ICCF-23

The 23rd International Conference on Condensed Matter Nuclear Science

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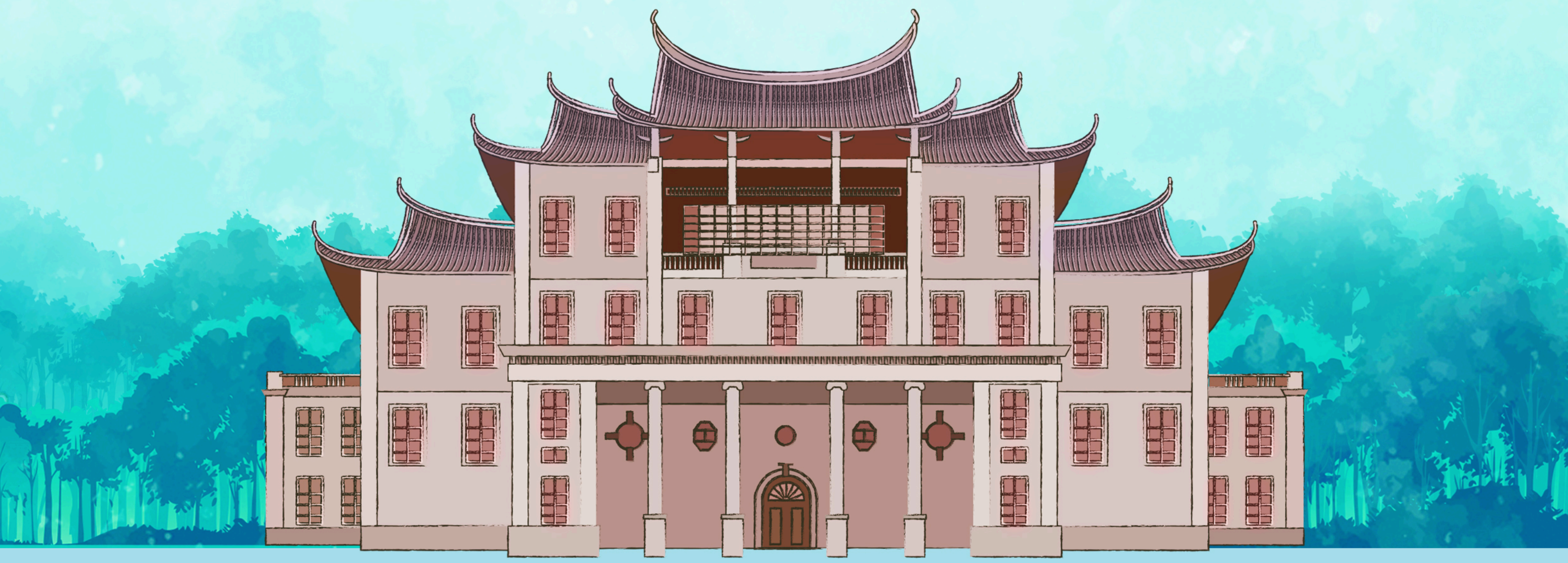
Abstract Book



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Contents

Ternary hydrides

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Hydrides, characterized by the presence of one or more hydridic hydrogen (H^-) bound to a more electropositive element or group, exhibit intriguing properties and functionalities and have been investigated for hydrogen/thermal energy storage, batteries, superconduction, and fuel production. These potential applications place hydrides at the forefront of energy and materials research.

Hydrides are found in the forms of molecules, clusters, surface species and bulk-phase materials. Our research interests are mainly on surface and bulk-phase hydrides. In this talk, we will brief the synthesis and structure of some ternary hydrides made of transition metal and alkali or alkaline earth, e. g., Li_4FeH_6, Li_2PdH_2, and discuss the unique properties they have for mediating chemical transformation.

Progress in Energy Generation Research using Nano-Metal with Hydrogen/Deuterium Gas

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The field of condensed matter nuclear science originated in 1989 with Fleischmann and Pons' electrolysis of Pd with heavy water. Electrochemistry is an excellent method for packing deuterium into Pd metal at high density. However, from the perspective of using the excess heat generated for practical purposes, temperature increase of a few degrees in room temperature heavy water does not have much practical impact, although it was an epoch-making event from scientific point of view.

On the other hand, various phenomena such as anomalous heat generation and nuclear transmutation, which occur when deuterium or hydrogen gas interacts with metals such as Pd, Ni, and Ti, were reported from a very early stage. Among them, Ni began to attract attention from industry because of its abundance on earth, lower cost, and its ability to react with hydrogen at several hundred degrees centigrade. It also became increasingly clear that nanoscale metals were important for inducing anomalous reactions.

Recently, there has been an increasingly strong demand around the world for energy sources that do not emit CO_2 to prevent global warming. Hydrogen energy using nano-metal in this field could be just the technology to meet this global social demand.

In this presentation, we will briefly review the research on anomalous heat generation induced by the interaction of hydrogen or deuterium gas with nano-metal. We will also describe recent progress in our research team.

We have been studying energy generation using nano-sized multilayer metal composites with hydrogen gas. Two nano-sized metal multilayer composite samples, which were composed of Ni, Cu, and the other thin films on bulk Ni (25mm×25mm×0.1mm), were used. These samples were fabricated by Ar ion beam or magnetron sputtering method. Heat burst and excess energy generation were observed during the experiments under vacuum condition (< 10^{-5} Pa) using nano-sized metal multilayer composites on Ni substrate and hydrogen gas. Up to now, the value of averaged released energy evaluated with total amount of absorbed hydrogen reached as high as 21 keV/H or 2.0 GJ/H-mol [1]-[2].

We will talk about "heat burst phenomena induced by intentional change of input electrical power", radiant calorimetry of excess heat production" and "optical observation of spontaneous heat burst phenomena.

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Progress in Nano-Metal Hydrogen Energy

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In this ICCF23 talk, we review our R&D works on nano-metal hydrogen energy (MHE) in 2018-2020, after the 2015-2017 NEDO-MHE Project [1, 2]. Major issues that we have obtained [3, 4, 5, 6] are as follows:

Hydrogen Gas Loading Method using Nano-Metal Composite powders (Ni based binary nano-islands) at elevated temperature has provided reproducible AHE (anomalous heat effect) with significant excess thermal power (ca. 200 W/kg-sample at best) continuing for several weeks.

Repeated re-calcination of PNZ-type and CNZ-type powders is very effective to enhance AHE excess thermal power. Levels are of encouraging grade for extending R&D of MHE toward industrial application.

CCF (condensed cluster fusion of hydrogen isotope) is of guiding theoretical view of the AHE phenomenon.

MHE (nano-Metal Hydrogen Energy) reaction is hard radiation free, namely biologically safe enough.

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(PDF) Comparison of AHE data between H2 and He runs for CNZ7rrr sample - English version (researchgate.net)

Conventional Fusion in an Unconventional Place

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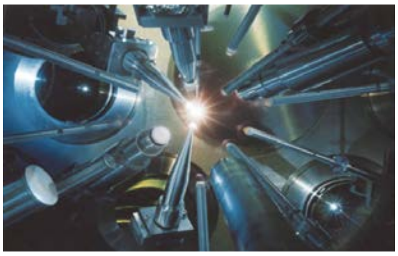
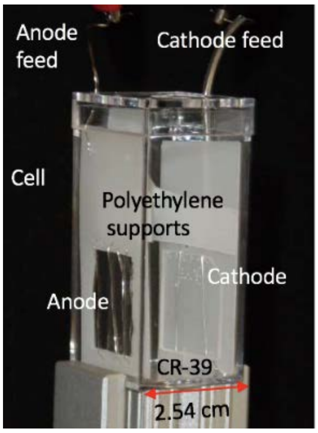


LLE Omega Laser Fusion [3]

Although hot fusion research began 70+ years ago, great technical difficulties exist in bringing fusion to commercial fruition. Consequently, there is a need for alternative approaches other than thermonuclear D-T fusion [1]. These approaches range from beam and muon-catalyzed fusion (with unlikely energy gain), to proton boron-11 fusion [2] (with high bremsstrahlung energy losses), to the less understood condensed matter nuclear reactions *aka* Low Energy Nuclear Reactions (LENR).

This talk will contrast the hot fusion triple-product [4] with the condensed matter nuclear science alternatives. Notably, both high and low energy fusion research need better modeling that experimental data synergistically drives. While many LENR electrolysis and gas loading experiments failed, the successful experiments had factors in common that modeling can expose [5]. Finally, the patented co-deposition protocol [6,7], successfully used for 30 years [8,9,10,11,12], will be discussed. Government, institute and university laboratories from 14 countries have published over 60 peer-reviewed co-deposition papers. Hundreds of successful experiments have established its reliability and reproducibility. Both are necessary to demonstrate and probe a scientific phenomenon leading to power scaling and a deployable technology.



Co-deposition Cell

[1] D(t,n)α
[2] ^{11}B(p,α)2α, *aka* tri-alpha reaction
[3] www.rochester.edu/currents/V29/V29N05/photos/Omega2.jpg
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Some Novel Analytical Techniques Applied to LENR Active Materials

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We will explore the results from the analyses of several low energy nuclear reactions (LENR)-active tubes run by Brillouin Energy (BEC) using several different techniques. The most novel analytical techniques are terahertz (THz) imaging and THz spectroscopy. This imaging technique gives insight into the lattice spacing of crystalline and micro-crystalline metals and ceramics complimentary to that from X-ray diffraction (XRD) measurements. Figure 1 shows one example of this imaging performed on the nickel outer coating on one of BEC's catalyst tubes showing a cube of material 100nm on each side [1]. XRD of powder removed from this sample showed the normal lattice spacing for pure Ni powder. However, THz imaging showed lattice dilation in the Ni coating. We will discuss the potential source of this dilation as well as its possible importance to LENR. We will also discuss the results of THz spectroscopy performed on materials from this and similar tubes [2].

In addition to novel techniques, more common analyses can give LENR researchers important insights into the properties of their active materials. Some of these other techniques of interest are:
X-ray fluorescence (XRF)
Optical microscopy
Scanning electron microscopy/energy dispersive X-rays (SEM/EDX)
Inductively coupled plasma – mass spectroscopy (ICP-MS)
Inductively coupled plasma – optical emission spectroscopy (ICP-OES)

We have used all of these techniques to identify the chemical and metallurgical properties of the coatings used in Brillouin's LENR studies. Sample preparation is usually very important before performing any of these analyses. We regularly cut, mount and polish samples for microscopy analyses. Figure 2 shows a very useful line scan performed on a coated sample using SEM/EDX to show a depth profile of different elements present in the coating. These and other results will be discussed with suggestions how different techniques can be applied to other LENR experiments.

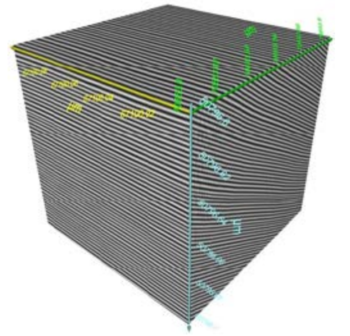

Figure 1. THz image of Ni coating, showing a 100nm cube.

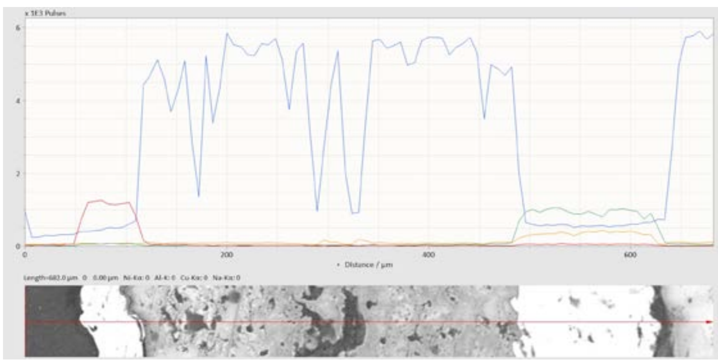

Figure 2. SEM/EDX line scan by Alan Goldwater, MagicSound Lab

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Huge Variety of Nuclides that Arise in the LENR Processes. Attempt at Explanation

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LENR studies have shown a wide variety of manifestations of this phenomenon. It manifests itself in metals with hydrogen dissolved in them, in plasma, in gas discharge, in electrolysis, and even in biological systems. In addition to energy release, which far exceeds the capabilities of chemical reactions, LENR is characterized by a huge variety of emerging chemical elements. The report provides examples of the appearance of many initially missing elements in different LENR installations. For example, in the nickel-hydrogen LENR reactor created in our laboratory, which worked for 7 months, Ca, V, Ti, Mn, Fe, Co, Cu, Zn, Ga, Ba, Sr, Yb, Hf were found. Moreover, the appearance of new elements is found not only in the "fuel" but also in the surrounding matter. The huge variety of chemical elements that arise can be explained by the fact that in the processes of LENR, the interaction covers several atoms at once. This can be an interaction initiated by neutrinos (antineutrinos) of very low energies, since such particles have a de Broglie wavelength (the size of the interaction region) much larger than the interatomic distances in condensed matter. Huge fluxes of neutrino-antineutrino pairs are generated in metals and dense plasmas by thermal collisions of electrons with atoms at a sufficiently high temperature. Another possible agent that causes collective nuclear transmutations is probably the light magnetic monopole (the magnetically excited state of neutrinos).

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Recent progress on phonon-nuclear theoretical models

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The models have as a foundation a relativistic phonon-nuclear interaction, derived from a many-particle Dirac model. Although this model is not covariant, numerical solutions for a moving two-body composite are reasonably close to what would be expected from a covariant theory. Similar coupling arises from the 2-body Bethe-Salpeter model.

The first step in excess heat production in the model is the transfer of the large 24 MeV quantum from the D_2/^{4}He transition to produce a reasonably stable highly excited state in a nucleus in the host lattice. Indirect evidence for this comes from low-level energetic particle emission in experiments not producing excess heat. A second step involves subdivision to two reasonably stable highly excited nuclei near 12 MeV. Indirect evidence for this comes from low-level neutron emission in the 4-6 MeV range.

Excitation transfer of the 5.5 MeV quantum from the HD/^{3}He transition is considered in the case of light water experiments. Highly excited states are known in the case of Ni isotopes. Transitions near resonance are identified. One such near resonance occurs in ^{137}Cs, suggesting an explanation for the 661 keV emission observed in the Piantelli experiment, and also a connection to the Vysotskii and Kornilova experiments. New experiments are needed to clarify if this interpretation is correct.

The null reaction in which the D_2/^{4}He transition transfers excitation to ^{4}He to produce D_2 was proposed more than 20 years ago. This process has the possibility of increasing the probability of two deuterons being close together, and may be connected to excess heat production at high rates, low-level dd-fusion, other energetic particle emission, and low-level 3-body reactions reported by Kasagi et al, and by Hubler et al.

Progress on the calculation of phonon-nuclear matrix elements includes a reduction of the relativistic phonon-nuclear interaction in the case of the one-pion exchange potential with pseudovector coupling. A reduction of the HD/^{3}He phonon-nuclear matrix element has been carried out. The phonon-nuclear matrix element for the ^{57}Fe transitions relevant to recent excitation transfer experiments has been considered. Some progress has been made on excitation transfer models in a lattice, suggesting the possibility of new experiments involving single crystals where the emission would show up in a diffraction pattern.

The acceleration of excitation transfer due to off-resonant energy shifts is predicted. A new model for many-quantum down-conversion has been studied.

The Nature of the D+D Fusion Reaction in Palladium and Nickel

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The LENR reaction can be made to occur in Pd and Ni having different physical forms. The behaviors of solid Pd, sintered Pd powder, and sintered Ni powder are discussed.

The required deuterium ions can be made available to the LENR process using gas discharge, electrolysis, or exposure to D_2 gas. Results obtained using each of these methods are described.

Initiation of the nuclear reaction sometimes requires creation of a large D/Pd ratio, but not always. In many cases, very little deuterium is required to produce detectable power. In every case, the amount of power is not affected by the D/Pd ratio after the nuclear process starts. Also, increased temperature causes the amount of power to increase exponentially, with the activation energy being related to the source of deuterons available to the nuclear process.

The reaction involving deuterium emits part of the nuclear energy as energetic ions having the characteristics of a hydrogen isotope, not helium. Very little photon radiation is detected outside the walls of the container in which the source is located.

The behavior is consistent with the nuclear active environment (NAE) being in physical gaps having a critical width located outside the crystal structure, not in vacancies located within the lattice structure. Successful production of LENR involves formation of these sites in high concentration and with reliability. This paper describes an effort to meet this challenge.

Progress towards replication; revisited

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I addressed this topic first in 2002 in a presentation at ICCF-9 held at Tsinghua Univ. in Beijing. Subsequently in the proceedings of that conference I and three of my closest collaborators (F. Tanzella, P. Tripodi and V. Violante) published [1] "Progress towards replication". In this we described a collaborative effort formally established between SRI International in Menlo Park, California, and ENEA (Frascati) in Italy. to provide a framework for an International replication effort that focused the complementary skills of the two laboratories on carefully selected problems of Pd/D studies. Our joint effort was an attempt to establish reproducible experiments that can be used to prove the existence of a new phenomenon (or phenomena) based on: (i) fundamental theoretical understanding; (ii) clear and simple experiments; and (iii) reliable diagnostic measurements of unarguably nuclear effects.

Why was such formality sought and considered necessary? Why were we attempting to test and demonstrate cross-laboratory (and trans-national) replicability? What experiments were attempted? What success was achieved? Where does the situation of replication in the broader field of Condensed matter Nuclear Science[1] stand today nearly two decades later? I will attempt to answer these questions in the larger context of the need for and achieved success of replication in our field today.

Anticipating that my comments may cause some discomfort, even controversy, I will speak as a single author expressing my opinions alone. A single reproducible experiment that works every time (or most times) based on a complete and understood written protocol that yields unambiguously nuclear or nuclear-level products would transform our field overnight from "marginal" to "main-stream". I don't believe we have achieved this state in any experiments with which I am familiar. Nevertheless it is very clear to me from study of the literature and my own work that a real phenomenon of CMNS exists. What prevents us from taking the final step to full reproducibility and widespread acceptance? What is, or might become, our transformational reference experiment?

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A Lattice Energy Converter

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As previously reported, a Lattice Energy Converter is capable of spontaneous-initiation and self-sustained production of ionizing radiation and the conduction of electricity from a specially prepared palladium electrode that is occluded with hydrogen without the use of naturally radioactive materials. While the LEC is relatively simple to construct and the experimental results have been replicated, the underlying processes are complex. In this paper, we will present experimental results along with analysis based on more than 150 years of research into the metal-hydride system and more than 120 years of research into the conduction of electricity through gases.

Direct measurement confirming Generation of Excess Heat

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It is now a reasonably well accepted and demonstrated concept that excess Heat/Energy through Low Energy Nuclear Reactions (LENR) or Cold Fusion could be the future green energy in many applications [1] [2]. Several groups across the globe is working to realise and capture the excess heat generated [3] [4] [5]. Some groups have used air calorimeter [3] and some other used water calorimeter [6]. However always these were questioned by third parties in the same field for quantity and consistency as m,easured using air flow velocities.
Both of these methods have limitations with the instrumentation and sensors. The group at CER has devised a different method to prove quantity of excess heat with Ni-Pd-D_2 system.

As calorimetric method of estimation of generation of excess energy is always under question , the group at CER has carried out a direct measurement using only the temperature of the reactor surface when the reactor is kept inside a thermally insulated non metallic box . The temperatures of the core of the reactor, surface of the reactor and inner surface of the insulator box were also recorded.

In the beginning a calibration experiment is carried out without any fuel in the reactor and subsequently the active experiment with the same set up but with Pd added as fuel inside the reactor. The reactor surface temperature for the power input given to the heater is also estimated mathematically. The measured surface temperature for calibration matched exactly with the mathematically derived value of temperature.

The experiment with active materials inside the reactor showed higher surface temperature than the value measured in the calibration experiment. Higher temperature in experiment with active material is clear indication of generation of excess heat in the reactor. Mathematical correlation has again been carried out accounting for the excess heat and match with measured values confirmed.

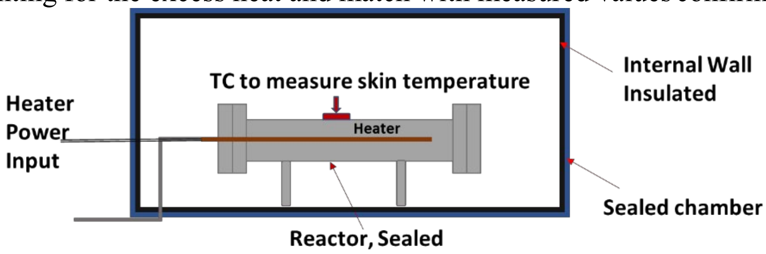

Figure 1: Adiabatic isolation of the reactor

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Ultr-high Density Cluster Enabled LENR

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Initial thin-film electrolytic LENR studies lead to the investigation of ultra-high density regions of Deuterium found in voids or dislocation loops in the films [1-2] Hydrogen "clusters" in these regions were estimated to have roughly 100–1000 atoms with superconducting properties below 70 °K as shown by SQUID measurements [3]. Subsequently, ways to increase the clusters per unit volume were studied, typically using multiple loading-deloading techniques to build up voids and dislocation loops near film interfaces. Later, we extended these techniques to the creation of clusters in pores in nanoparticles employed in subsequent gas loading experiments [4]. The nanoparticles are formed from various alloys ranging from Pd-rich to Ni-rich zirconia based materials. Deuterium or hydrogen gas at pressures up to 100 psi is used, with the Pd-rich or Ni-rich nanoparticles, respectively. The LENRs are initiated by an initial temperature rise associated with gas absorption in the nanoparticles. Depending upon conditions, LENR heating then rises to 300–400 °K, followed by a slow drop off over about 4 hours under constant pressure conditions. This drop off is attributed to a decrease in H/D flux with static pressure, cf. the need for voltage pulses to maintain flux in the earlier thin film electrolysis work. Periodic pressure variations are employed to obtain controlled runs over much longer periods. Other methods for initiation of reactions and run time control of the reactions have been investigated with varying results. It is proposed that these observations explained in terms of flow-momentum exchange between diffusing gas ions and the clusters. Considerable attention has been devoted to the calorimetry used in studies of deuterium pressurized nanoparticles in recent experiments [5]. The relation between these studies and the earlier thin-film plus nanoparticle work will be discussed in detail.

