear surface is exposed to D_2 gas at a pressure of 0.1 MPa typically. The deuterium permeation condition is somewhat different from that used in refs. [1] and [2]; the Sr doped Pd/CaO interface is exposed to the flow of deuterium purified by permeation through the Pd bulk. The sample surface is diagnosed with probe beam ions to emit characteristic X-rays which are analyzed either with a CdTe detector or a Si-PIN-type X-ray detector positioned at 150 degree relative to the probe beam direction. Additional solid-state charged-particle detectors are provided for RBS, NRA and/or ERDA characterization of the sample.

The first experimental results show little evidence for continuous transmutation of the atoms involved, while *ex situ* XPS analysis suggests occurence of nuclear transmutation of Sr to Mo. Areal densities of Sr before deuterium permeation and Mo after the permeation are calculated to be 1.3×10^{14} cm^{-2} and 6.6×10^{13} cm^{-2}, respectively, giving an efficiency of nuclear transmutation of about 50%. We are going to investigate the dependence of the transmutation efficiency on various parameters systematically for the purpose of increasing the amount of transmutation products.

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Producing an Element of Mass Number 137 on Multi-layered Pd Sample by Deuterium Permeation

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A base Pd foil (99.95% pure) of 0.1×12.5×12.5 mm in size was rinsed with acetone and pure water, and then washed by aqua regia to remove impurities on the Pd foil surface. Next the Pd was annealed at 900   for 8 hours, followed by being cooled to room temperature in furnace and washed again with aqua regia. Using the base Pd foil, we prepared three types of samples. The first one was a plain Pd sample just as the base Pd foil was. It had no deposition of any additional elements. Second one had small amount of Cs deposited on the base Pd foil. The last one had small amount of Cs on the uppermost of multi-layered Pd sample. The multi-layered sample consisted of a couple of CaO and Pd thin films on the base Pd foil. The CaO and Pd thin films were formed on the Pd foil by Ar ion beam sputtering under the input energy of 30 W for 5 minutes and 20 W for 1 minute, respectively. After forming the thin films, small amount of Cs was deposited on the multi-layered Pd sample by an electrochemical method. In this method, the Cs was deposited by applying an electric field to 0.5 mM Cs_2CO_3 solution; a 1 V negative voltage was applied to the multi-layered Pd sample for 10s. A Pt foil of 10× 10 mm in size was utilized as a counter-electrode. The thickness of CaO and Pd films formed were 2 nm and 40 nm, respectively. No deuterium gas was loaded to the samples before deuterium permeation experiment.

Elements analysis on the Pd samples was performed after deuterium permeation experiment and for control Pd samples using TOF-SIMS. The TOF-SIMS has provided the marked count peaks at mass numbers 135 and 137 in spectra after deuterium permeation at 70 , only when the multilayered Pd sample with a small amount of Cs was used. The substance with mass number 137 could be ^{137}La or ^{137}Ba produced during deuterium permeation by some nuclear transmutation occurring on/in the uppermost of multi-layered Pd sample. The single couple of Pd/CaO thin films on Pd foil might contribute to induce production of an element with mass number 137. This would imply a transmutation of 4 mass number increasing before ^{141}Pr production.

Possibility of Inducing Selective Transmutation in Discharge Experiment

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In the condensed matter nuclear science, it is one of the most interesting topics to clarify the mechanism of selective transmutation just as Cs to Pr observed in deuterium permeation experiment with Pd/CaO multi-layered sample. For establishing the reaction model theoretically, it is quite important to reproduce the phenomenon with various methods and evaluate it quantitatively. Several researchers have independently tried to confirm the reaction and some positive results have been already reported.

As reported at past conferences, we have also attempted to induce selective transmutation in discharge experiment with deuterium gas, taking into account for the key items mentioned in the permeation method (e.g. multi-layered sample structure, deuterium fluence, and so on). Although some phenomena considered as the evidence of nuclear reaction has been observed in our method, clear symptom for the selective transmutation has not been found up to now. In this paper, we review our discharge study and discuss the possibility to induce selective transmutation in our method.