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European Union's Project: Clean Energy from Hydrogen-Metal Systems (CleanHME)

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A consortium of 16 scientific institutions and trade companies from Europe, Canada and the US started in 2020 a research project devoted to the study of various powders and metallic bulk materials in a hydrogen atmosphere to find the best solution for a future nuclear fusion energy source at extremely low energies. The project will be supported by the European Union over the next four years. The main research idea is to combine accelerator experiments performed at the lowest possible energies that enable the precise determination of electron screening energies and gas-loading experiments measuring excess heat and the expected low-level nuclear radiation. This approach also aims to understand the mechanisms by which nuclear processes are enhanced at room temperature and at the slightly increased temperatures observed in previous experiments. We also hope that the optimization of the chemical composition of active materials, gas pressure and ambient temperature will allow the construction of a new type of small gas reactors producing cheap, clean and safe energy for various purposes. In this talk, our research program and the research methods used will be presented in detail.

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Plasmonic Condensed Matter Nuclear Fusion

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The intensity and density of the triggering energy supplied to activate the nuclear fusion reaction are key factors to produce a smooth and reproducible initiation of the reaction. We previously proposed and numerically analyzed a scheme to provide high-density optical or electromagnetic energy to fusion-fuel materials by lasers and plasmonic field-enhancement effects, to significantly increase the reaction probability [1–6]. Large degrees of field enhancements, or energy focusing, were observed around metal nanoparticles and nanoshells [1], planar metal surfaces [2,3], metal/oxide interfaces [5], sharp metal tips [4], and metal nanogaps [6]. Strikingly, the field enhancement factors for hydrogen-absorbing transition metals, Pd, Ti, and Ni, can surpass those for noble metals in the microwave region [3,4]. This electromagnetic boosting effect may have unconsciously benefited the experiments reported so far, particularly for the electrolysis-type ones, and its active utilization with proper choices of materials, structures, and operating conditions can improve condensed-matter fusion systems further.

Gas-phase experimental research in quest of condensed-matter fusion is underway by using multilayered deuterium-containing Pd plates. In our experiment, we in particular directly apply a bias voltage across the Pd sample to provide a current injection through Pd, to stimulate the nuclear reaction by Joule heating, also anticipating strong electrodiffusion or electromigration, in addition to the conventional deuterium diffusion induced by pressure/mass-concentration and thermal gradients. We installed multiple kinds of lasers in the gas-phase D–Pd reaction system to irradiate the Pd samples coated with noble metal nanoparticles, as energetic stimulation support, potentially with a boosting plasmonic local field-enhancement effect. We simultaneously observed a sudden temperature increase with an overshoot and a neutron signal. Significantly, we observed a clear signal of substantial-amount ^4He generation from the Pd samples as a shoulder peak on the D_2 peak, and a possible ^3He signal, via in-situ mass spectroscopy [7]. We also observed a sudden burst of these gas species out of the Pd sample. Our results might indicate a certain anomalous nuclear-related reaction in the D–Pd system.

This work was financially supported, in part, by the Thermal & Electric Energy Technology Foundation, the Research Foundation for Opto-Science and Technology, and the Japan Society for the Promotion of Science.

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Laser induced transmutation in palladium thin films in hydrogen atmosphere

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Ubaldo Mastromatteo [1], published in 2016 a very simple experiment where he directed a laser beam on a thin film of palladium deposited on a silicon oxide substrate in H_2 and D_2 atmospheres. By SEM he showed formation of many new elements. Recently we did the same experiment with identical samples in H_2 and D_2. Both experiments in H_2 and D_2atmosphere lasted 3 months. We used a 5mW laser at 650nm. In this presentation, we will show the formation of hot spots detected by SEM and analyzed by EDX. Also, we did look for neutron formation with CR39 detectors. Finally, a TOF-SIMS analysis showed some isotopic anomalies.

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Electrodeposition of Hydrogen Adatoms on Graphene

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Conductive carbon materials, such as graphite, glassy carbon, carbon black, carbon nanotube, graphene, etc., are used extensively as electrode materials or catalyst carriers in various electrochemical researches because it is inert in the electrode/electrolyte environment. It is well know that the under potential deposition (UPD) of hydrogen adatoms has never been observed on carbon materials. We proposed, designed and demonstrated a “spillover-surface diffusion-chemical adsorption” system, and realized the stable chemisorption of atomic hydrogen on graphene by using platinum as catalyst and proton or water as hydrogen source. The experimental results of Raman spectroscopy evidenced the existence of C-H adsorption bond. The kinetics of surface diffusion of hydrogen adatoms on graphene were also measured. This phenomenon is valuable for the hydrogen energy.

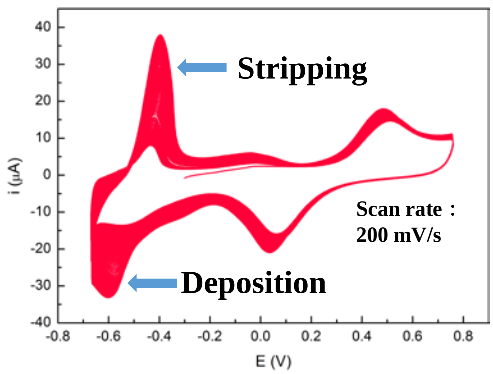

Fig. 1 The cyclic voltammogram of electrochemical deposition and stripping of hydrogen adatoms on a platinum sheet supported single layer graphene composite electrode in 0.5 M H_2SO_4 solution.

Hydrogen isotope separation through two-dimensional crystals

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Graphene and other two-dimensional (2D) crystals have recently been reported to be able to sieve hydrogen isotopes with both high hydrogen-to-deuterium selectivity and low energy consumption, at room temperature. This facilitates the potential developments of 2D materials-based isotope separation techniques. This talk will focus on the essential mechanisms for proton transport through 2D crystals, e.g. graphene and hBN, with unexpectedly high transport rates [1]. Then, discuss the origins of the isotope effects, the proton and deuteron separation factor and the performance and scalability of the prototype devices [2, 3]. Hydrogen isotopes transport with room temperature quantum sieving properties through atomic scale channels made of van der Waals crystals will be discussed as well [4].

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Input Stimuli and Output Signals in LENR Experiments

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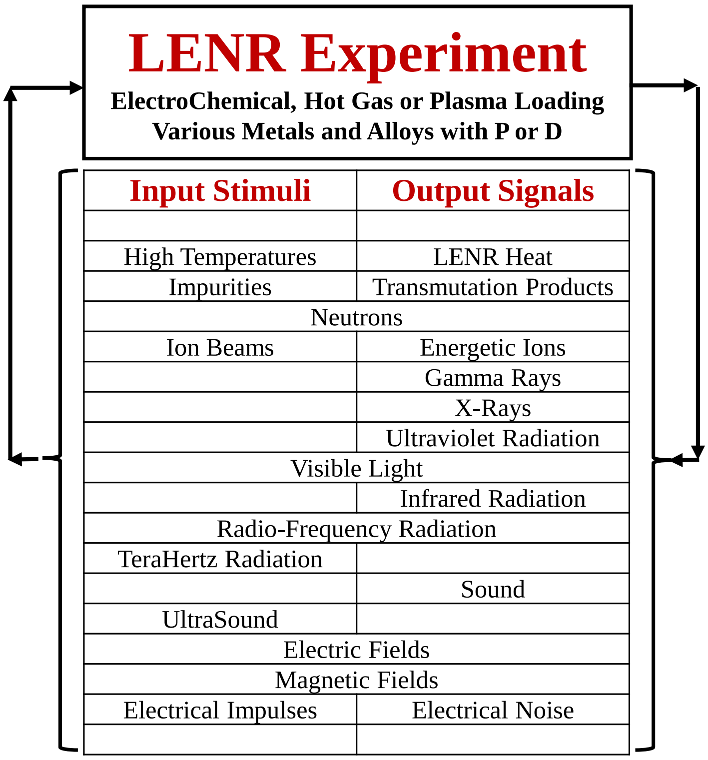
Over the decades, a wide variety of stimuli have been put into, and diverse signals have been measured from LENR experiments. The available empirical results raise two kinds of questions: (1) of all the published effects, which might be most valuable to emphasize in future experiments, and (2) what other stimuli or signals might be used to further the understanding and commercialization of LENR? This paper addresses these questions using the organization shown in this figure. Both productive past experiments and attractive future experiments will be considered.



Input. We will focus on a few of the input stimuli. Several past experiments have shown the efficacy of running LENR experiments at high temperatures. The potential roles of impurities are also significant. High frequency electromagnetic radiations in the visible, terahertz and radio-frequency ranges have been shown to lead to increased LENR rates. Published data show that electrical impulses also lead to increases in LENR production in some cases.

Output. Heat and reaction (transmutation) products are the most commonly measured output signals. However, our interest in this study will be more on the emission of electromagnetic signals in the visible, infrared, radio-frequency ranges. We give particular attention to the possible value of electrical noise in detecting the occurrence of LENR at levels well below calorimeter thresholds.

Input and Output. Electric and magnetic fields have been shown to both influence and arise from LENR experiments. There are some very basic questions regarding such fields, which we will discuss.

Any of the input stimuli or output signals are candidates for systematic, parametric experiments, which might illuminate LENR mechanisms and rates. Some such experiments will be recommended.

Review of Cavitation Induced Effects

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The He4 mass spectrum measurements from prior work are interpreted with respect to the crystal structure of the target foils, FCC or BCC. This interpretation brings a clear picture of various metal target foils and how they interact using a range of frequencies when cavitating with argon saturated DOD. The DOD is circulated to keep the temperatures low for more efficient cavitation. Ar gas is used as a cover gas in the experiments. Being a noble gas, its polytropic gas constant is the highest. In the adiabatic bubble collapse, its energy raised to the power of gamma equals a constant, $(PV)^g = C$, where g is the polytropic gas constant and is the ratio of their heat capacities. The g appears as an exponent in the PV energy expression and makes it very sensitive for maximizing that value. The gamma for Ar is 1.67. After DOD cavitation the TF (target foils) lattices were searched for He3, He4, and tritium. The mass spectrum measurements showed the presence of He4 atoms and a review of He detection as it relates to the target foil lattice.

The search for heat from 10 cavitated metals in light water and heavy water did not result in any positive results over 5% . However, the cavitated metals did show various anomalies that are difficult to explain in terms of the conventional understanding of cavitation. Several examples of "reaction" products and morphological constructs will be shown.

A novel Helium 4 detection system was constructed and has shown exceptional sensitivity down to the ppb level. A short description will be discussed showing the technique and method for the detection of He in the presence of hydrogen or deuterium gas.

Early Excess Power Using NRL Pd-B Cathodes

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The excess power in cold fusion experiments appears unusually early for Pd-B cathodes prepared by NRL (U.S. Naval Research Laboratory). This early excess power may exceed 100 mW and can be measurable within minutes of the start of the D_2O + LiOD electrolysis. This effect readily exceeds the maximum possible excess power for deuterium loading into the palladium. This unusual early excess power effect was first noted by Martin Fleischmann in his analysis of the Pd-0.5B (0.5 weight % B) data obtained in 1997 at the New Hydrogen Energy Laboratory in Japan [1]. A new experiment in Ridgecrest, California in 2017 using this same Pd-0.5B electrode showed similar early excess power effects. The re-examination of two previous experiments conducted at NRL in 1995 and using two different NRL Pd-B cathodes in a Hart Seebeck Calorimeter also showed early excess power effects. Therefore, this early excess power has been measured using three different types of calorimeters at three different laboratories and using three different NRL Pd-B cathodes. Possible explanations of this early excess power other than LENR (Cold Fusion) have been eliminated such as the change of the thermoneutral potential (E_H) during deuterium loading or errors in any experimental measurements. In fact, a simple equation has been obtained that gives the maximum power for the loading of deuterium into the palladium, $P_{(max)} = (E_H - E_H')I$, where E_H = 1.5267 V, E_H' = 1.3448 V, and I is the cell current in amps. For example, $P_{(max)}$ = 0.0273 W for a cell current of I = 0.1500 A when all of the cell current is used for deuterium loading. Boron added to the palladium may be an essential element for excess heat effects or it may create the special reaction zones such as vacancies, cracks, defects or grain boundaries needed for LENR.

Assuming that boron is essential for the excess heat effects, then the long electrolysis times (weeks, months) reported by Fleischmann and Pons could be due to the leaching of boron from Pyrex glass (mostly $SiO_2 + B_2O_3$) and gradually depositing at the palladium cathode. This may also explain why experiments at the Navy China Lake laboratory often gave larger excess heat effects for repeated experiments that used the same palladium cathode. There is some experimental evidence reported that boron-10 may be the heat source fuel in palladium cathodes [2]. A previous study of a NRL Pd-B cathode has identified helium-4 as the major fusion product [3].

The Fleischmann-Pons differential calorimetric equations were used for determining the early excess power for the isoperibolic calorimetric cells. The largest calorimetric term for these initial measurements is the C_pMdT/dt term which was carefully considered for possible errors. The cell heat capacity (C_pM in J/K) was evaluated by several different methods. Possible errors in dT/dt (K/s) were minimized by numerical integration methods which agreed with results obtained by using C_pMdT/dt directly.

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Excess heats in a Pd(Pt)-LiOD+D_2O reflux open-electrolytic cell

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A heavy water reflux open-electrolytic cell was developed. It differs from the isoperibolic cell used by Fleischmann-Pons [1] and Miles [2] in a long branch tube opened to outside for escape of evolved gas in electrolysis and reflux of heavy water condensed on the inner wall at ambient temperature as shown in Fig. 1. The evaporation rate (4.32I in μg/s) and power (9.79I in mW) of D_2O in open electrolysis at 25°C are small constants, which are almost independent on the atmosphere pressure, and the power balance is simplified therefore. Mass losses in Pd-D_2O electrolysis were measured and the results verified that the actual amounts of evaporation were consistent with the theoretical value within 0.2% under careful design and operation. Excess powers the in the Pd(Pt)-LiOD+D_2O cell were measured by a Seebeck envelope calorimeter after denoising [3]. Four phenomena are observed: (1) Excess powers were more easily observed in Pt-D_2O(H_2O) than in Pd-D_2O system. The maximum excess powers were 79 ± 12 mW with input power of 4.1 W for Pt-D_2O system and 156 ± 12 mW with input power of 2.6 W for Pt-H_2O system. The reasons are unclear and this phenomenon has puzzled us for a long time because the Pt-D_2O(H_2O) cell is always considered as the reference system in experiments. (2) The maximum average excess powers were 19 ± 9 with input power of 4.2 W and 46 ± 3 mW with input power of 2.6 W for Pd-Cu and Pd-B rods, respectively, provided by M.H. Miles. (3) The open electrolysis is in unsteady state and this state can be divided into 2 categories, i.e. long-time shift and short-time fluctuation, by sorted of voltage or input power changing with time. For long-time shift, the excess power of instantaneous must be compensated by the time rate change of input power. For short-time fluctuation, the data logging rate cannot follow the changing of input power, the output power are always less than the input power for all Pd(Pt)-LiOD+D_2O cells. (4) The concentration of LiOD in heavy water solution decreases with time during open electrolysis and it was found that LiOD had turned into precipitation of Li_2CO_3 as verified by XRD. All these factors make the calorimetry to be complicated and the exact reproductions of excess heat in open-cells must be careful.

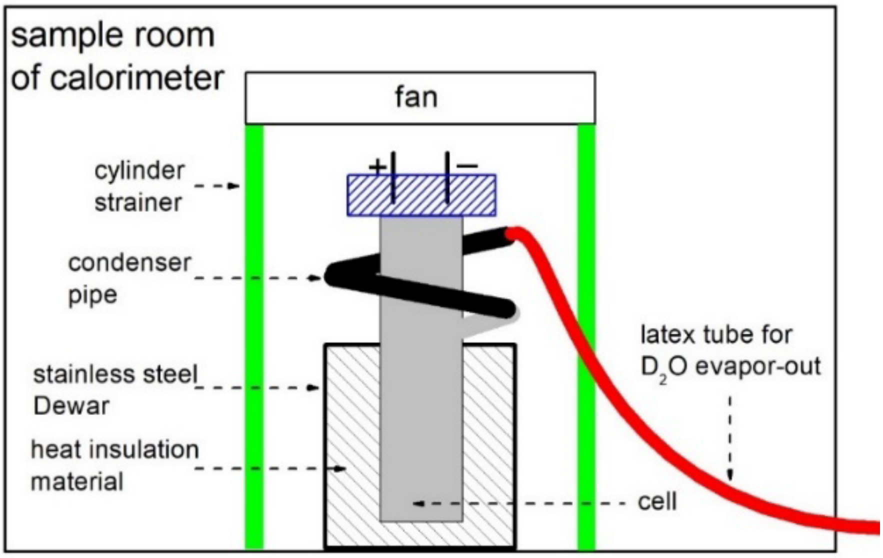

Fig. 1. Schematic of Pd-D_2O reflux open-electrolytic cell in the calorimeter.

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First results on coaxial-coiled thin Constantan wires, by electromagnetic excitation of very high-power density and high voltage pulses, at microsecond time regime.

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In the framework of LENR-AHE (Anomalous Heat Effects) studies we focused, since 2011, on innovative, low-cost materials instead of the usual, precious-metal, Pd. We found that the Cu-Ni alloy, also used for J-type thermocouple construction, has the peculiarity of easy dissociation of H_2 (or D_2) from molecular to atomic state, at enough low temperatures (150 °C), and to keep it inside the lattice and/or at surfaces, up to temperature of 700-800 °C, even at low gas pressures (few bar). Because long time experience (since 1994) on thin and long wires geometry of the electrodes, we concentrated our efforts taking advantages of such specific shape, specially from the point of view of electromigration of ab/adsorbed H, under proper longitudinal electric field (0.5-1 V/cm), DC and/or pulsed. On 1995 we got noticeable results using Pd wires in electrolytic environments (D_2O) at mild temperatures (40-60 °C). Later-on, in some experiments, we used even gaseous environments at high temperatures (up to 700-800 °C). Main problem of Pd was its large brittleness after H, D absorption. Moreover, we experimentally reconfirmed that one of key condition to induce AHE is the "flux" of H moving inside its lattice (longitudinal) or through the surface (transversal). Pioneers of transversal flux were G.C. Fralick-NASA; M.K. Kubre-SRII-USA, Y. Iwamura-MHI-J, Y. Arata-Osaka Univ.-J We focused on longitudinal flux (following the theoretical models developed by G. Preparata-Milan Univ.-I), although our unconventional electrolytic experiments (1995-1998) had both.
Anyway, apart the initial state, the flux needs external energy to be continuously activated because, in our experience, AHE are due to non-equilibrium conditions, i.e. are needed continuous stimulations, usually energy consuming, apart some specific (but delicate) geometrical set-up (like Capuchin knot in some of our geometrical arrangements).
Recently we developed an unconventional geometry of the electrode aimed to use, at almost the same time, longitudinal and transversal flux at high temperatures in gaseous environments: our goal is to minimize extra energy added, to maximize the AHE and keep it operative for time as long as possible. At ICCF22 we presented results obtained using Constantan wire arranged as *reversed coaxial coil* with inner electrode made by Fe tube. The thin Constantan wires had the surface treated to make them at submicrometric dimensionality and covered by a mixture of Low Work Function (LWF) materials. We observed that the time span of AHE was increased just by activating the wire surface by mild sinusoidal High Voltages (50 Hz, up to +-600 V, few mA), while the coil was DC powered to get both DC electromigration and proper high temperatures (>600 °C). The activation was effective mainly at low gas pressures, where the Richardson regime is possible. The Fe counter electrode operated mainly as electron donor, thanks to high voltage (Child-Langmuir effect) and low pressures. Because low pressure, over time, we observed an excessive de-loading of the H from the surface of the Constant, until the AHE vanished. So, to keep the AHE, some proper amount of H_2, i.e. enough large pressure (some hundreds of mbar), is needed. The effect is improved if the gas is ionised, i.e. Paschen/DBD regimes. Considering all such requirements we designed such coiled coil able to operate at high voltage in *pulsed* conditions: we could get, at the same time, very high values of electromigration (pulsed condition), large temperature because longitudinal current, transversal excitation i.e. flux, because gas ionization at mild pressures (high voltage), Richardson regime (for short time) just reducing gas pressure, all properly compatible with peculiar Paschen behaviours.
We will explain the specific set-up and summarise the recent results obtained, also considering the severe stress of the system: High Voltage, High Pulsed Power, High Frequency, High Temperatures.

Decay-Instability of Transmutated Chemical Elements Obtained in LENR Experiment

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It is well-known that there are chemical element transmutation and their isotope composition change in LENR experiment [1-3]. Time evolution of the transmutated chemical elements and their decay-instability have been studied in this work. The new transmutated chemical elements (Fe, Cu, Ca…) were obtained from the initial cathode material Ni (0,9999) in plasma-water reactor by a pulsed repetitive electric discharge (I_d ~100 A, t_i ~10 µs, F_i ~2 кHz), [1,2]. The chemical compositions of these initial elements and transmutated ones were measured by EDS method and ICP-MS method. It was revealed that there is considerable decay-instability of these transmutated chemical elements at time. This instability was accelerated dramatically by external weakly ionized plasma action (WIP, N_e/N_a ~10^{-6}), figure 1. One can see from this figure that the relative concentration of the initial Ni atoms (cathode material) is not changed, but the relative ones of exposed electrode and the relative ones of dusty erosive cathode particles are dramatically decreased. Author supposes that theoretical model of bi-nuclear atom [4] can explain the obtained experimental results.

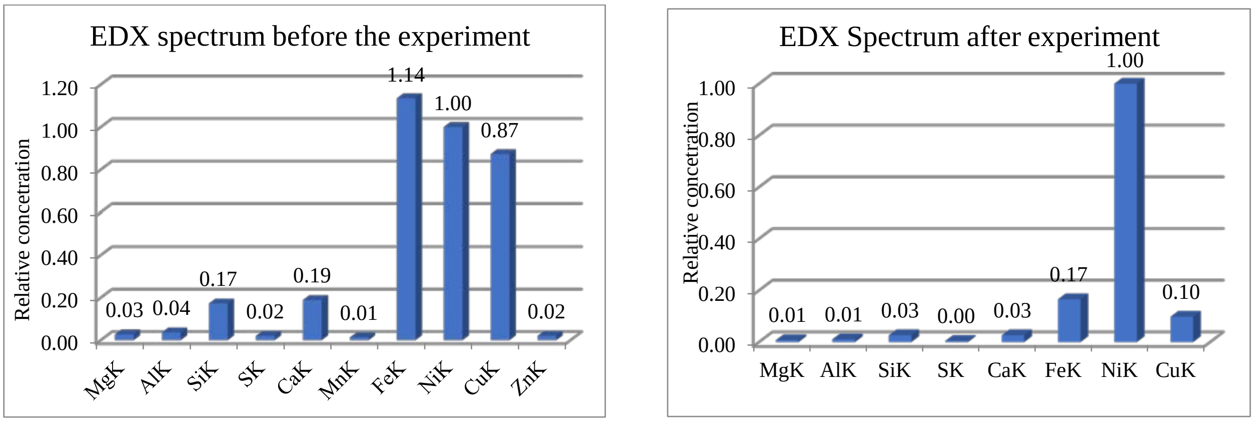

Figure 1. Relative concentrations of the transmutated chemical elements (erosive cathode particles) before exteriment (right) and after WIP's actions (left). Processed EDS spectrums

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Radiant calorimetry of excess heat production in NiCu multilayer foil with hydrogen gas

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It is shown in the NEDO project [1,2] that a nano-structured composite metal with hydrogen gas produces anomalous excess heat (AEH) when samples are heated to several hundred degrees. We have developed more convenient heat-generating method [3], using a multilayer composite metal thin film instead of the amorphous metal powder. The method is superior as follows; easy to make samples, good reproducibility of AEH, easy to observe low-energy radiations. However, the values of the excess heat deduced so far include non-negligible reducible uncertainty, because the evaluation is based only on thermometry, the temperature of the sample core.

In order to reduce the uncertainty as well as to obtain much information on light emission, we are developing radiant calorimetry in which light radiation emitted from the sample is detected over a wide range in wavelength. Employed are a thermometer TMHK-CLE1350 (wavelength 3-5.5 μm) for mid-IR, an FTIR spectrometer Hamamatsu C15511 (1.5-2.5 μm) for near-IR, and a spectroscope Hamamatsu C10027 (0.3-0.9 μm) for visible light.

Extensive spectral measurements of light radiation provide visual evidence of excess heat power. One can see such an example in Fig. 1, which compares the two spectra measured with (red dots) and without (blue dots) H_2 in the NiCu thin film sample heated by the input power of 34.5 W: the red dots exceed the blue dots over the entire region. This difference of radiant intensity is clearly the excess power due to the reaction involving H_2.

Detailed analysis reveals the difference of the foil without and with H_2 in other physical quantities more specifically: the temperature rises from 942K to 992K, the amount of radiation increases by 6.2%, the emissivity reduces from 0.144 to 0.124. The total excess power is evaluated to be 6.0 W, in this case.

In the present work, we show the result on two types of samples: (1) nanostructured Ni-Cu multilayer film deposited on a Ni plate and (2) pure Ni plate which is used as a substrate of (1). The heat flow analysis was performed based on the temperature measured at three points of the sample holder, the sample surface temperature, and the total radiant heat flow from the sample surface. It was found that the excess power of 2 – 6 W was observed for the sample (1) and the total energy produced in 120 hours was 0.72 MJ that corresponds to 3.8 keV/H atom. Experimental details and results of measurements will be discussed in detail.

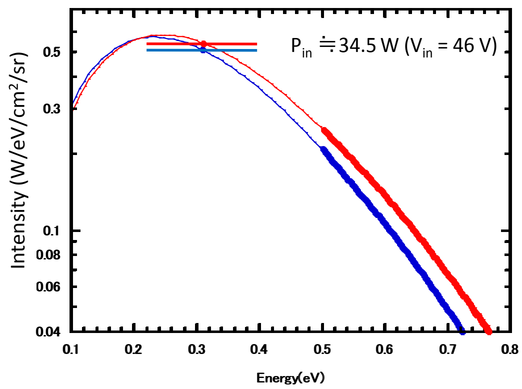

Fig. 1 Light spectra emitted from NiCu multi-layer thin foil; measured without H_2 (blue) and with H_2 (red).

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CF/LANR Excess Heat Activates Shape Memory Alloys

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Nitinol [1,2,3] is a Shape Memory Alloy [SMA, also known as Flexinol and Muscle Wire]. It was used here as sensor to detect CF/LANR activity based on its complex unique metallurgy and its response to heat. Several Nitinol devices were examined both for their responses to ordinary and CF/LANR-induced excess heat. Controlled heating was by electrically driving an ohmic control alternating with an active NANOR®-type component (#N7-24) with a ZrO_2-PdD core [4,5]. The metrics measured were heat induced force, temperature, and changes in the Nitinol wire's length as determined by using *in situ* 3D accelerometers and gyroscopes, thermocouples, and a time-of-flight (TOF) optical reflection measurement along the nitinol itself, during the heating (Figure 1). The input electrical power (blue lines) to the ohmic control and NANOR®-type component, are shown as a function of time, along with the output thermal power (red lines) from each, and the kinematic responses. Observe the RMS force wrought (qualitatively determined by the response of accelerometers) during this time in the curve below (green line). In this run, it can be seen that there is LANR activity, and excess power (beyond that applied) can be easily seen. Note that, as usual, the incremental (excess) power curves rise in a supra-linear way to constant input power.

In summary, the nitinol LANR detectors are not selectively specific for LANR/CF-induced excess heat, but can detect the excess heat. They are also not as sensitive, nor as reliable, and also more difficult to use, than other methods described in the cold fusion literature, previously; and are probably limited to qualitative corroboration. By contrast, calorimetry (with ohmic controls and time integration), coherent antiStokes spectroscopy [6,7] and Deuterium Line RF spectroscopy [8,9] continue as the superior methods to selectively semi-quantitatively detect active LANR/CF states.

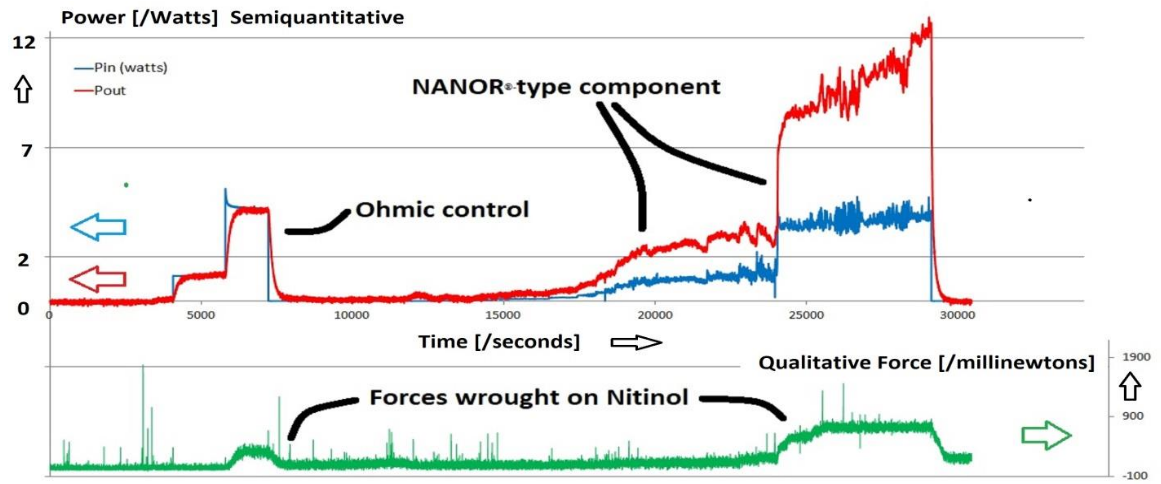

Figure 1–Input electrical power delivered to an ohmic control and then Nanor®-type component [7-24], and the resultant output thermal power and the force wrought upon the nitinol next to both.

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The Electromagnetic Considerations of the Nuclear Force, Part II: The Determination the Lowest Energy Configurations for Nuclei

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This paper is Part II of a series of papers, describing the concepts of the Electromagnetic Model of the nuclear force—that force which holds together the nucleons in a nucleus. The Electromagnetic Model claims that the nuclear force is a direct result of the electromagnetic forces of the quarks within the nucleons. Part I of this series, "The Electromagnetic Considerations of the Nuclear Force" explains how the electromagnetic force is able to achieve nuclear bonding, when quarks are considered. Historical objections and common misconceptions regarding the electromagnetic force within nuclei are answered and clarified in the first paper of this series [1].

In this second paper, the lowest energy configurations of the nuclides are determined by using the laws of electromagnetics. The lowest energy configuration of hundreds of nuclei, from ^{2}H to ^{250}Ca, have been determined, computer-modeled, and simulated by applying the laws of electromagnetics to the quarks. For the lowest energy configurations of the nuclides, a pattern emerges in which there are basic building blocks, AKA segments or clusters, within the nuclides. These building-block segments are linked together in a chain-like manner, to form what are known as "nuclear molecules". This finding of clustered segments is very similar to the concepts of the Cluster Model of the nucleus [2]. Recent research, both theoretical and experimental, regarding the Cluster Model has shown that cluster-type structures do indeed exist within nuclei [3-5].

By applying the equations of the electromagnetic energy to the positively-charged and negatively-charged quarks that are within each nucleon, analytical predictions can be made about the lowest energy configuration of the nuclides. Simply described, the lowest energy configuration is with the most number of quark-to-quark bonds formed, and with the net positive charge of the nucleus spread out as far as possible, while still maintaining the bonds. Any negative charge, such as that found on an unbonded down quark, tends to be situated within the highest concentration of positive charge. This paper describes how the various possible lowest energy configurations are tested and compared with one another, in order to determine which configuration is actually the lowest energy configuration. Thus, the configurations described in this paper are not mere speculation, but rather they represent the lowest energy configuration of the nucleons when taking into consideration the laws of electromagnetics, as applied to the quarks.

From carbon ^{12}C upwards, the stable nuclides follow a straightforward pattern, and can be described by a few simple rules:

- There is one alpha-particle segment for every two protons and two neutrons.
- If the number of protons is odd, then contained within the configuration there is one tritium-segment, made of one proton and two neutrons. This tritium segment has one negatively-charged unbonded down quark.
- When there are more neutrons than protons, the extra neutrons form single-neutron segments, each with a negatively-charged unbonded down quark. These single-neutron segments are interspersed between the net positive charge of the alpha segments, thereby lowering the net repulsive Coulomb energy of the nuclide.
- When the number of protons and the number of neutrons are equal to each other and both are odd, such as nitrogen ^{14}N, then there is a single neutron segment plus a single proton segment. This situation is rare for stable nuclides.
- Unbonded down quarks are nearer the middle of the configuration, allowing the net positive charge to be slightly more spread out.

Contrary to outdated conventional models of the nucleus—such as those that do not acknowledge the existence of quarks—this model proposes that an inherent structure exists within each nuclide, and that this structure strongly influences the nuclear behavior of the nuclide. For example, this model is able to achieve excellent predictions of binding energy, using only one variable. The binding energies of these nuclei have been calculated and compared to experimental data; the calculated binding energies agree with the experimental binding energies within a few percent. No other currently-accepted model of the nuclear force has been able to demonstrate such a tight prediction of binding energy using only one variable. Also, by examining the structural configurations of each nuclide, we can gain a better understanding of numerous other nuclear behaviors—behaviors that are a direct consequence of the electromagnetic forces acting within that structure. Thus, by identifying and recognizing the inherent structure within each nuclide, we can achieve more rigorous and accurate predictions of nuclear behavior. This, in turn, can give us a better understanding of Low Energy Nuclear Reactions.

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A role for relativity in Cold Fusion

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Cold fusion is still rejected by many, despite decades of experimental support, because it violates much of the well-known physics experiments and theories of the last century. At the beginning of that century, relativity was rejected (as difficult to understand and unnecessary) even though there had been prior decades of hints to suggest it was needed. It was accepted largely because of a single experiment by a famous scientist. (Some people still argue against the model.) Relativity has now been proposed as a necessary ingredient for the mechanism of CF. Relativity is the basis of the deep-electron orbits that can explain much (i.e., all so-modeled effects) of the cold-fusion results. We suggest that it might also provide hints as to what is needed, experimentally, to initiate the CF process for testing and commercial operation.

This mainly graphical presentation will show how the deep-orbits can be modeled from both the relativistic-classical and -quantum mechanics equations. It will seek to demonstrate how the electrodynamics of an orbiting electron can produce the 200x greater effective-Coulomb potential than that provided by electrostatics. This mechanism, if validated by cold fusion, will have immediate application to many aspects of nuclear physics.

Can the collective emission of the excited surface phonon trigger low-energy nuclear reactions?

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Low-energy nuclear reaction (LENR) in condensed matter is a very challenging topic due to the complex control parameters to reproduce the experiments, and the remarkable impact to human society. The resonant tunnelling optical model with coupled complex potentials [1] is very interesting due to its simplicity and interoperability. The model includes a complex Coulomb barrier with a positive real part and negative imaginary part, coupled with a complex nuclear well with a negative real part and positive imaginary part. Physically, the positivity in imaginary part denotes the absorption nature, and the negativity in imaginary part denotes the emission nature. However, it is very hard to understand for emission nature of Coulomb barrier.

Here, we proposed a hypothesis of coherent emission of the excited surface and/or sub-surface atoms contributed to the negative imaginary part of Coulomb barrier, and then to the origin of LENR. Typically, excited surface phonons are incoherent due to the random inter-atomic collisions. The possible factor is to locally excite the surface phonons and result in the Bose-Einstein condensation. In particular, the localized anharmonic vibrations proposed by Dubinko et al might be one of the possible ways to realize the localized excited coherent surface phonon [2]. We calculate the phonon band structure of PdH and PdD by considering the anharmonic vibrations, and try to bridge the gap of the localized anharmonic vibrations and the emission nature of surface phonons. The proposed mechanism might be useful for understanding some LENRs triggered by thermal heating, THz pumping, gas pumping or inflating, etc.

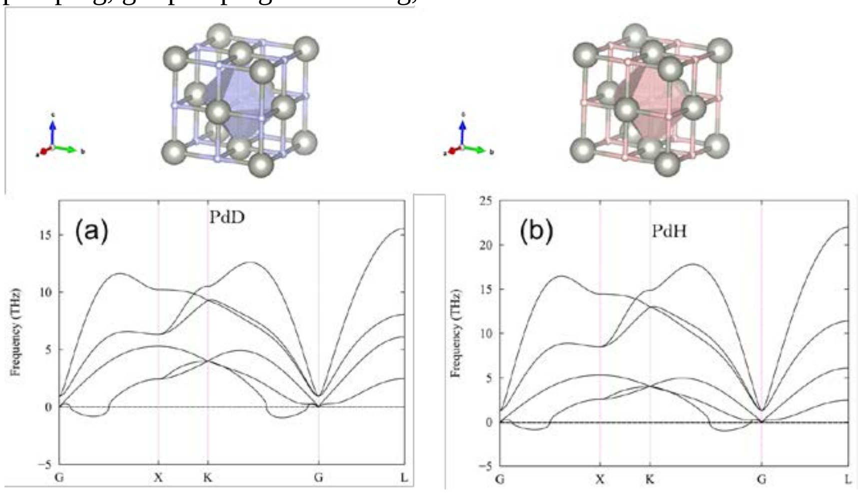

Figure 1. Anharmonic phonon spectra calculated for PdD (a) and PdH (b).

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Excess Energy from Heat-Exchange Systems

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In ICCF22, we presented a vapor compression machine (VCS-1) using a 2.75RT freon compressor (Figure 1) which can produce excess energy [1]. The hot refrigerant vapor from the compressor (around 150ºC) is used to heat the water flowing through a tiny passage of a triple-pipe heat exchanger. This may cause a violent cavitation of water. The machine was modified furthermore and tested for two years since then. The calorimetric method for COP measurement was improved. The COP inside the steam generator is defined as the heat carried away by water (Q_{wnet}) divided by the net heat input (W_t - Q_L), denoted as COP_x . This is used as the criterion to determine the possibility of excess energy generation. If the measured COP_x was greater than 1, then the cavitation-induced low-energy nuclear reaction (LENR) might occur. The test shows that the maximum COP_x reaches 1.97 (Figure 1) and COP_x increases with decreasing inlet water temperature.

We also modified the triple-pipe heat exchanger into double-pipe one and replaced the freon compressor with a 5 kW steam boiler operating at 110~130ºC (Figure 2). COP_x reaches 1.55~2.55 and some peculiar phenomena were observed. The inner copper pipe (steam side) was deformed and the outer pipe wall (water side) was cracked and leaked, after a few hours' operation. The outside surface of the inner pipe (thickness 0.4mm) became shining black which contains 10~23% carbon and 20~28% oxygen. This is caused by a huge pressure (>160 bar) or a high temperature (>500ºC) resulting in buckling of inner pipe and rupture of outer pipe that was probably induced by LENR.

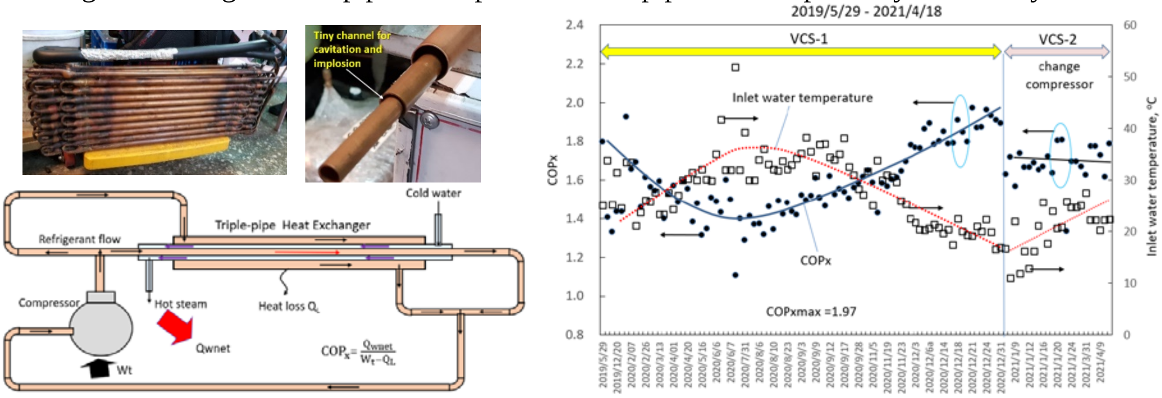

Figure 1. Schematic of vapor compression system (left) and test results (right).

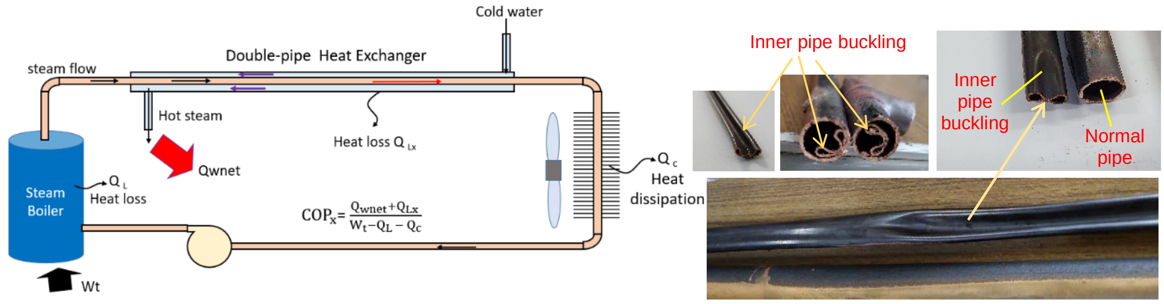

Figure 2. Schematic of double-pipe steam generator (left) and pipe deformation due to LENR (right).