Electrochemical compression of Hydrogen, inside a Pd-Ag thin wall tube, by alcohol-water electrolyte.

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A very simple experiment was performed in order to verify and possibly improve the procedure developed by Yoshiaki Arata (Osaka University) since 1955 and patented in 1994 in Japan (in 1997 also in USA, N° 5647970): electrolytic cell with hollow cathode made of a hydrogen absorbing material (Pd).

The main reason for such a replication is that the electrolytic compression of Deuterium (D) is the basics for any Cold Fusion work. Moreover, the experiment allows for a direct evaluation of the D_2 (or H_2) pressure inside the hollow cathode, without making use of indirect measurements, like those based on the well-known Baranowsky curve (change of the Pd electrical resistivity, versus D or H absorption).

The cathode was a Pd-Ag (75%-25%) tube, closed at one end (diameter 10mm, useful length 90mm) with a very thin wall (only 0.05mm thick), previously used as a Hydrogen purifier (home-made by Dr. Silvano Tosti: ENEA, Frascati, Italy).

The effective volume of the Pd-Ag tube (partially filled with a porous ceramic tube, in order to avoid the vacuum collapse of the closed tube), pipes, valves and pressure gauges was about 18ml.

The anode was a Pt (purity >99.99%) wire (diameter 0.25mm) wounded as a cylindrical spiral of radius about 40mm. The total length of the Pt wire was about 200cm, number of turns about 5.

The volume of the electrolyte was about 2000ml. The cell was commercial glass (Pyrex type). The solution, according to our long experience in this field, was alcohol-water type (C_2H_5OH 90%, H_2O 10%) electrolyte. $Th(NO_3)_4$ (in HNO_3), $SrCl_2$ and Hg_2SO_4 salts were added. Th and Sr salts were added in the order of some tens of micromoles, and the Hg ion in the order of only a few micromoles. The electrolytic current density was as low as 2-10mA/cm^2. The anode-cathode voltage was 20-130Volts. During the experiment the cell temperature ranged between 20 and 60°C.

The Pd-Ag tube surface was previously mechanically cleaned (by fine, silica based, sandy soap), acetone rinsed, washed several times with distilled water, and finally treated at a temperature of about 450°C for a complete degassing.

Before the cathodic H loading operations, the surface was "activated" by proper cycles of anodic stripping. Vacuum was made inside the tube, the pipes, the pressure gauges and the valves.

We reached a maximum value of pressure inside the hollow cathode of about 5.6atm (absolute 6.6). The maximum value of 5.6atm was due to the mechanical strength limit of the 50micron wall of the tube.

We would like to note that the Faradic efficiency, i.e. the amount of Hydrogen gas produced by the electrolytic current (collected and pressurised inside the tube) was as large as 15--20%.

In comparison, the device invented by Arata (using usual H_2O and LiOH 0.1M mixture, tube 2.5mm thick) had an efficiency of the order of 1--2.5%. Anyway, Arata was able to reach pressures as high as several hundred atmospheres and, up to now, we can't say anything regarding the capability of our electrolyte in obtaining such a high pressures.

The next step of our experiment is to use a thicker (0.250mm) ultra-pure (99.99%) Pd tube, specially developed for this purpose by ORIM SpA Company.

In conclusion:
1) the effectiveness of the original device developed by Yoshiaki Arata since 1955 was fully confirmed;
2) the surprisingly high Faradic yield for H-D loading might open some ways toward some practical applications;
3) the results, about ultra large H/Pd and D/Pd ratios, and very large Faradic efficiency, previously obtained in our experiments (using long and thin wires) are confirmed using a direct measurement method.

Such an experiment was performed because the truthfulness of the Arata results and even the very existence of the Arata device have been strongly challenged and suspected to be merely a "computer simulation experiment".
Following the positive results of our experiment we've received the acknowledgement of a large part of the scientific community (in Italy) formerly sceptical about all that concerns Cold Fusion.