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Long Term Anomalous Heat from 9 nm Pd Nanoparticles in an Electrochemical Cell

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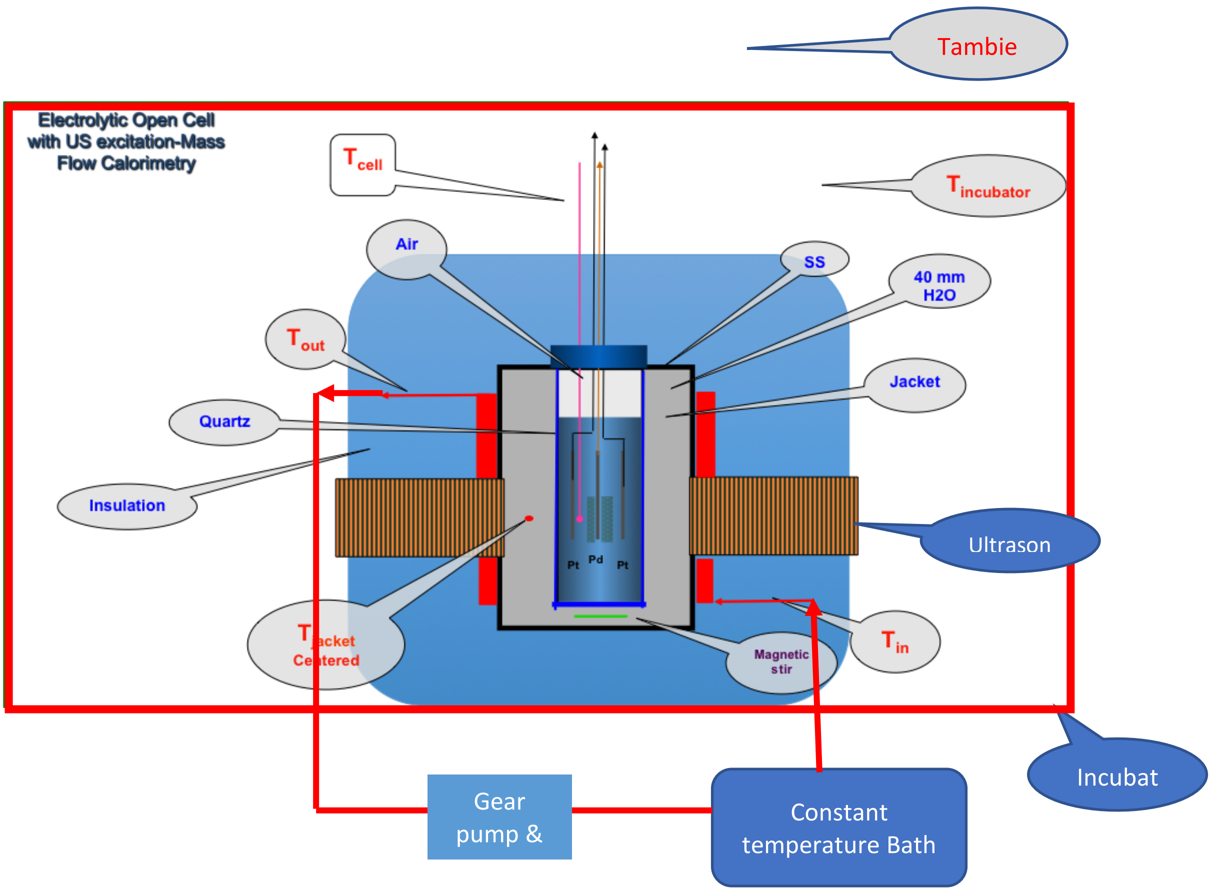
We report 58 days of 90 milliwatts anomalous excess heat in an electrochemical cell which integrates to 453,000 Joules of liberated energy, including 4 days of anomalous heat after electrolysis power was shut off. The Pd cathode was placed in tension and 9 nm Pd nanoparticles were deposited on the cathode in situ at the onset of the experimental run. We employed a Fleischman-Pons type open electrochemical cell, modified to allow ultrasonic stimulation of the cathode. The electrochemical cell was surrounded by a liquid water jacket to facilitate the transduction of ultrasonic wave energy into the electrochemical cell. The electrochemical cell and water jacket are placed inside a mass flow calorimeter. There are thermal sensors in the water jacket and adjacent to the cathode. The ultrasonic transducers were not used in this experiment. All temperature sensors were consistent in reporting of the anomalous heat. Details of the experiment will be described.



Temperature and pressure dependence of anomalous heat generation occurring in hydrogen gas absorption by metal powder

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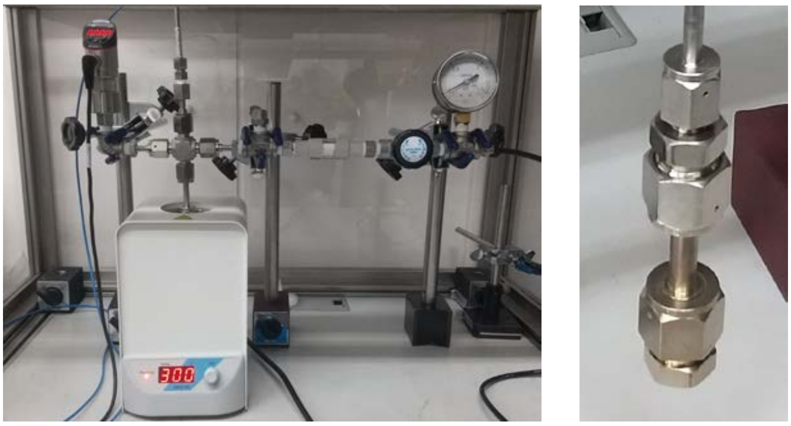
It is known that anomalous heat is generated when hydrogen (or deuterium) gas is absorbed by nickel or palladium powder [1-2]. There are lots of researches while increasing either initial temperature or pressure in reaction chamber. In our previous report [3], we developed a small constant-volume reaction system (shown in Fig. 1) in order to validate excess heat generation, while increasing both of pressure and temperature simultaneously. This is because only temperature increase may lead to less reaction due to the possibility that hydrogen gas heated gets out of metal powder such as palladium or nickel.

In this report, we conduct fundamental experiment of hydrogen gas absorption, up to 300 °C and 0.5 MPa. Sample (nickel powder or Pd-Ni-Zr composite powder) absorbs loaded hydrogen gas, after evacuation and preheating. Temperature changing of the sample is measured by K-type thermo couple. As a result, temperature rise of about 4 K is observed in the experiment conducted for nickel powder, while that of about 12 K for Pd-Ni-Zr composite powder is obtained. Emphasis is placed on the fact that temperature rise is assisted by not only preheating but also gas absorption under higher pressure. Obtained experimental results brings an insight on quantitative evaluation of correlation between output of temperature increase after reaction and input parameters such as preheat and loading gas pressure of hydrogen gas. This will also be important as basic database for the focusing compression engine proposed by us [4].



a) overall view b) reaction chamber

Fig. 1. Reaction system

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Progress of Reproducing the Mizuno's Experiment in QiuRan Lab

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The objective of this study was to independently reproduce Mizuno's experiment.

We replicated the D2(H2)-Pd(Ni) reaction system reported in the literature[1]. On the other hand, we developed a different calorimetric system employing two calorimeters to measure the heat generated by the reaction system. One is a Seebeck calorimeter and the other is based on the hydrothermal temperature difference. We improved the reliability of the Seebeck so that it achieves 0.1W accuracy consistently, as in Figure 1.

We operated the D2(H2)-Pd(Ni) reaction system at different conditions. The following observations were found to be reproducible:

Condition 1: When the pressure of D2 in the system was higher than 6 kPa, no excess heat could be observed.

Condition 2: Initially with ~800Pa D2 inside the system, we applied vacuum-pumping to the system for 5 hours, during which a negative excess heat (heat absorption) pulse was observed. After rebalancing, we filled D2 to the system quickly to reach 800Pa again, a positive excess heat (heat generation) pulse was then observed, which peaked at 40W and last for 4 hours. Integration of the two pulses would result of a net gain of 40kJ excess heat. An input heating power of 250W was maintained throughout the experiment.

Condition 3: Initially with ~500Pa D2 inside the system, we repeated the operations of quickly pumping vacuum and refilling D2 to reach 500Pa, positive excess heat pulses were then observed in most cases. These pulses peaked at 3-5W and last for 3 hours. An input heating power of 250W was maintained throughout the experiment.

Condition 4: The pressure of D2 in the system was maintained at ~10Pa. Continuous excess heat power of 1.5-2.5W was observed while the input heating power was between 150W and 250W.

In conclusion, we were able to reproduce the Mizuno's Experiment to a certain extent in QiuRan lab. The power level of excess heat was found to be related to the D2 pressure, input heating power and the vacuum-pumping operations. Although reproducible, the level of excess heat power in this study was far less than that observed in the Mizuno's experiment. In QiuRan lab, we are building and testing new D2(H2)-Pd reaction systems for higher level of excess heat.

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The Explanatory Power of the Structured Atom Model (SAM)

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The Structured Atom Model is founded on the intuitive notion, supported by observations, that the atomic nucleus should have structural properties. It is a visual tool that permits understanding of physics at a detailed level without having to master difficult mathematics or resorting to quantum mechanics. Starting from a few simple assumptions, for example the neutron not being fundamental, but a proton-electron combination, we discovered many properties of the nucleus as well as several organizational principles that nature appears to use for constructing the elements. SAM is connected to the real world because during its development at every step we checked whether the new element that would result was congruent with observed data such as isotope stability and abundance, oxidation state, etc. In this process we saw a new periodic table of the elements (PTE) come into existence that raises new issues as to the completeness and limits of the current PTE.

Summarizing, we found that SAM provides insight in a great variety of physics phenomena through visual identification. For example, we can see, observe, or explain:

- how the isotopes of an element differ from each other,
- where the cycle-of-eight comes from and why it breaks down,
- the attributes of elements such as oxidation state by studying nuclear structure,
- why the elements become unstable after lead,
- why alpha decay happens with some but not with other elements,
- how and why normal beta decay occurs,
- how nature uses decay paths including those through isomeric transitions,
- why double beta decay happens,
- how and why uranium-235 splits asymmetrically,
- the origins of the “neutron” drip line, and the “neutron”/proton ratio in heavier elements.

We have created a new numbering system for the elements which in turn opens space in the periodic table for new elements that nature has skipped over or that we have not found yet. However, those new elements that nature skipped could possibly be created artificially.

This is the first time that we disclose the full scope of the Structured Atom Model and we think that it is important that the LENR community becomes fully aware of the power of SAM as a research tool. Therefore, the final part of the presentation focuses on various LENR experiments, concluding with our vision for a LENR breakthrough based on SAM.

Nuclear transmutations are better facilitated by alloys over pure metal cathodes in electrolysis.

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Recently, various studies have shown Nuclear signatures in low energy physical and chemical processes ("Cold fusion" edited by Jean-Paul Biberian). One of the most effective methods to realize low energy nuclear reactions (LENR) is via electrolysis. Our primary objective is to explore the importance of alloys as opposed to pure metals as cathodes for LENR. To explore this question, we evaluated four systems: Pure Ni, pure Cu, Ni-Fe alloy (Ni 93% and Fe 7% WDS) and Kanthal (Fe 74%,Cr 21% and Al 5%).

The electrolysis setup uses very pure graphite (99.99%, impurity < 0.01% by WDS) for anode, and metal (alloy) wire/strip as cathode. 1 molar potassium carbonate (99.995% by trace metal analysis) aqueous solution is the electrolyte and the system is biased at 20 V, 1 A for 10 hours or so. We employ highly sensitive X-ray spectroscopy (EDS and WDS) and mass-spectroscopy characterization (TOF SIMS) to characterize the elemental composition and isotopic variations on the cathode before and after the electrolysis.

Elements like Ni and Ni-Fe transmute to Cu, Fe, and Mg. Isotopic shifts are also observed in Ni and Cu which forms undeniable proof of transmutations in metal after electrolysis.While confirming transmutations, the electrolysis experiments reiterate that the macroscopic control of electrochemical conditions (like potential bias, time, amount of current) do not provide an adequate control on the microscopic nuclear environment. Hence, with the same macroscopic parameters, there are variations in nuclear transmutations rates.

Overall, our experiments show that it is easier to induce nuclear transmutations in alloys as compared to pure metals. Currently, we are exploring the underlying reasons forthe effectiveness of alloys.

Artificial radioactivity in the nonequlibrium plasma of the glow discharge in Pd-D and Ni-H from the point of view of nuclear-chemical reactions

Irina Savvatimova

It is shown that artificial radioactivity can be initiated in conditions of nonequlibrium plasma glow discharge. The analysis of the isotope and elemental composition in the near-surface layers of ***Pd*** and ***Ni***, the original and after 40-hour exposure in deuterium- or protium- containing plasma by the ICP mass spectrometry (ICP-MS) has revealed significant changes in isotope composition of impurity elements. The significant reduction in ***Pt*** and ***Pb*** impurities in ***Pd-D*** systems in times have found.
In addition, an increase in the content of ***W*** isotopes was found in the ***Pd-D*** system, which correlated with a decrease in the content of ***Pt*** isotopes.
In the ***Pd-D*** experiment the content of ***Pb*** isotopes (masses 206, 207, 208) decreased by ~ 200 times and ***Pt*** isotopes by ~ three times, and in the ***Ni-H*** experiment, ***Fe*** (by ~3-10 times) and ***Zn*** (from 20 to 1000 times).

Table 1 Reducing the content of ***Pb*** and ***Pt*** isotopes in ***Pd*** after exposure in ***D*** plasma (ICP)*

Pb* in *Pd	**204**	**206**	**207**		**208**
Before exposure, %	1.51	24.64	19.67		54.18
After exposure, %	6.29	23.67	19.98		50.06
The remaining isotope, %	< 0.1	<0.57	< 0.61		<0.55
Pt* in *Pd	**192**	**194**	**195**	**196***	**198***
Before exposure, %	0.76	32.66	32.41	26.27	7.90
After exposure, %	0.81	32.27	34.26	25.05	7.61
The remaining isotope, %	< 30.9	< 28.5	< 30.5	< 27.5	< 27.8

*In **Pd** σ for impurity elements in 15 dimensions varies from (0.01 to 1-3) %.

Table 2 Reducing the content of ***Fe*** isotopes in ***Ni*** after processing in hydrogen plasma

Fe* in *Ni	***54***	***56***	***57***
Before exposure, %	6.55 ± 0.02	91.22 ± 0.10	2.23 ± 0.01
After exposure, %	18.85 ± 0.10	79.56 ± 0.26	1.59 ± 0.02
The remaining isotope, %	37.6	11.4	9.3

Zn* in *Ni	**64**	**66**	**67**	**68**	**70**
Before exposure, %	46.9 ± 0.02	28.36 ± 0.02	4.34 ± 0.01	19.62 ± 0.02	0.71 ± 0.00
After exposure, %	98.7 ± 0.33	0.32 ± 0.01	0.13 ± 0.01	0.80 ± 0.03	0.01 ± 0.00
The remaining isot.,%	5.5	0.03	0.08	0.1	0.07

The processes of decay of impurities and other transformations (transmutations) in the nonequlibrium plasma of the glow discharge are considered from the point of view of nuclear-chemical reactions.

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Where and How LENR Occur

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The occurrence of LENR involves two separate considerations: (1) the location where reactants come together, and (2) the mechanism by which the nuclear reactions occur. Understanding, and also the practical reproducibility and control of LENR, require attention to both where and how LENR happen.

Where: The locations and conditions needed for production of LENR, what Storms called the Nuclear Active Environment (NAE) [1], have received much attention over the decades. Both the interior and surfaces of materials have been considered, with frequent attention to defects. The interiors of real lattices range from being **highly pure and perfect** with thermal vacancies (like silicon crystals grown for chips) to other **pure but defective crystals** with 0-D point defects (single vacancies or small clusters of vacancies), 1-D line defects (various dislocations and also vacancy tubes in Super Abundant Vacancy or SAV materials), 2-D planar defects (internal grain and twin boundaries, and external surfaces), and 3-D defects (including gaps, cracks and voids), to **impure crystals** (with interstitial or substitutional impurities) to **alloys** (of many kinds). There is a similar range of defects on surfaces, including 0-D point structures (surface vacancies or adatoms), 1-D defects (notably ledges), 2-D defects (such as the surface itself and incomplete overlayers) to 3-D defects (including gaps and cracks). Storms favors cracks on and in materials [2]. Miley has touted dislocations as the NAE [3]. Staker apparently believes that LENR occur within tubes of vacancies in SAV materials [4]. This paper considers grain boundaries and surfaces as the NAE. Both of these 2D structures are very common, and have open characteristics. Those two features favor both high accumulation and facile motion of deuterons or protons into and within materials on scales ranging from the macroscopic to the nanometer scale. High loading and high fluxes of deuterons are both known empirically to favor production of LENR.

How: The physical mechanisms for nuclear reactions also require detailed consideration. Numerous theories have been advanced to explain how LENR occur, but most of them are incomplete [5]. One of the more complete LENR theory was advanced by Kálmán and Keszthelyi [6]. It involves a three-body catalytic mechanism, and standard second-order Quantum Mechanical calculations. Their published numerical results have yet to be validated, but their mechanism agrees well with results from significant LENR experiments. For example, some experiments have shown that LENR power varies with the square of the degree of loading. Many experiments have shown the value of a flux of deuterons or protons. The Kálmán -Keszthelyi mechanism agrees with these and some other LENR observations.

This paper will review laboratory LENR data which supports both possibilities: (1) LENR tend to occur near grain boundaries within lattices, and also on the surfaces of lattices, and (2) the three-body catalytic mechanism is a leading candidate for the understanding of LENR. Experiments to test both perspectives will be recommended. Significant LENR data that does not clearly align with the two possibilities will also be examined. Such data challenge the perspective of this paper.

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Phonon Assisted Fusion

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This paper continues and expands upon a paper presented at ICCF-22 related to phonon assisted fusion.

The overall thesis is that there exist sparsely occupied "nearly free" deuteron states which are modelled similarly to nearly free electrons in traditional solid state physics. These states are occupied in the range of 10^{-4}, depending on D doping and lattice temperature. The probability amplitude of the states is largest in regions other than where Pd and bound are. The charge of nearly free D's, whose spatial extent is in the range of .4 A, is neutralized by a much shorter electron Debye length than the local de Broglie wavelength, so D-D repulsion is negligible, and nearly free D's overlap. This results in a "large" excited compound (roughly .4A) nucleus that could decay either through the normal paths, with hot particles, or through an additional path, which involves multiphonon assisted transitions. The transition rates for the traditional paths can be shown to be decreased by ~28 orders of magnitude because of the increased volume of the compound nucleus, whereas the phonon assisted rates are appreciable under certain conditions.

When threshold conditions are right for a specific phonon mode, the mode becomes rapidly occupied, with the created phonons draining energy from the excited nucleus. The mode occupation grows until a saturation point is reached where the mode decay rate, which is phonon occupation dependent, exceeds the phonon generation rate. Hence, the total power released depends on the number of modes above threshold, and the number of phonons in those modes, as limited by saturation.

This leads to two formulas: one for mode threshold, and a second for mode occupation/power generation, which are derived.

The threshold equation and the power equation depend on parameters which are spatially non-uniform, temperature and pressure dependent, and generally not measured locally, if at all. This leads to huge non- uniformities and experiment-to-experiment variations.

The equations give clues as to how to choose and improve LENR systems, including hydrogen systems. Of particular interest are, for a microcrystal in a material:

- The impact of pressure, impurities and vacancies on phonon densities of states at a given wavevector, and the consequent impact on thresholds
- The impact of external stimulation of phonon mode occupation to initiate a reaction
- The number of "nearly free deuterons" as a function of temperature, doping, externally applied potentials
- The microcrystal size and shape
- The material lattice parameter The phonon decay rate as a function of k and mode occupancy, temperature, stress and host lattice

Newly available information on phonon spectra in nearly pure Pd:D, and stressed Pd:D suggest that phonon lifetimes are strongly influenced in perhaps unappreciated ways.

Correlated quantum states in LENR: first exciting results from an experimental test

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First experimental test of the Correlated-Coherent quantum States (CCS) model [1-2] is described in this paper, showing its potentialities in the explanation of anomalous effects in Nuclear Physics and Astrophysics, such as excess energy production in LENR and the big cosmological enigma of primordial lithium [3].
The occurrence of nuclear reactions at very low energy is a clear indication of a strong enhancement of Coulomb barrier transmissivity, which has been observed in several other accelerator experiments [4-5]. These experiments are, however, downwards limited in energy ($E_{min} \geq 5$ keV) due to the strong electrostatic repulsion. In the present experiment ([6-7] for more details) the $^{7}Li(p,\alpha)^{4}He$ reaction has been investigated at a c.m. energy around 450 eV, where the expected "standard" cross section is of the order of 10^{-50} barn! The detected α are unambiguously identified as coming from the above reaction and cannot be ascribed to background. In the same experiment no evidence of the alternative reaction $^{6}Li(p,\alpha)^{3}He$ has been found, according to the expectation of CCS theory [6-8].
Some technical issues, which are related to this difficult experiment are discussed and possible suggestions for improvement and planning of the next activity on this topic are also presented.

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LENR Solution of the Cosmological Lithium Problem

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The basis of modern cosmology is the Big Bang theory. The validity of this theory is based on three main facts: a) the redshift of spectral lines of distant stars; b) the presence of cosmic microwave background radiation; c) the theory of primary Big Bang nucleosynthesis (BBN) of light H^2, He^3, He^4, Li^6 and Li^7 isotopes in expanding very hot plasma. Calculations of the formation and evolution of the first three isotopes were repeated many times and are in very good agreement with the results of modern astronomical observations. The problem (paradox) arises during the comparison of the results of theoretical calculations based on the BBN model with data of astronomical observations for the concentration of Li isotopes. The modern registered relative (Li^A/p) concentration of Li^7 isotope is 3 times less ($K(Li^7) \equiv (Li^7/p)_{observ}/(Li^7/p)_{BBN} \approx 1/3$) than the calculated initial (BBN) value, which according to theoretical estimates should remain approximately the same now. In contrast, observed concentration of Li^6 isotope is 300 ... 500 times higher $(K(Li^6) \approx 300...500)$ than predicted by BBN.
The maximal difference between the BBN estimations and astronomical observations corresponds to old stars of the first generation ($t \approx 10^{10}$years) and decreases for younger stars. This circumstance allows us to conclude that such an effect is associated not with a one-time phenomenon, but with multiple repeatable processes in the volume of stars, the result of which monotonously increases with time!
The lack of a substantiated explanation for such radical differences casts doubt on the correctness of the Big Bang model and all subsequent analysis of the cosmological process of global nucleosynthesis. There were many unsuccessful attempts to resolve this paradox through the use of "standard" nuclear reactions of creation $He^4(H^2,\gamma)Li^6$, $He^4(He^3,\gamma)Be^7 \to Be^7(\beta^-,\gamma)Li^7$ and destruction $Li^6(p,\gamma)Be^7$, $Li^6(p,\alpha)He^3$, $Li^6(H^2,\alpha)He^4$, $Li^6(H^2,\gamma)Be^8$, $Li^7(p,\alpha)He^4$ of Li^6 and Li^7 isotopes in volume of star. Correct analysis based on these reactions shows that the observed changes of the concentrations K_{Li} of these isotopes after the Big Bang can't be provided for any time, any density and any star temperature!

We have shown for the first time that these lithium paradoxes can be well described by the processes of nuclear transformations in the volume of stars in the region near the boundary between the radiative transfer zone and the convective zone if we take into account the influence of star shock waves on these reactions. A specific mechanism for optimizing of nuclear reactions is associated with the formation of coherent correlated states (CCS) of protons and deuterons, which occurs at the front of such shock waves [1,2] and which leads to a short-term generation of very large fluctuations of the energy of these particles $\delta E \geq 10\ldots20keV$ at a typical temperature $kT \approx 100eV$ in this region of star. To realize the observed change in the concentrations of both isotopes, *1...10* powerful shock waves per year for 10^{10} years are needed in any part of discussed star region. The main reasons of Li^7 and Li^6 paradox are connected with effective CCS formation in $Li^7(p,\alpha)He^4$ reaction and fundamental impossibility of CCS formation in alternative $Li^6(p,\gamma)Be^7, Li^6(p,\alpha)He^3$ reactions in any stars [2,3].

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Abnormal absorption of hydrogen in nickel at ambient temperature with associated emission of neutrons

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While it is known that nickel at a temperature of a few hundred degrees if in hydrogen can slowly absorb a certain amount of this gas [1], there is no evidence that this can occur at room temperature and at pressures below 1 bar. On the contrary, by conducting studies and experiments on LENR anomalies in the ARGAL laboratory in Bareggio, Italy, it has been experimentally verified several times that nickel in the form of wire, thin ribbon, foam, if properly covered with a thin layer of palladium, can absorb hydrogen in considerable quantities even at room temperature.
Example of results on thin nickel sheet (cut from a ribbon) with 200 nm of Palladium deposited on its surface. (Fig. 1).

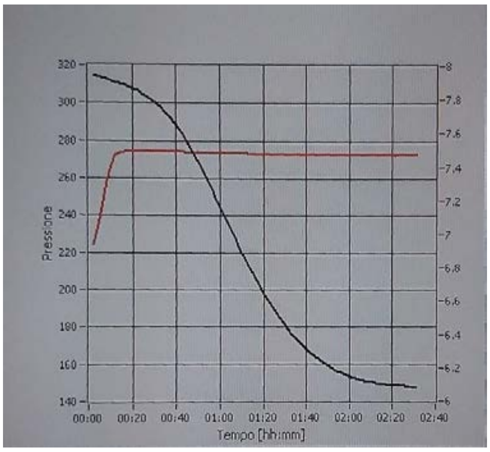

Fig. 1- graph in which the black line indicates the drop in pressure from 315 mbar to 147 in about 2 hours and 30 minutes. The red line shows the behavior of a Palladium resistor as thin film Hydrogen sensor.

The material weighing approximately 0.6 grams, inserted inside a steel chamber connected to a vacuum system and a hydrogen generator for the introduction of the gas, after a few minutes from the introduction of hydrogen at a pressure of 315 mbar, began to absorb the gas and the pressure as seen in figure 1 rapidly dropped to 160 mbar. The reactor chamber volume is 290 cc and so the amount of the hydrogen absorbed can be easily calculated, and also the <H>/<Ni> ratio.
Simultaneously the neutron monitoring began to show a significant rise in the background as can be seen in Figure 2 which shows two distinct peaks in the distribution of n / h neutrons per hour. The background distribution is the dotted line histogram.

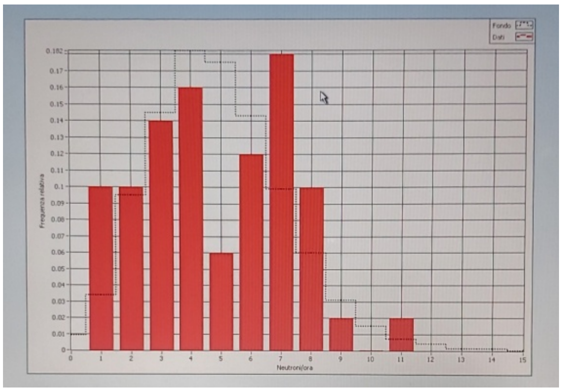

Fig. 2 – neutron per hour monitoring histogram with data relating to many hours in which the reactor was under vacuum and for a similar number of hours after the absorption of hydrogen following the introduction of the gas at a pressure of 315 mbar

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Atomic Nuclei Binding Energy

Similarities between Binding Energy Values of Chemical Elements : Example of Nickel and Copper

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Several authors predict that alpha particle structures are present in atomic nuclei.Convincing arguments of such structures are provided by systematics of the binding energy of the even-even nuclei with equal number of protons and neutrons. So, it is to see if this is the case for any nucleus. A first point to consider is the binding energy (E_B) of an alpha particle and its relationship with the binding energies of Deuterium,Tritium and Helium-3. A second point is to see if these E_B values play a role in the E_B of any nucleus. In other terms ,could one determine the E_B value of any nucleus on hand of those of alpha particle, Deuterium,Tritium and Helium-3 ?

To do so it is to compare as many nuclides as possible. The present study takes the cases of several isotopes of Nickel and Copper in order to look for similarities between them.
The author tries to organize the atomic nucleus in a way similar to Pauling's model of nuclear structure,with some clusters within the nucleus Pauling called Spherons. The sub-nuclei taken into consideration by the author are the alpha particles and four types of bonds, determined in the following way :

- Deuterium-like bond, called NP with value 2.2246 MeV, linking a neutron of one alpha particle with a proton of a second alpha particle, or a neutron or proton outside an alpha particle to that alpha particle.

- Tritium-like bond, called NNP with value 8.4818 MeV, linking three nucleons of three different alpha particles, or one or two nucleons outside an alpha particle to one or two alpha particles.

- Helium -3 like bond, called NPP with value 7.718 MeV, having a similar function as NNP.

- A dineutron bond, called NN with value 4.9365 MeV, linking two neutrons not being located within the same alpha particle .This bond value is deduced from the alpha particle binding energy.

The study of the binding energy values of the chemical elements aims at understanding the mechanisms of transmutation and hence the possibility of cold fusion.

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Error Analysis in D(H)/Pd Gas-loading System

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Previously, referring to Focardi's earlier work[1], nearly one hundred watts of excess heat power was measured by using isothermal calorimetry in the hydrogen/palladium and deuterium/palladium gas-loading systems[2,3]. In order to verify the reliability and accuracy of the measured excess heat, a large volume and high power heat-flow (Seebeck) calorimeter[4] was introduced into the D(H)/Pd gas-loading system.

An ideal calorimeter will fully sense and measure the heat released inside the reaction chamber. But in the actual situation, the generated energy can not be collected completely for some seasons, leading to a part of the heat escaping to the outside of the system before measurement. A high-precision calorimeter will minimize this part of the heat as less as possible.

Due to the structure of the reaction chamber (calorimeter) and the differences of the thermal conductivities of the gases used in the calibration and triggering experiments (nitrogen and deuterium respectively), the chamber will have different temperature gradient and the generated energy will not be totally measured.

The different temperature gradient leads to errors when calculating the excess heat power using isothermal calorimetry. In the heat-flow calorimeter, this part of energy would be misunderstood as excess energy due to heat escaping. According to the experimental data, it can be concluded that the error is not obvious at low applied power, and it increases significantly with the increase of applied power.

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Spectro-Electrochemical Characterization on H/D-Pd Monolayers Coated Au Single-Crystal Electrodes and Nanoparticles

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Adsorption/absorption/reaction of hydrogen and deuterium on/in palladium (H/D-Pd) are important in both fundamental research and application, especially for hydrogen energy and other unexplored energies. The behaviour of H/D in subsurface of Pd metal is distinctively different from that at the surface and in the bulk phase. It could be possible to have overloading of H/D in the subsurface and create some unique lattices and configurations with input energy pulse. It's therefore highly desirable to comprehensively understand the H/D-Pd subsurface systems on many aspects. However, it's not easy to isolate the subsurface experimentally and avoid large discrepancies between the experiment and theoretical calculation. Recently, we have tried to systematically study H/D-Pd monolayer(s) coated on structurally well-defined Au single-crystal electrodes and nanoparticles. Two methods, *i.e.*, indirectly redox replacement of Cu UPD layer and directly electrochemical deposition of Pd, were developed to well control the Pd atomistic layer from 1 to 3, 5 monolayers over Au(111), (100) and (110) facets and Au nanoparticles of ~ 50 nm in diameter, respectively. The Pd layer, crystal facet, applied potential and electrolyte dependences were studied using cyclic voltammetry and in-situ Raman spectroscopy. The metal surfaces and subsurface of various monolayers were modelled with the first-principles computations using the Vienna ab initio simulation package (VASP), which will be discussed in details.

Discrepancies with the Recent Models of Nucleons

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Experimentally it has been found that the mass of a proton is roughly 100 times greater than the sum of the rest masses of the three quarks that make up the proton. Similarly for a neutron—the three constituent quarks of the neutron comprise only a small percentage of its mass. Because of these unexpected findings, recent models of the nucleons have been proposed in an attempt to explain what makes up this 99% missing mass. However, these new models unfortunately also consist of much confusion and misinformation.

The recent models of the nucleons and their quarks typically claim one or more of the following three concepts:
Concept one: This concept claims that the missing mass is made up of the mass of the binding energy. This binding energy has mass due to the relativistic energy/mass equivalence equation, $E=mc^2$. In other words, the models claim that the binding energy holding the quarks together inside of the nucleon has mass, and furthermore, that this binding energy mass therefore makes up 99% of the mass of the proton and/or neutron.
Concept two: This concept claims that the three quarks are moving at relativistic speeds with extremely large amounts of kinetic energy. This extreme relativistic speed inflates the mass of the quarks, due to the equations of special relativity. This mass inflation of the quarks makes up the missing 99% of the mass of the nucleons.
Concept three: This concept claims that there are hundreds more quarks, inside the nucleons. These additional quarks make up the remaining 99% of the mass.
All of these concepts have inherent problems, as discussed below.

Concept One: This concept claims that the binding energy makes up the missing 99% of the nucleon mass. The unfortunate problem with this claim is that there is a sign error when accounting for the binding energy of the quarks inside the nucleon. Binding energy is the energy which acts on a group of particles, such as three quarks, holding them together in a stable configuration, such as a proton. Regardless of what type of energy—quantum, electromagnetic, gravitational—that this binding energy must be subtracted from the mass of its constituent components. The mass of the binding energy is not added to the mass of the particles that it binds, rather it is subtracted. This sign error creates a significant problem with these models, namely a blatant violation of thermodynamics and conservation of energy. Specifically, when particles are held together by binding energy and bound in a stable configuration, they are in a lower energy state than when they are separated and isolated. In other words, there is a decrease in the overall total energy of the bound configuration of particles.

When that bond was formed, energy was released to the external environment. And if that bond is to be broken to separate the configuration of particles, an externally applied amount of energy is required to break that bond. Thus, the bound particles are in a lower energy state, and therefore, at a lower mass. Recall, energy and mass are equivalent and can be thought of as simply different units of measurement; if the energy goes down, then the mass goes down. Stated succinctly, the binding energy is subtracted from, not added to, the mass of the object. Quantum physics does not to claim that conservation of energy can be violated. Quantum uncertainty can violate conservation of energy for only an extremely short duration of time, and then quantum uncertainty must give back any energy it took during that brief time. Quantum uncertainty must still abide by conservation of energy, especially for long durations of time and for large values of energy. Thus, quantum uncertainty cannot and does not explain the excess mass of the proton.

Concept Two: This concept claims that relativistic mass inflation makes up the missing 99% of the nucleon mass. In other words, if the three quarks move at extremely fast relativistic speeds, they inflate their mass relativistically and become much more massive. The problem is, in order to get this much relativistic mass, the quarks need to go 0.99995 times the speed of light. If the quarks are moving that fast, they would instantly be hurled out of the proton, due to their excessive momentum. This problem can only be resolved if the binding energy is stronger than this relativistic mass-inflating energy. Thus, in order to prevent the quarks from being hurled out of the proton, we need a binding energy that is stronger than this relativistic mass-inflating energy. In other words, in order for the proton to be stable, the net sum of these two conflicting energies must still produce a mass that is less than the mass of the constituent parts. The relativistic energy needed for the mass inflation competes with binding energy in a tug-of-war. For the proton to be stable, the mass must have a net decrease.

Concept Three: Hundreds of additional non-valance quarks make up the missing mass, and the addition of hundreds of more quarks will add more mass. The problem now is that every one of these additional quarks violates Pauli exclusion principle. Also, all of these hundreds of quarks violate the Copenhagen Interpretation of the Heisenberg Uncertainty Principle. Thus, the addition of hundreds of non-valence quarks into the proton violates two of the foundational stanchions of quantum physics.

As a starting point for understanding of nuclear physics, nuclear scientists utilize the nucleon models as the basic building blocks for understanding nuclear physics. Thus, for a better understanding of nuclear physics—and in particular for LENR—the currently-accepted models of the nucleons must be free of blatant violations of thermodynamics, conservation of energy, and modern physics. When trying to account for the various energies and masses, the recent models are severely flawed and unacceptable. Thus, they do not provide a coherent or consistent model that can be used as a basis for nuclear physics. In order for progress in the field of nuclear physics to advance, models such as these should not and cannot be promulgated or endorsed as being correct.

Hydrogen Reacted Nickel Electrodes for Nuclear Power-Cell Manufacturing by Low Energy Nuclear Reactions (LENRs)

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It is shown for the possibility of the nickel based power source comparing to the conventional Low Energy Nuclear Reactions (LENRs) using palladium-platinum electrode structure. S. Focardi and F. Piantelli used hydrogen gas in combination with nickel rods [1]. For realization of this result, the commercial company opens as Defkalion Green Technologies S.A. in Greece where they used the nickel based electrode [2]. The proton particle is described as the irradiated ion beam. In this work, several variables are investigated for the ion-radiation interactions. For simulations, the Stopping and Range of Ion in Matter 2008 code system is used to show that the ion dose is changed to the space of the atomic lattices [3].

Using the packing efficiency, the value of the face centered cubic (FCC) structure is as follows,

$$\frac{4\times\frac{4}{3}\pi r^3}{16\sqrt{2}r^3}=\frac{\pi}{3\sqrt{2}}=0.7405 \quad (1)$$

Hence, the 25.99 % (=1 – 0.7405) is vacant volume of the atomic structure. The lattice space gives the place for the lattice squeezed nuclear reactions, which could be assumed in the nanostructure. Therefore, the packing efficiency could be related with the nuclear reaction of squeezing.

Using SRIM simulations, Fig. 1 shows the hypothetical configuration of the LENR where the lattice shows the room for the nuclear reactions. So, the small space of the lattice could be assumed as the space for nuclear reactions. The Fig. 2 shows the vacancies of the ion in the lattice structures.

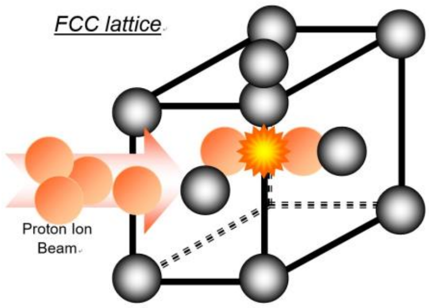

Fig. 1. Hypothetical simplified configuration to the nickel layer.

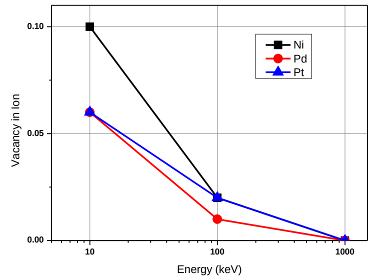

Fig. 2. Vacancy in the hydrogen beam injection of the LENR in the FCC lattice.

This work gives the investigation of the possible LENR behaviors in the molecular level structure. Following the new energy power source of the LENR, the commercialization needs the better efficiency as the new power-cell.

This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea Ministry of Science and ICT (NRF2020M2B5A111090811).

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Analysis of Thermodynamic Optimization for Nickel Catalyzed Reactor in Low Energy Nuclear Reactions (LENRs)

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A company, Defkalion Green Technologies S. A. was established in Greece to manufacture and market products based on the energy catalyzer (E-Cat), which was invented by Andrea Rossi [1]. S. Focardi and F. Piantelli made use of hydrogen gas in combination with nickel rods [2]. By scientific papers as well as online scientific exchanges, the science elements of Rossi's invention had been fully documented and extensively discussed online. The simplified configuration is shown in Fig. 1, which describes the configuration of a reactor.

The power generation purpose following heat productions is to connect with the electricity generator to the reactor in Fig. 1. The mass flow rate can regulate the power productions. The equations are written as,

$$\Delta\dot{Q} = \rho\dot{v}Ac_p\Delta T \quad (1)$$

$$\frac{\Delta\dot{Q}}{\Delta T c_p} = \dot{m} \quad (2)$$

where, $\dot{Q} = heat\ rate$, $\dot{m} = \rho\dot{v}A = mass\ flow\ rate$, $\rho = mass\ density$, $v = velocity$, $A = area$, $c_p = heat\ capacity\ at\ constant\ pressure$, $T = temperature$ are shown.

Using the software system, the features include dynamic functions, subscripting (arrays), Monte-Carlo sensitivity analysis, optimization, data handling, application interfaces, and more [3]. In this work, the calculation is shown for mass flow rate of 1,000 minutes. Fig. 2 shows the trend of mass flow rates. Results show necessity mass flow rate for constant power productions.

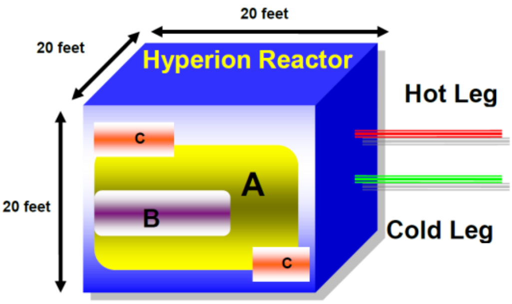

Fig. 1. Configuration for reactor (A: body of E-cat, B: Hydrogen canister, C: Monitor and control equipment).

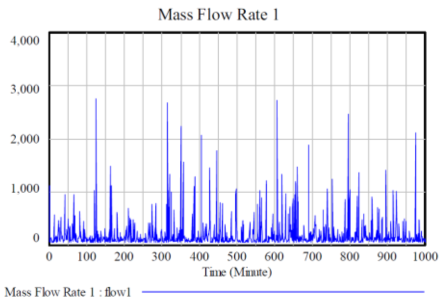

Fig. 2. Mass flow rate (Y-axis: kg/sec) for glycol coolant (Max. = 1,000 min.).

Furthermore, it is needed to construct the standard of the LENR energy commercialization. The constant heat production using control of the mass flow rate is proposed in this paper.

This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea Ministry of Science and ICT (NRF2020M2B5A111090811).

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Visible Blue-white Scintillation by Energetic Charged Particle Emission from Ni Film Cathode in Light Water Electrolysis at Room Temperature

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The method employed in the present work might be the simplest one ever known to realize the low energy nuclear reaction. Electrolysis is carried out for the Li_2SO_4/H_2O solution of 0.1 mol/L in a small plastic cell under DC condition at room temperature. The inner bottom of the test cell is a 5 μm thick Ni film serving as the cathode. The cell consists of a vertical plastic cylinder with inner volume capacity of ~8 ml, a plastic stopper holding a ϕ0.5 mm Pt wire anode, the Ni cathode, a scintillator composite and a transparent plastic plate in the lower portion. The cell is the same that used in the prior work [1], except that the scintillator composite and the transparent plastic plate, respectively replace the track detector CR-39 and the base block in the lower portion. The ZnS(Ag) is used as the scintillator, which is deposited on a polyester sheet to form the scintillator composite. The scintillation appearing in the ZnS(Ag) is observed by the naked eye without any electronics.

The key point of the method is in the lower portion of the test cell. To construct the lower portion, an optical grease is coated on the front surface of the 5mm thick transparent plastic plate, followed by mounting the scintillator composite on the optical grease. Then, the rear surface of the Ni film cathode is set in close contact with the front surface of the scintillator composite. The scintillation is observed from the rear side of the transparent plastic plate. The distance between the plate and the eye of the observer is ~12 cm. According to the result of a computer simulation, when an alpha particle is produced at the front surface of the 5 μm thick Ni film, ~3 MeV is the lowest energy of the alpha particle to penetrate through the Ni film and to reach the scintillator. The short penetration distance suggests that the use of thin Ni film is a key factor for detecting the alpha particle.

The single run of the electrolysis consists of the former run and the latter run. Total 6 runs are carried out. Pure water is added after the former run to fill up the test cell. The DC changes from 3 to 160 mA in stepwise every 24 h for 7d in the former run [1]. Similarly, the DC changes from 5 to 160mA in stepwise every 24 h for 6 d in the latter run. The time interval between the end of the former run and the beginning of the latter run is ~10 min. Thus, the electrolysis of the single run continues totally 13 d.

The observation of the scintillation is carried out in a dark room at arbitrary time during the electrolysis. The minimum unit of the continuous observation time is 10 min. The observation of 6×10 min is typically conducted twice in 24 h under each fixed DC value. The total time of 120 min in 24 h in a fixed DC value is equivalent to ~8 % of the electrolysis time. The color of the scintillation observed by the naked eye looks to be white mixed with a little blue. The scintillation appears in an extremely short moment and in different strength between the scintillations. The time interval between the flashes of the scintillation is found to vary exceedingly.

Average count of the flash per hour is defined as the flash rate. The flash rate increases with the DC value in both the former and latter runs. The rate in the latter run is larger than that in the former run at any DC value. These characteristic might be explained by increasing in the density of the proton absorbed in the Ni cathode by the electrolysis. The considerably high flash rate is found in the electrolysis experiment. Total 15 flashes are counted in the total observation time of 1 030 min under the 160 mA in the later run. These values give the largest flash rate of 0.9/h. Contrary, two flashes of unknown origin are observed in the control experiment in the total 900 min and these values give the flash rate of 0.1/h. The result reveals that the electrolysis markedly increases the flash rate. The scintillation could be attributed to the energetic charged particles produced by the possible low energy nuclear reaction in the Ni film cathode during the light water electrolysis.

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Formation of hydrogen miniatoms in the medium of free electrons – the key to the mechanism of low-energy nuclear reactions

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Computer modeling by molecular dynamics methods previously showed that the electrons of the outer shells of metals have a shielding effect on deuterons and significantly accelerate nuclear fusion reactions [1-6]. We have modeled the behavior of hydrogen atoms in the flow of free electrons in metals. The trajectories of the particles were calculated by numerically solving a system of differential equations of mechanics. Relativistic equations were used, and the interaction of particles was considered Coulomb without taking into account magnetic effects. About 10^4 stories were modeled, each of them containing up to 100 collisions of free electrons with a hydrogen atom. The total number of simulated atoms that experienced collisions was ~ 10^6 [7]. Dynamic modeling revealed the formation of neutral particles consisting of protons (deuterons) with an electron rotating around them in nonstationary, close to elliptical orbits with an apogee to a distance of less than 10^{-11} cm and to a perigee of ~ 10^{-12} cm [7]. These particles, which are continuously changing in size and shape, are up to 3 to 4 orders of magnitude smaller than ordinary hydrogen atoms, but 1-2 orders of magnitude larger than neutrons. Such nonstationary hydrogen miniatoms can exist for a short time (on ours estimate, up to ~ 10^{-12} sec.) in the environment of free electrons of metals, easily move in them and, like neutrons, approach the nuclei of isotopes of hydrogen or other elements at a distance at which nuclear fusion reactions or transmutation of elements are possible due to the tunnel effect. Taking into account the formation of such hydrogen miniatoms the previously calculated rate of low - energy nuclear reactions in metals [1 - 6] increases more than by 5-6 orders of magnitude, that is, to values corresponding to experimental data. Formation of hydrogen miniatoms in the medium of free electrons is of primary importance in the mechanism of low-energy nuclear reactions.

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Calorimetry for Low Energy Nuclear Reactions (LENRs) in Hydrogen Pressurized Nanoparticles

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This is a continuation of earlier work on LENR in metal hydrides.[1] We hypothesize that, through particular material processing, we can create a metal oxide framework capable of being super saturated with hydrogen during a reduction reaction and producing LENR. The central conceit is that hydrogen can be packed into defects in the crystal lattice of a metal hydride, and that as these absorbed hydrogen atoms become more crowded and energetic, they will be more likely to cross the Coulomb barrier in a fusion reaction.

Our goal in these experiments was to make crossing the Coulomb barrier as likely as possible, which necessitated maximizing crystal defects in the metal hydride, maximizing the hydrogen packed into each defect, and maximizing the temperature of the packed hydrogen. After fabricating a defect-rich metal oxide material, we heated the material and exposed it to pressurized deuterium, causing a reduction reaction, and hopefully a fusion reaction. To measure the energy release from possible nuclear reactions, we employed a convenient calorimetry which tracked input heat and the temperature rise of the metal hydride. Results were benchmarked against equivalent experiments that employed a non-reacting gas in place of deuterium. After accounting for the input heat and the other heat sources, excess heat would represent heat due to LENR. While our results showed promise, these measurements encountered problems which made results difficult to interoperate. They Involved evaluation of excess heat by converting the change in temperature of the metal hydride to energy as determined from prior calibration of this relationship. This represented an output energy from which we subtracted input heat, heat due to reduction, and Joule-Thompson heat. These measurements for output heat remained questionable because of difficulty in finding exact temperature equilibria, preventing a trustworthy value of excess heat. We then performed an analysis of variance and covariance to see when we measured a greater equilibrium temperature to input heat ratio. Results were still statistically inconclusive. To overcome these problems, we are currently using added excitation methods to create larger temperature differences and longer equilibria times. These experiments and initial results will be presented along with a review of the prior studies.

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On the Mechanism of Realization of Low-Energy Nuclear Reactions in Low-Temperature Plasma

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Earlier it was shown [1. 2] that the mechanism of the implementation of low-energy nuclear reactions (LENR) in a low-temperature plasma (under conditions of a glow discharge, during laser ablation of metals in aqueous media) can be understood on the basis of the concept of the existence in nuclear matter of non-nucleon metastable excitations initiated by high electrons (in terms of chemical scales) energies of the order of 3-5 eV. Specifically, we are talking about the formation of sufficiently long-lived (~ 10 minutes or more) light neutral nuclei – β -neutron and β-dineutron, respectively, with a disturbed nucleon structure **(**the states of “inner shake-up” or isu-state**)**, under conditions of a non-equilibrium low-temperature protium- or deuterium-containing plasma [2]. In the absence of Coulomb barriers, these nuclei effectively participate in nuclear chemical processes, forming compound nuclei with target nuclei, in which the nucleonic structure is also disturbed. The latter factor determines the relaxation of the excitations of compound nuclei during their decay (with the formation of products) not by the emission of quanta, but by the URCA process - by the emission of neutrino-antineutrino pairs that are safe for the environment.
The literature data [3] are presented, independently indicating the possibility of existence in the discharge chamber of the plasma vortex reactor (gas flow- water steam) of neutron-like nuclei, which may turn out to be the $^{1}n_{isu}$ particles whose mass is 0.78 MeV less than the mass of a neutron. Indeed, according to [3], neutron-like nuclei are recorded as neutrons on proportional He-3 detectors, but the test reaction for neutrons of initiation of artificial radioactivity of indium by streams of these particles gives a negative result. We see the reason for this result in the fact that the formation of a compound nucleus In with a neutral $^{1}n_{isu}$ nucleus with a disturbed nucleon structure complicates the “necessary” rearrangement of the nuclear matter of a compound nucleus, the relaxation of which will be more naturally realized through the emission of $\nu\tilde{\nu}$ pairs, and not γ -quanta, as it is realized in in the case of a well-defined nucleonic structure of excited nuclei.
In this work, within the framework of the concepts being developed, the results of the initiation of artificial radioactivity of impurity elements Pt, Pb in the Pd -cathode and Fe, Cu, Zn in the Ni -cathode, as well as of a significant reduction in the amount of these impurity elements in the cathodes and of the formation of the W -isotopes in the Pd -cathode [4].

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A single electro dynamical force field with gradients of electrical potential and gas dynamic pressure for all known interactions in condensed and non-condensed matter with examples of exact and numerical solutions

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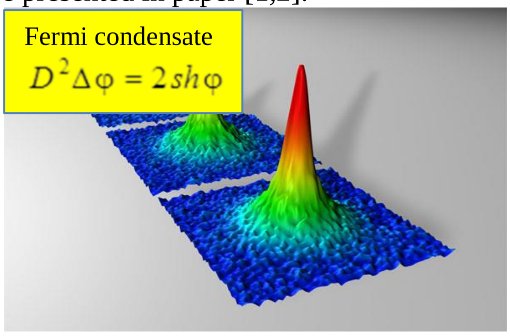
The paper presents some results of a single electro dynamical force field simulation in condensed and non-condensed matter. Our single force field theory for all known interactions base on modern experimental achievements, first of all, on two revolutionary experimental discoveries of the second half of the XX century, have made after the development of the general theory of relativity and the quantum mechanics. The first discovery is the registration of the final temperature of the microwave background radiation (MBR) in the outer free space with the temperature $T_0 = 2.735\ K$, the second discovery is the detection of "hidden mass" of the Universe (also called dark matter (DM)) in the volume of 96% of the total amount of matter.

The single force field theory with the electro dynamical interaction bases on an equilibrium of gradients for plasma dynamic potential and gas dynamic pressure in DM. It uses Newton's physics, Coulomb's law, Maxwell's electrodynamics, Boltzmann's kinetics and for the gravitation and electroweak fields extremely small differences in the distribution of potentials near the "point" electric charges in the centers of proton and electron. The presence of this charge generates a force interaction in the external and internal particle space. The force field is described by the mutual influence of forces determined by the electrical potential gradient and the gradient of the gas dynamic pressure. A mathematical description for such model of interaction is given for the stationary case by the quasi linear Poisson equation [1] for potential φ

$$D^2 \Delta\varphi = 2sh\varphi \qquad (1)$$

Here $D = sqrt(\varepsilon_0 kT / q \cdot n_0)$ is the Debye shielding radius, which determines the screen space size, T – temperature, n_0 - typical DM particle concentration in the considered medium.The equation (1) describes the single force field simulation in condensed and non-condensed matter for any interaction (electromagnetics, electroweak, strong, gravitation).We would like to show two results for solutions of equation (1) in the case of Fermi condensate matter and near the Earth (Fig.1). Additional numerical data for solutions of equation (1) in cases of weak and strong interactions were presented in paper [1,2].



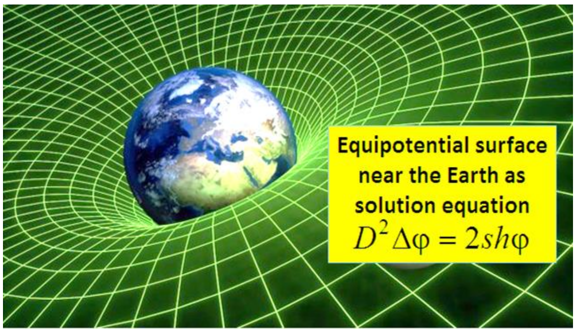


Fig.1.Potential distributions for the Fermi condensate matter and near the Earth.

This work opens up a new area of research on the fundamental gravitational properties of cosmos, galactic structures, black holes, protons, neutrons and nuclei, which can provide access to their physical radii, the internal shear forces acting on the matter and their pressure distributions.

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Conservation laws in string theory of condensed matter for modeling of electromagnetic and gravitational force fields

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In the late 1960s, a young Italian theoretical physicist, Gabriele Veneziano, was looking for equations that could explain the strong nuclear interactions – the extremely powerful "glue" that holds the nuclei of atoms together, binding protons and neutrons together. He discovered that the Euler function, long regarded as nothing more than a mathematical curiosity, describes this strong interaction. The Euler beta function or Euler integral is following special function of the argument t

$$\mathrm{B}(x,y) = \int_0^1 t^{x-1}(1-t)^{y-1}\,dt$$

Our paper presents string theory of condensed matter bases on another equation, which follows from the conservation laws, and modern experimental achievements. The force field consist on the gradients pressure p and electric potential φ, that can be expressed by a system of equations

$$\frac{\nabla p_\pm}{n_\pm m} = \mp\frac{1}{4\pi\varepsilon_0}\frac{e}{m}\nabla\varphi, \Delta\varphi = -4\pi e(n_+ - n_-), p_\pm = n_\pm kT,$$

where the indices + and - correspond to the positively and negatively charged components of the medium having the same temperature T, the value e is the elementary charge of the dipoles. From presented systems the equation of the electric potential φ for a polarized space in a dimensionless form is written in a fairly simple form [1]

$$D^2\Delta\varphi = 2sh\varphi.$$

Figure 1 shows some typical solutions of this equation (on the left) and the Euler beta function (on the right).

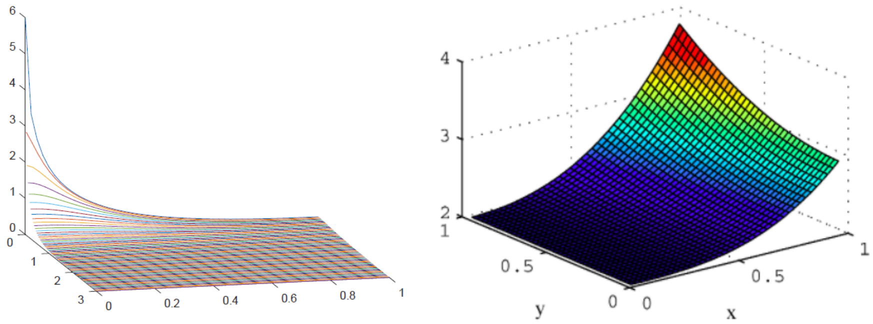

Fig. 1 The typical solutions of our equation (on the left) and the Euler beta function (on the right).

Our string theory uses modern experimental achievements of the second half of the XX century, made after the development of the general theory of relativity. The first discovery is the registration of the final temperature T_0 = 2.735 K for the microwave background radiation in the outer free space, the second discovery is the detection of "hidden mass" of the Universe (also called dark matter) in the volume of 96% of the total amount of matter. Field theory conservation laws for condensed matter are based on Coulomb's law, Maxwell's electrodynamics, and on the extremely small difference in the distribution of potentials near the "point" electric charges in the centers of the proton and electron. Also we demonstrate the analytical solution for structure of black holes, cosmic jets, gamma rays and neutrinos.

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LENR Experiment of Heterogeneous Hydrocarbon Plasma Jet Interaction with Thin Ni-Plate-Target

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Heterogeneous Hydrocarbon Plasma (HHP), was used in LENR experiment in the work [1, 2] at the first time. This HHP was created by erosive pulsed capillary discharge plasmatron (I_d~ 100A, U_d~ 160 V, T_i~ 10ms). PMMA ($C_2H_8O_5$) was used in this plasmatron as a working erosive substance. The experiment was carried out in argon atmosphere (P_{st}~ 1 Bar). It was measured that HHP consists of the carbon nano-clusters and hydrogen atoms and hydrogen ions. This work is a continuation of the previous ones [1]. The interaction of HHP with thin Ni-plate-target (width 0,1÷1 mm) has been studied in this work. HHP- jet heated, melted and evaporated this thin Ni- target. In a result of this interaction HHP jet small hole with the diameter 1÷3 mm in Ni-plate was burned. Parameters of this hole were measured. The metal plate weights were measured before and after experiment also. It was revealed that the value COP was about of 4÷10 in this experiment (where COP= Q_T/Q_e, Q_T – thermal energy of heating and melting of Ni plate-target, Q_e- electric energy used for HHP creation). The new transmutated chemical elements Li, Al, Ca,… were recorded in HHP in this experiment by optical spectroscopy and EDS-method.

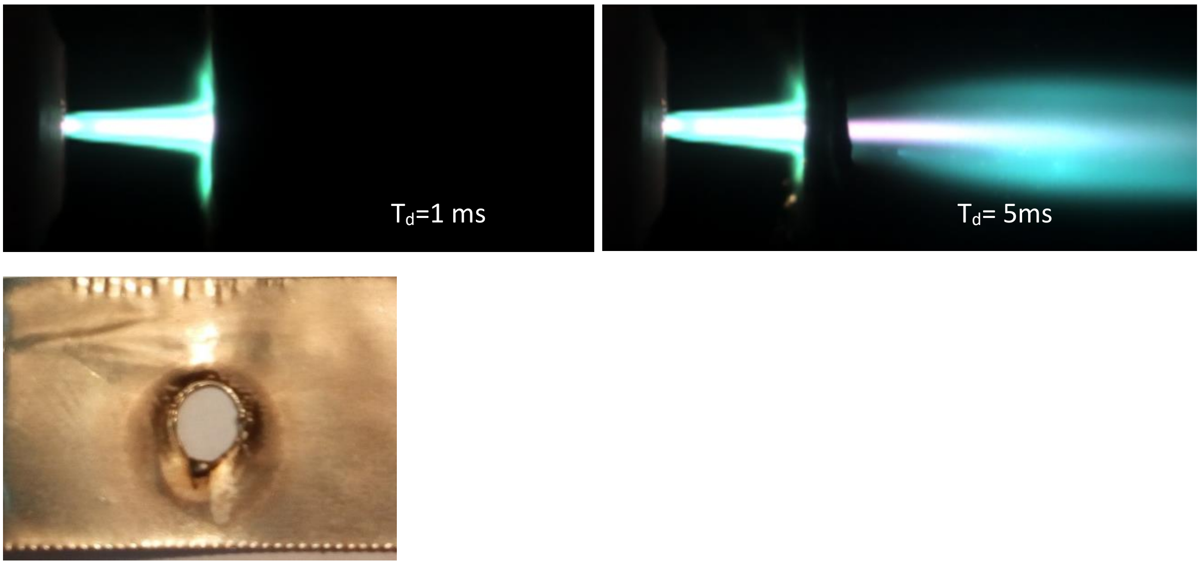

Figure1. Interaction of pulsed HHP-jet with thin Ni- plate-target (top). T_d- delay time from plasmatron's ignition. Hole in the Ni- target (down) with diameter 3x5 mm burned by HHP.

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A Hypothesis of Kinetics and Dynamic Control of Nuclear Reactions in Solids

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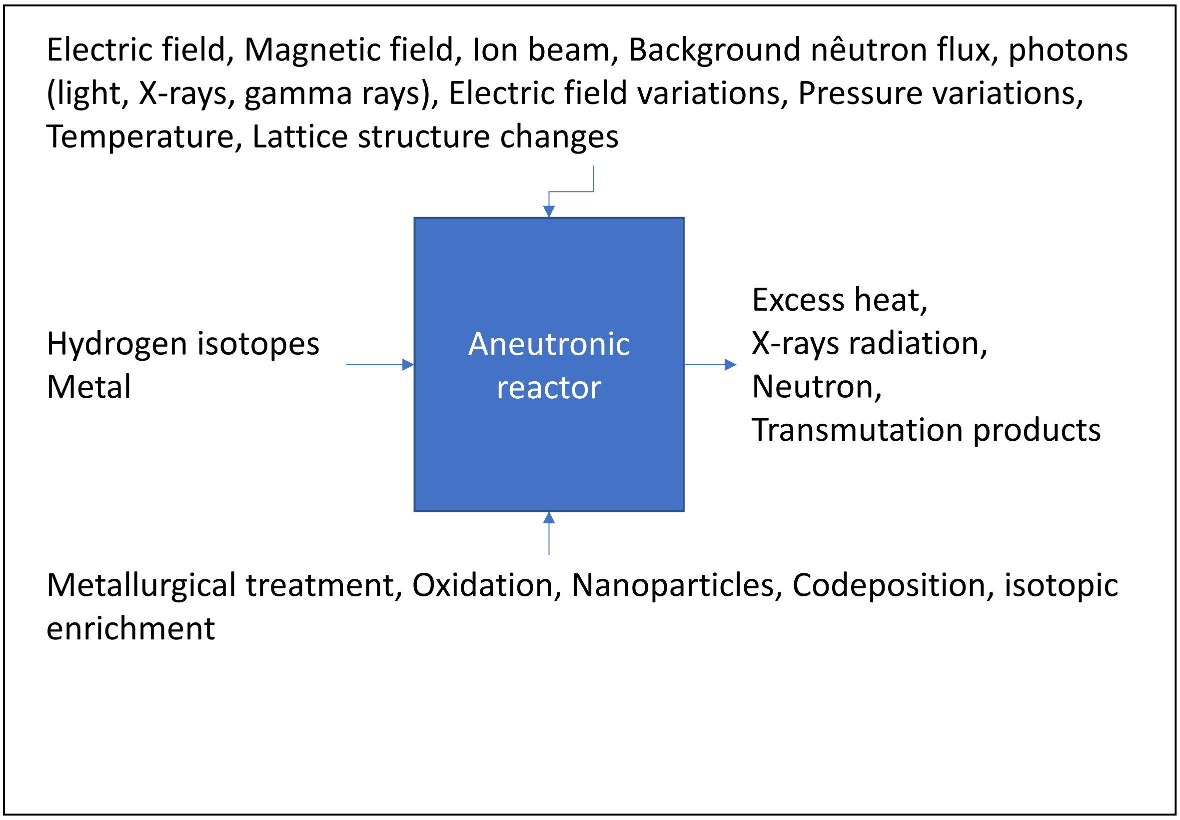
Several authors suggested that background noise could influence nuclear reactions in solids, resulting in neutrons or excess heat. Literature shows that repeatability is improving, but the control over the intensity remains out of reach. This work aims at identifying possible causes for intensity variations and proposing solutions to improve controllability. The first step is to search in literature the characteristics of nuclear reactions in solids: input, output, controlling factors and enabling means. The second step is, from solid experimental facts, draw solid conclusions. The third step is developing some assumptions about the phenomenon. For each controlling factor, verify the feasibility of implementation in a heat exchanger with high surface over volume ratio. Finally, present some alternatives of architectures to improve reactions intensity control. A solid conclusion is hot spots come from aneutronic nuclear chain reactions, meaning each energetic charged particle causes the appearance of more than one new charged particle (effective multiplication factor $k_{eff}>1$). Another conclusion is background neutron radiation starts chain reactions and it causes excess heat intensity variations. An assumption is a local $k_{eff}>1$ causes micro explosions terminating the localized reactions because heat propagates faster than the particle population, resulting in low average k_{eff}. Therefore, nanoparticles or working temperatures near melting point reduce local k_{eff} allowing slow enhancement of particle population up to a level proportional to the background neutrons. A suggestion is to shield the reactors using moderators with neutron absorbers to avoid undesirable power excursions and add a voltage-controlled neutron source to control the excess heat because of the penetrating nature of neutron radiation. Magnetic or electric fields could also help the enhancement of excess heat.



A Survey on the evolution of Yearly Works on Pd-D, Ti-D and Ni-H Systems within Cold Fusion Field

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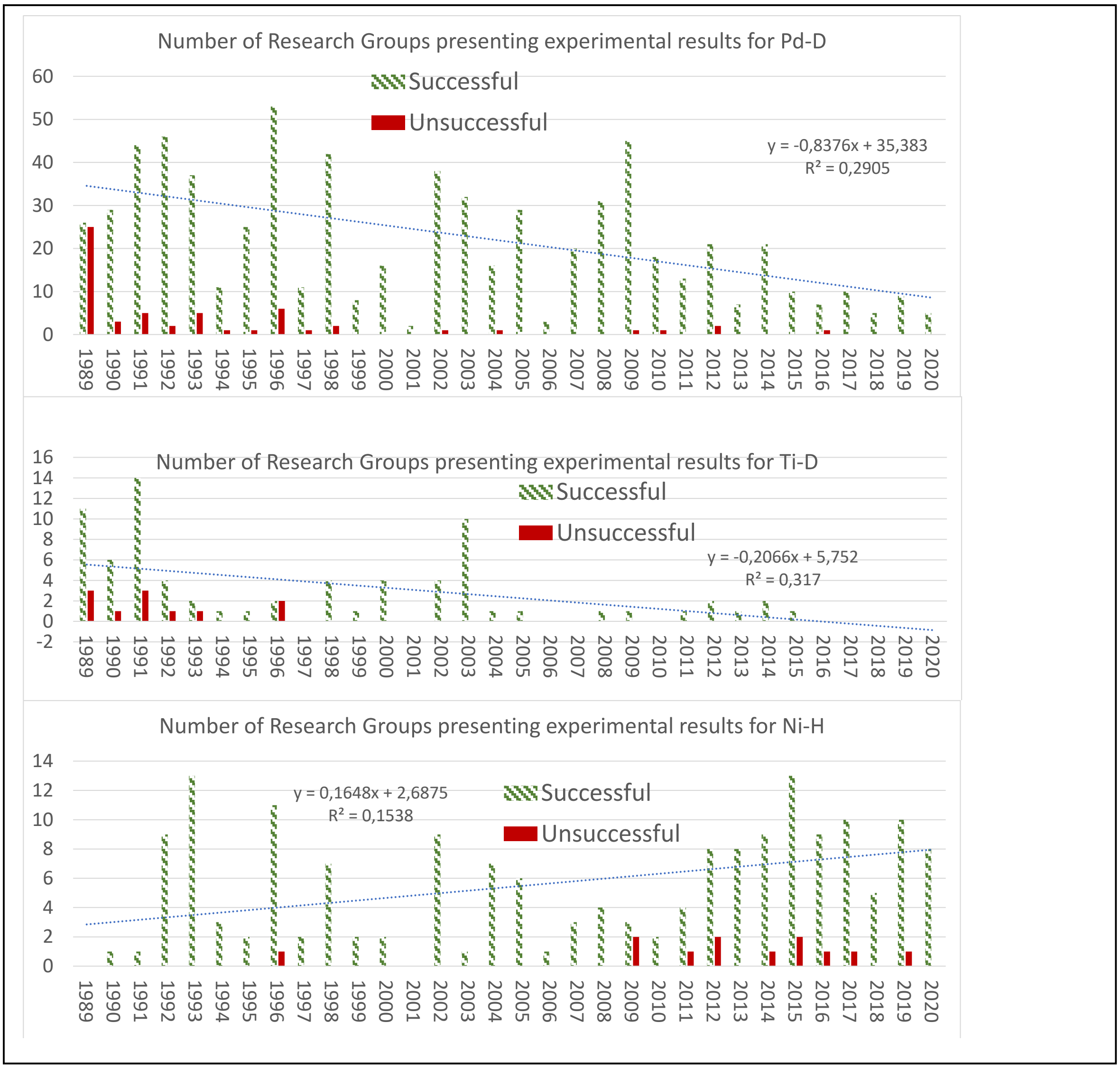
More than 30 years have been passed since Stanley and Pons press conference announcing the discovery of "Cold Fusion". This work aims at presenting a general view of the evolution of experimental works in the various sub-fields, like Pd-D, Ti-D, Ni-H systems. For each subfield, this work presents the yearly number of successful and unsuccessful works published in conferences or journals. For Pd-D systems, since 1989, the number of positive results (finding some nuclear reactions) is superior to negative results but there is a trend of reduction of yearly works. Ti-D systems follow the same tendency. Ni-H systems, on the other hand, present a rising tendency besides having a higher ratio of successful/unsuccessful experiments. Perhaps the smaller cost of materials and easier replication is being decisive for new research groups starting in the field, besides enterprises starting advertisement of products based on the Ni-H system.



Some Facts About Nuclear Forces and Evidence of their Range being Longer than People Believe

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Nuclear forces are believed to have ranges around 2 fermi and beyond that range, only electrostatic force is relevant. Before trying to make theories about the phenomena of nuclear reactions observed in solids, it is important to revise critically the existing experimental literature and nuclear theory to check if current models are coherent and if they could explain the observed phenomena. The first step is to check the current nuclear models, the second is to analyse the neutron cross-section data, the third is to discuss coherence between empirical data and models, the fourth is to identify the order of magnitude of nuclear forces range, the fifth is to revise the full height of Coulomb barrier. It was found one isotope (Gadolinium-157) that can attract a thermal neutron at least at 2781 fermi and repulses neutrons at 179 Fermi. It was also found that the plane projection of volumes where neutrons are directly captured is distinct of the projection of the volume where neutrons are scattered for most isotopes. But Kryptonium, Ruthenium, Xenonium, Iridium, and Mercury elements seem having their scattering volumes covered by the absorption volumes, or not having a scattering volume at all. Ca-44, Ca-48, Ni-64, Se-74, Te-123, Dy-162, Hf-177 and W-186 isotopes seem having a partial screening of their scattering volume by the absorption volume. Resonance capture volumes seem to be independent of direct capture volumes and have interface with scattering volume. Three facts suggest absorption volumes are consequence of nucleons arrangement, assuming an FCC nucleus model. The first is that a single additional neutron may change the order of magnitude of absorption radius (like He-3 to He-4). Second, excited states also change absorption cross-sections, like Na-23 whose first excited state increases absorption cross-section and Cl-37 whose first excited state decreases absorption cross-section. Third, neutron capture resonance depends on existence of an excited state of the compound nucleus (target nucleus plus the neutron) with energy larger than this neutron binding energy. In other words, to have a resonance, the target nucleus needs to have two places available for a neutron, and the energetic distance between them needs to be larger than a minimum (the very neutron binding energy). Compared to Coulomb forces, the nuclear forces attracting neutrons are weak, about 6 orders of magnitude smaller than electrostatic repulsion at mean thermal neutron capture radius.

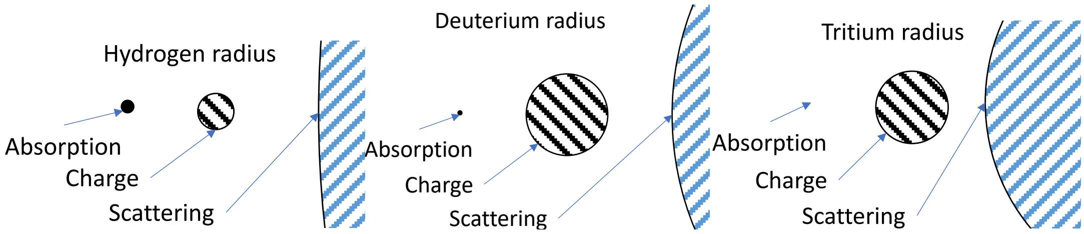

Figure 1 – Hydrogen isotopes Absorption, Charge and Scattering radius. Note scattering and absorption radius decreases with number of neutrons and charge radius is maximum for Deuterium. Long range nuclear forces could explain such radius variations according with number of neutrons.

Functional Roadmap for Commercial Cold Fusion Systems

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Nearly everyone interested in cold fusion is aware of the incremental progress by Forcardi, Rossi, Jet Energy, Defkalion Green, Egely, and others to commercialize this technology. Important details have been incorporated into patents and patent applications.[1,2,3] In comparison to earlier information, however, we attempt here to step-back for a moment to provide a general vision of functional activities that need to be performed by commercial cold fusion systems. The reason is that consideration of the details of such functional activities is a crucial step in developing commercial systems: it enables a forum and opportunity for discussing all of the operational (engineering) tasks that must be performed by the system and then flowing down related information into design specifications for the systems' components. Gaps in the development process can be expected if some of the functional activities or tasks are omitted and not considered early on. The flow-down of functional activities and tasks to component design specifications is also required to support subsequent processes involved in system testing and manufacturing. This paper provides examples of six (6) key functional activities and fifteen (15) operational tasks that must be performed.

Our discussion in the ICCF-23 meeting this year is critically important as only eight (8) years are available to develop a robust energy solution to global warming/climate change. The drop dead date is 2032.[4] Commercial cold fusion systems may be the only realistic option since nuclear power plants are very expensive to build and operate. Nuclear fission plants are also not acceptable due to radioactive pollution they produce. Hot fusion cannot be seriously considered since it is many decades from being commercialized.

For commercial systems to be developed in this short time, scientists in this community must be more willing to collaborate and become part of engineering development efforts within their countries. Rather than continuing solely with their individual laboratory research efforts, the scientists must bring their current knowledge into focused systems engineering activities and then perform directed research to address areas supporting the engineering process. Financial support can be expected from national and state governments with greater emphasis on the importance of cold fusion as a solution to climate change. International support can also be expected for the best commercial system concepts.

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Climate Change and LENR

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Projected climate change will drive more frequent and damaging storms, wildfires, droughts and affect farming, movements of fish, and increase disease and sea level. Sea level rise is especially worrisome since 60% of the world population may eventually be displaced, resulting in devastating migrations and loss of property and livelihoods, and international competition for resources and survival.

Climate change is coming much sooner and more destructively than most realize because countries have delayed acting. Present solutions are not up to the job. The political will necessary to drive timely and effective solutions does not exist, and is not likely to appear soon enough. LENR could make a substantial difference, but only if actual products can replace most power sources starting at the latest in 2030.

The current temperature change from the 1995 reference is about 0.9°C. Climate experts believe that a temperature rise of 1.5 is the maximum that can be tolerated based on Paleolithic examinations, which show vast ocean rises with even lower temperatures. Today, the Intergovernmental Panel on Climate Change is proposing strategies that allow temperatures to rise over 2 degrees C, with plans to eventually remove CO_2 from the atmosphere to get back to a 1.5 degree rise. Those plans are inconsistent with present global Nationally Determined Commitments (NDC's), which will result in temperatures rising 3.7°C. Generally speaking, even these NDC's are not being met.

Planned solutions are complex, interrelated, politically sensitive, and technically implausible, leading to a low probability of delivering the desired ΔT profile on the required schedule, even with the best of intentions. Two of the central parts of the default plan are moving entirely to wind and solar to replace hydrocarbon generation, and direct air removal of CO_2 after it is in the atmosphere. Both have problems that could, conceivably be solved by adequate LENR generation.

Wind and Solar require some "dispatchable", (meaning reliable, on short notice) power to deal with their significant fluctuations. (Batteries and smart grids are not sufficient as the grid nears 100% green. 50% of maximum capacity will have to be reliably available.) The present plan involves massive biomass energy generation to feed boilers equipped with Carbon Capture and Storage, and huge tracts (in the millions of square miles) of new biomass growth. The only presently conceived alternative is Gen 4 nuclear, which has not been built or tested, and which may not be suited for third world countries, or for local power applications, and may not be politically acceptable even if available.

Similarly, direct air capture requires vast amounts of energy, and places to put the resultant carbon. Requiring as much energy as it does increases the overall clean energy problem.

LENR power generation appears to be the only solution that resolves the overall problem, avoiding very complicated strategies and interacting issues, and avoiding the delay caused by huge infrastructure rollovers—but only if LENR can be commercialized soon enough to affect policy in many countries.

The principles of generating the vector potential of magnetic of and electric fields (VP MEF) and fixing the variations of the VP MEF in teal time

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Key words: Vektorial Potential; Finsler Geometry; Nuclear-Vacuum Power; Byuon-Finsler Torus Systems; Anthrop - Anisotropic Imbalance Multiverse.

The development of quantum-mechanical resonance approaches [1,2,3] allows to substantiate the New Paradigm of Natural Science, which generates the System Physical Picture of the Anthrop - Anisotropic Imbalance Multiwerse. At the same time, the consideration is based on the presence of a 4D stream of VP MEF, which permeates the Universe from the Galactic to the subnucleon levels and forms all material entities observed in our 3D Space, with the arrow of Time, from neutrinos to Galactic clusters.

Quasiparticles **byuons**, - carriers of the VP MEF, which has the dimension of **action**, propagate along closed one-sided non-orientable surfaces homeomorphic to a circle. When a 4D flow of nondispersive buons is transformed into a flow over a surface like a 3D Klein bottle, which has an observed self-intersection, in the form of a Laval nozzle, one of the 4 coordinates is transformed into a hypercoordinate, anthropically perceived as the Time.

Primary **quadratically nonlinear** (Newtonian - gravitational, although it is possible to consider another, not $\sim\frac{1}{r^2}$, interaction) and the resonant interaction of byuons occurs at distances equivalent to the Planck size $\sim 10^{-34}$ cm. In the case of the formation of a flat stable complex of at least two byuons, in full accordance with the ideas of Faraday and Maxwell, according to the formula $\vec{H} = [\vec{\nabla}\vec{A}]$, a Magnetic Field (MF) is initially born. To describe this new object, it is necessary to increase the dimension of the interaction space by one and bring the dimension to 3 in accordance with the geometry requirements, since the MF accessible to observation is perpendicular to the plane of interaction of the carriers of the VP, which, in essence, generate an entity perceived as MF.

Further, it becomes possible to form the observed objects in accordance with the Hyperbolic Analogue of the Electric and Magnetic Fields (GAEMF), discovered by D.G. Pavlov [4,3]. A bunch of primary objects formed by the resonant fluxes of the VP MEF occurs due to the interaction of primary magnetic forces. The obtained 3D toroidal objects, in turn, in accordance with GAEMF, are combined into structures that accumulate and carry the energy of the MF in the form of closed "on themselves", not considered in modern natural science, objects - Buonno Finsler Toroidal Structures (BFTS) and Buonno Finsler Crystals (BFC) [4,5,3]. Here, in a space with characteristic linear dimensions from 10^{-34} sm to macro-dimensions, characteristic of condensed bodies around us, as researchers, a set of energy minima arises, in which quasi-mass objects can be formed, which can be attributed to the elements that make up ether and microleptons [16,8,17]. The elements that make up these objects are linked by magnetic forces and magnetic field gradients. By analogy with ordinary bodies, which can be decomposed into elements in gradients of electric fields (NaCl↔ $Na^+ + Cl^-$), these objects are decomposed in gradients of Magnetic Fields and gradients of VP MEF [8,2].

It is this kind of objects that manifest themselves as "strange" radiation, which is observed by researchers studying, among other things, low-energy transmutation of chemical elements [6]. “Strange” objects accumulate in condensed media (in water) and can be ejected by media as a result of initiation, for example, low-intensity laser radiation [7]. Stable elementary particles - neutrinos, photons, protons, electrons, resonances of different lifetimes, atoms and so on [2,8,3] can be **constructed** in various ways. BFTS are becoming integral elements of the structures being formed [3]. Manifestations of Finsler's geometry and the presence of toroidal structures are also recorded on larger scales, up to the Metagalactic.

Considering the **practice** of discovering and researching Parallel Worlds [9], we can talk about the completeness of the primary construction of the picture of the 4-dimensional Anthrop - Anisotropic Imbalance Multiverse in accordance with the New Paradigm of Natural Science.

The presence of the initial one-dimensional flow of the VP MEP, which propagates along one-sided non-orientable surfaces, homeomorphic to a two-dimensional circle, with an increase in dimensionality at each step of designing the required object, makes it possible to understand, reproduce, and develop A.V. Vachaeva-N.I. Ivanov [10]; Monoharana et al. [11]; Puthoff and Targ [12]; V.S. Grebennikov [13]; Vysotskiy V.I., Kornilova A.A. [14]; Filimonenko I.S. [15]; J. Hutchison and other researchers.

Due to the fact that the primary - the Universal flow of the VP MEF carries enormous energies ($1.9\cdot 10^{11}$ gaus·sm), it is possible, using fairly simple devices, to register the variability of these energy flows in real Time using fairly simple equipment. Namely: Procedures for accurate weighing of bodies containing magnetic elements (compass, for example) and asymmetric torsional balance of high sensitivity [3,18].

In general, even now we can talk about **practices** related to: 1) Achievement of intra-nucleon energies by orders of magnitude superior to nuclear ones; 2) Devices for movement in space and time, fundamentally different from those used; 3) Communication systems based on a different ideology and not limited to the generation and propagation of Maxwell-Hertz radio waves; 4) Methods of processing condensed materials; 5) By influencing biological objects at the level of membrane-cellular, mitochondrial-energy and mediator processes.

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A Sketch of the Solid State-Nuclear Sciences

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Since the discovery of nuclear reactions in PdD_x alloys in 1989, there have been accumulated very many experimental data sets showing existence of nuclear reactions in materials composed of transition metals and occluded hydrogen isotopes (let us call them the *CF materials*, for short)). As the cause of these nuclear reactions in the CFP, we have got to accept the existence of the interactions between nucleons in the CF material through the nuclear force (let us call this interaction the *nuclear-force interaction,* for short).
Even if the nuclear force has recognized as the cause of nuclear reactions observed in the CFP since its discovery in 1989, there should be its fingerprints in other phenomena in solid state physics and chemistry occurring in materials with similar compositions to the CF material (let us call these materials the *nuclear-solid materials,* for short). Since the Graham's discovery of the absorption of hydrogen by palladium and palladium-silver alloys in 1866, the physics of the transition metal hydrides has shown a great development revealing various characteristics of the physics in them especially the extremely high diffusivity of hydrogen in metals and alloys (let us call this phenomenon as the *super-diffusivity*, for short). We have noticed the relation between the CFP and the super-diffusivity and explained some characteristics of the CFP using the data of the super-diffusivity. On the other hand in the electrochemistry, there have been observed such wonderful events closely related to the interaction between the transition metals and the hydrogen at the electrode surface as the hydrogen electrode reaction (HER) and the underpotential deposition (UPD). There are many characteristics of the HER and UPD remaining unexplained for more than 80 years after the formulation of the problem in 1933 by A.N. Frumkin. Furthermore, there have been discovered the *exotic nuclei* with a large unbalance of the numbers of protons and neutrons in the isolated nucleus in these 20 years.

In this paper, we point out several characteristic events in the super-diffusivity of hydrogen isotopes in transition metals and alloys, HER and UPD in electrochemistry, and the exotic nucleus interacting with occluded hydrogen isotopes in the nuclear-solid materials which seem to have close relations to the nuclear-force interaction noticed in the CFP.

THE PRESUMPTION OF PSEUDOSCIENCE.

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In defence of electrochemists Martin Fleischmann and Stanley Pons, and cold fusion, of with course! the help of science eliminated prejudices and errors, and achieved: protection produced true, freedom for further development, the common good and internal well-being.

On motives of the publications in Russian mass media. If cold fusion did not exist, it would be worth to think of.

The farther from the beginning of the cold nuclear fusion, the more imagination, transitions into the category of myth-making, violent perversion of facts, forgeries and unhealthy mockery of the authorities in the media and on the Internet.

About the purely Russian invention in science - about the COMMISSION ON COMBATING PSEUDOSCIENCE AND FALSIFICATION OF SCIENTIFIC RESEARCH.

Evaluation of the advantages of nuclear fusion over other methods of energy production (See Table 1). One gram of deuterium can become a continuous heat source with a capacity of 3 kW for a whole year!

There is a strong suspicion that, having mastered the method of obtaining energy from cold fusion, we will only have one step left to completely release the energy of matter according to the famous formula $E=m\times c^2$!

Cold fusion or LENR?

The content of the scientific paper by M. Fleishman and S. Pons in Journal of Electroanalytical Chemistry with specific results. About scientific ethics, the violation of which is blamed on M. Fleishman and S. Pons.

Intense heat release, and therefore the effect itself begins only on the 66th day (~5.65×10^6 seconds) CONTINUOUS operation of the electrolytic cell and continues for 5 days.

What kind of non-reproducibility can we talk about here?

There is not a single scientific paper in peer-reviewed journals that scientifically justifies the impossibility of cold nuclear fusion.

Verification of devices for measuring physical quantities must be carried out with a device that has an accuracy class higher than the device being verified. Therefore, the tests on heat in MIT and Caltech, which are often referred to on the issue of the failure of cold fusion, are not really any tests.

The "experts" are lying about neutron irradiation.

The Coulomb barrier, thermonuclear fusion, plasma, sounding from the lips of thermonuclear physicists have nothing to do with cold nuclear fusion.

We must understand that cold nuclear fusion is a natural process that created and synthesized the entire world around us, and this process takes place both in the bowels of the Sun and inside the Earth. It can't be any other way.

Cold nuclear fusion is not pseudoscience, but only the assumption of pseudoscience.

Long live cold fusion-the discovery of M. Fleishman and S. Pons! And Stanley Pons should be awarded the Nobel Prize!

Table 1.

The way to get energy	kWh/kg	J/g	Energy/to previous energy
Burning oil (coal)	11.6	42 kJ/g	1
In the fission of uranium-235	22.9×10^6	82.4 GJ/g	1,974,138
In the fusion of hydrogen nuclei	117.5×10^6	423 GJ/g	5
The energy to the formula $E=mc^2$	29×10^9	104.4 TJ/g	247

A Theory of Light Element Nuclear Reaction

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Many experiments have shown anomalous heat and/or helium from hydrogen (light or heavy isotopes). Electrolytic, thermal, plasma, acoustic and other methods have been used. These observations, conventionally known as Low Energy Nuclear Reactions, were extensively documented by Edmond Storms [1] (especially Table 2, pages 53 to 61 therein) and by several others. All of the reactants and nuclear products involved in these reactions are stable and no neutrons or other dangerous emanations are involved.

A frustrating characteristic of this phenomenon is its inconsistency: some researchers have never produced the effect, others observe heat or helium in most trials. Few (if any) can always predict the result. This paper discusses the nuclear reactions that may likely produce substantial amounts of helium and heat from hydrogen, using the methods reported to have done so. The inconsistency is explained and some requirements for the necessary reactions are theorized upon.

Experiments by this author [2], [3] using dry reactions of light hydrogen in copper matrices containing lithium or boron will be extended with respect to this theory. A more efficient method is being studied that has some potential to be scaled up to commercial power levels,

A list of potential nuclear reactions, including mass/energy balances, is given. That list makes comparisons to well-known energy releases by fission, explosive fusion and controlled hot fusion (e.g. ITER). LENR energies, per atomic mass unit, approximate the levels of those commercial/military/research reactions (in the order of about one MeV/AMU). They can be about one-third that of the D + D = He reaction. Thus, the term "cold" fusion is not appropriate.

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Mitigating the Loss of Irreplaceable LENR Research Records: Initiative Update

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Now more than 30 years after the announcement of LENR in 1989, many of its earliest and most productive researchers are leaving the field. The large body of their accumulated research is at risk of being lost, which would be a tragedy not only for the LENR field, but also – because of the immense energy prospects of LENR – for all of humankind. The LENR Research Documentation Initiative (LRDI) has been underway for the past several years to mitigate this potential loss of these irreplaceable research records. The methods were developed in a pilot project with Dr. Edmund Storms and have been refined and expanded in work with additional researchers. So far the LRDI includes more than 25 participants and 18 projects. Onsite visits have been made to about 15 different locations, and more than 35 draft and final reports have been prepared. Unfortunately, as for so many efforts around the world, progress was curtailed in 2020 by COVID-19. Future plans call for reaching out to more candidates, more in-depth documentation for current participants, development of a more secure repository for the records, and assuring access to the information for the indefinite future. Plans also include extending the scope of the current USA-based initiative to participants in other countries.

A Possible Heuristic Explanation of Exotic Vacuum Objects (EVO's, Charge Clusters)

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In early 90's, Ken Shoulders was granted 5 patents on Exotic Vacuum Objects claiming that they were **a new form of matter**. He produced many monographs about them and suggested they were the physics that explained cold fusion.

In Ken Shoulders words, EVO's are, "Highly organized**, micron-sized clusters of electrons**, having soliton behavior, with electron populations on the order of *Avogadro's number*. When interacted with solid material, these charge clusters perform a low-energy phase transformation type of atomic disruption that **liquefies the lattice** and propels the material to a **high velocity** without apparent signs of conventional heating. Using an ordinary thermal interpretation, a thermal gradient for bulk material greater than **26,000 degrees C** per micrometer would be required to achieve these effects".

This talk presents lessons from thin film deposition methods like Vacuum Arc, Pulsed Electron beam, Pulsed Laser whose commonality with EVO generation is pulse energy impingement on a target. Rather than the hypothesis of a "new form of matter" as an explanation of EVO's, it is hypothesized that generation of a micro shaped-charge, in analogy with explosively formed shaped-charge munitions, can explain the characteristics of surfaces that were struck by EVO's. This hypothesis reproduces the effects that are underlined in the text above.

The structure of the planet Earth as "Cold" temperature and pressure

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Cold nuclear fusion (CSN) takes place at lower temperatures and pressures than in the accepted models of the planet Earth. The planet Earth is "cold", the pressure and temperature are created by the Earth's electricity, electrical discharges, as well as the friction of the rotation of the geospheres from the core, consisting of a plasma of CSN with a high content of iron oxide (Fe_2O_3), we can say the remains of a gas-dust nebula, from which the planets of the solar system and other systems are formed. Due to the rotation of the core, the friction of geospheres, plates, and geolitodynamic complexes (layers) occurs, creating electric charges in the Earth's crust, which accumulate in the Earth's electric capacitor (1 Farad) and at the same time it has the properties of the radiator of the planet Earth. And in the radiator, we know that the temperature is constant. This means that fluids (water, oil, gas) are radiator fluids (such as antifreeze) to remove heat from the friction of geospheres and cold nuclear fusion processes! And such a mechanism is the Wilson cycle in the theory of plate tectonics. The mechanism of fuel supply to the mantle and core is the process of subduction, where the CSN produces fluids that migrate up to the surface of the Earth's crust. The drift of the continents in this case is associated with the mechanical process of rotation of the geospheres, which forms the dynamo effect of the planet Earth, and not convection in the mantle! There were articles by geophysicists, which indicate that the movement of geospheres with a depth of ten times higher than previously assumed. The temperature of the core and plasma should not exceed more than 600^0C, because the organic matter above this temperature simply burned and this proves the organic origin of the oil. Water is formed due to the synthesis of inorganic chemical elements, which of course are more than organic matter and it turns out more. Due to electricity and cold nuclear fusion, all secondary minerals such as coal from oil, ores from aqueous solutions containing metals, diamonds from organic carbon, gold from lead, etc. are obtained. My proposed theory of sliding plate tectonics fully explains all the processes in the Earth's crust and confirms the theory of continental drift, which is much criticized in modern times. To test the theory, I conducted experiments on electrical discharges in a special reactor, in which reservoir conditions are created with various chemical elements, where their transmutation was observed. But various spherical nodules were obtained, in which the difference of chemical elements by spheres is well noted in natural conditions, where the core contains up to 90% of iron oxide, manganese, beryllium, etc., the chemical analysis of which was carried out in many nodules of different chemical composition. The vast majority of theories are based in mechanical action: rolling, spinning, tossing, etc. However, another force produces spheres – electric discharge. An electric z-pinch is far more powerful than gravity. In the laboratory, tiny spheres formed by electric pinches are often hollow. Electric forces tend to produce layering, along with distinct equators and poles, since electric forces "squeeze" perpendicular to the current. These features are found in the "natural" stone spheres. For instance, an accumulation of small spheres in Utah called, "Moqui balls" have both equatorial bulges and polar markings. In a previous Picture of the Day, a description of glassified spherules, created by Dr. Cj Ransom's experiments with high voltage discharges, lent credence to the theory of lightning strikes as the means by which stone spheres form. Based on research into the shape and size of so-called, "blueberries" on Mars, Dr. Ransom exposed samples of rock dust and soils to high voltage electric discharges. His results are remarkably similar to the Martian blueberries, and to other such accumulations of stone balls on Earth. (https://www.thunderbolts.info/wp/2020/12/07/spherical-stone-anomalies/)

Electrical discharges in loose «flour» rocks

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According to experimental data, spark electric discharges cause mainly the destruction and decomposition of polymers, as well as glow discharges cause mainly the folding of hydrocarbons, their polymerization. Known laboratory and practical data lead to the conclusion that when moving loose bodies, coal dust, flour, sugar, cement and others, quiet discharges and rarely spark discharges are observed. It can be assumed that in sedimentary fine-dispersed rocks, for example, sand-clay strata at low and high temperatures, when the particles do not stick together, but can break away from each other, they are charged and a quiet discharge occurs between them. In the plasma of a quiet discharge, a chemical reaction of the formation of hydrocarbons occurs, their cracking or dehydrogenation, and then the merging of the remaining molecules into the formation of heavy hydrocarbon molecules.
In this case, the electrification of the particles will occur as a result of their movement by gravitational forces or during tectonic phenomena. These reasons for the plasma-chemical reaction in sedimentary rocks complement the hypotheses of the organic origin of oil. The hypothesis provides the mechanism of the processes of chemical reactions and the energy source of such a reaction from the plasma of a quiet electric discharge. According to this hypothesis, discharges can occur in fine sedimentary rocks containing organic matter or carbon and hydrogen in compounds that occur under conditions where small movements of particles relative to each other and low humidity are possible. In the discharge plasma, a reaction of synthesis of molecules of hydrocarbon compounds can occur. German volcanologist F. Bulf previously suggested that oil companies pay attention to the possibility of synthetic occurrence of petroleum hydrocarbons from gases common to volcanoes, for example, carbon monoxide and hydrogen according to the schemes:

$$2CO+2H_2=CH_4+CO_2+q$$
$$CO+3H_2=CH_4+H_2O+q,$$

where q - is the thermal effect.

I will note that Berthelot, as early as 1869, wrote: In the spark discharge, he carried out reactions with oxygen compounds of carbon and hydrogen in mixtures of $CO + H_2$. As a result of the plasma chemical reactions, various gaseous and liquid hydrocarbons were obtained.
According to the plasma-chemical hypothesis, the formation of methane from hydrogen and carbon can proceed by the same reactions as under thermochemical influences. Hydrogen can be formed by decomposition in the discharge of hydrocarbons, water, or other water-containing compounds.
In the field of geographical study of oil gases and hot dry gases, it is a difficult task to explain in their composition the impurities of metamorphic and juvenile components of CH_4, CO_2 and impurities of heavy hydrocarbons, organometallic compounds, compounds containing sulfur, oxygen, etc.
Plasma chemistry explains the appearance of these carbon compounds both by inorganic synthesis, and by the destruction of organic matter to a gas state, the decomposition of these gases, and the polymerization of the decomposition products of organic substances in an electric discharge plasma.

Electric formation of oil and gas in the Earth's crust based on cold nuclear fusion (ICCF)

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Directly electric charges in the Earth are observed by the exits of nodules to the surface, earthquakes, volcanism, and does not contradict the proposed hypothesis of thunderstorm activity in the earth's interior. An electric discharge in a dielectric is accompanied by the detection of a large amount of energy that can cause an increase in temperature along the discharge channel to the value at which a thermonuclear reaction is possible. Electric currents flow in the Earth and this is due to the mechanical rotation of the plasma core and geospheres, which charge the planet itself due to friction. Plasma is a gas consisting of a mixture of atoms, molecules, ions, excited atoms and ions, electrons, and in some cases, free radicals. In plasma, atoms, molecules, and free radicals, when released, have significant chemical activity corresponding to their high kinetic energy. Under certain conditions, the formation and accumulation of free charges occurs in gases, insulating vapors, liquids and solids, then an electric discharge occurs. The hypotheses of the organic and inorganic origin of gas and oil do not consider the mechanisms of product formation from the starting materials. In the scheme of the hypothesis of the inorganic origin of oil and natural gases, it is possible to introduce plasma-chemical processes of gas-oil formation in the earth's crust, this is an essential moment of the formation of a product from carbon and hydrogen, which was not enough in previous hypotheses. The possibility of the formation of gas and oil in an electric discharge is also indicated by the practically feasible reverse operation of electrocracking of oil, the technology of which seems to be sufficiently developed. Similarly, decomposition processes are observed in the discharge of ethane, propane, butane, isobutane, hexane, and other natural and synthesized gases. The polymerization reactions are carried out under lighter conditions of electric discharge compared to the conditions of electric discharge for the cracking mode. This rule allows us to restate the suggestion about the preferred direction in the nature of the reaction of polymerization of gaseous hydrocarbons in a gas discharge and the formation of oil from gas. This process is energetically and thermodynamically more advantageous, so the reactions will occur mainly in the direction of polymerization. It is also appropriate to note that in gas-filled volumes of the earth's crust, there are greater opportunities for powerful electrical discharges to occur than in liquid oil deposits. The energy balance of the flow of discharges in gaseous and liquid dielectric media also develops mainly in favor of discharges in a gaseous medium, rather than a liquid one. The appearance of an artificial ball lightning was observed during a spark discharge in a mixture of air and propane at normal pressures and temperatures. The volume concentration of propane α was less than 5%. The duration of the discharge was 10^{-3} sec. At $\alpha \geq 2.8\%$, the discharge resulted in ignition of the propane mixture in the entire volume of the chamber. At concentrations of $1.8\% \leq \alpha \leq 2.8\%$, the discharge did not cause any phenomena. At a concentration of $1.4\% \leq \alpha \leq 1.8\%$, a luminous ball of yellow-green color with a diameter of several cm appeared in the discharge, which existed for up to 2 seconds. Electricity is charged by abnormally high reservoir pressures, which lead to the gushing of wells in the fields of Zhetybay, Uzen and Tengiz. Due to the rotation of ball lightning in the earth's crust, ball nodules were formed. Based on the z-pinch, we are conducting research on the creation of spherical nodules and obtaining a new energy source. The rotation of the ball lightning in the reactor will give an EMF (electromotive force) on the stator, and we will get a simple source of energy.

Conductivity and molar conductivity of LiOD heavy water solution

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The LiOD heavy water solution has been used as electrolyte in Pd-D_2O electrolytic system over 30 years, its conductivity not only affects the electrical and thermal properties but also can be used to determine the LiOD concentration easily [1,2]. In this paper, conductivities of LiOD heavy water solution (0.01 ~ 1 $mol \cdot L^{-1}$) at different temperatures (10 ~ 70°C) were measured as shown in Fig. 1. The conductivity κ in $mS \cdot cm^{-1}$, concentration c in $mol \cdot L^{-1}$ and temperature T in °C can be simulated as a quadratic form:

$$\kappa = 61.8c - 17.64c^2 + 2.47cT - 0.3828c^2T$$

This equation is simplified to:

$$\kappa = 123.55c - 27.21c^2$$

and the concentration can be expressed as:

$$c = 8.094 \times 10^{-3}\,\kappa + 1.443 \times 10^{-5}\,\kappa^2$$

at 25°C. The corresponding molar conductivities are analyzed based on solution theory. It is found that the simulated values are consistent with experimental data within 3% for LiOD concentration of 0.01 ~ 0.5 $mol \cdot L^{-1}$.

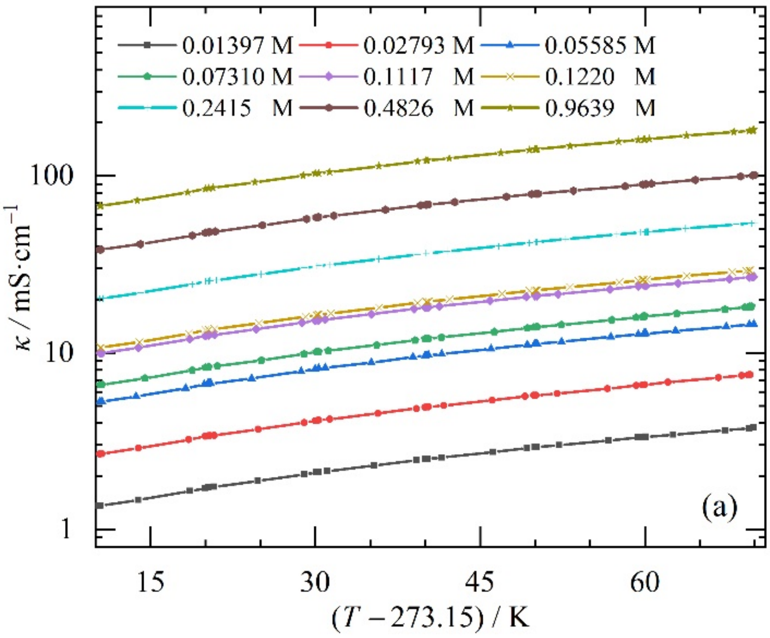

Fig. 1. Conductivities of LiOD heavy water solution at different temperatures and concentrations.

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Cold fusion powered vehicles

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A new energy vehicle project, nuclear-powered vehicles (NPVs), is put forward based on our experimental results and theoretical analyses. The scheme is simple and easy to realize. The idea is that a NPV can drive 100,000-150,000 km continuously only with a single filling of nuclear fuel (in factory condition). During the product life, it only needs to be maintained once every two years, such as replacing the tires, brake pads and other wearing parts as well as the cooling circulating water filter and air filter. When the vehicle is fuelled again to mileage of 200,000 km, the life of most parts is end and it can be scrapped. That is to say, a NPV need only one fueling in the lifetime and it is a kind of ideal vehicle of zero emission, no radiation, low cost and environmentally friendly. Its body, chassis, steering machine and so on are exactly the same as the traditional vehicle and we can use the available technology to manufacture it.

The core technology of NPV is the cold fusion power units (CFPU). For type of family car, the engine has capacity of 150 kW and the hub motor is used in the transmission system. After the power is adjusted by the controller, the power is sent to the wheel hub by electric cords to drive the car. A NPV can also be used as a mobile power source. With the help of power converter, the direct current from generators can be converted to 220 V alternating current. In case of power grid is damaged in natural or human-made disasters, the NPV can replace the municipal power for residents' use.

The CFPU mainly divided into three kinds according to powers. The small power of 150 kW is mainly for cars. Medium type of 300-400 kW is mainly for light trucks, cards and coach. Large type of 1,000-2,000 kW is mainly for heavy vehicles and all kinds of engineering machinery. The CFPU is composed of cold fusion reactor, nuclear fuel supply system, working medium heat exchange system, steam generator, turbine blade, turbine shaft brushless generator set, turbine shaft permanent magnetic generator set and turbine steam cooling cycle system, etc.

NPV's fuel is seawater concentrate fuel (SCF). We developed a device that can gradually concentrated the deuterium content in sea water to > 20at.% in cheap price and it can be used in CFPU as verified experimentally in our lab. The reaction energy of such fuel equals to the combustion heat of 300 liters of #90 gasoline. The present price of SCF is 1560 RMB (or 240 USD) per liter. This means this fuel is equivalent to the gasoline price of 0.76 RMB/L (or 0.12 USD/L). It is to say that the fuel tank of a NPV needs only 50 liters of SCF that is enough to keep it driving for more than 150,000 km [1,2].

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Convolution denoising of a large volume Seebeck calorimeter

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Calorimetry has been a crucial issue and debated all the time since the discovery of cold fusion in 1989. Seebeck envelope calorimeters (SECs) are widely used in this community for the benefit of large measuring room, high range and easy to operate. However, the thermal background noise of SEC (e.g. peak-peak signal is 0.1 W in Ref. [1]) is much greater than the microcalorimeter (e.g. 10 nW to 1 μW for Calvet microcalorimeters of TA and Setaram) due to large volume and worse temperature stability. Therefore, the low excess heat and its slight changes cannot be detected by present SECs. The reason is that the requirement of high thermal power measurement has to be satisfied by rapid heat transfer and thus the temperature stability is limited by the circulating bath matched. The multilevel thermostatic baths used in the Calvet calorimeter cannot be applied here.

In this paper, a new technique of denoising for SEC is reported. Its principle is as follows, thermal power noise of SEC mainly comes from temperature fluctuations of cooling fluid, our goal is to measure the fluctuation and eliminate it. Firstly, a reference vessel, which is a small size of SEC, is made. Its outer fluid pipe for thermostating is among the outlet of circulating bath and the outer fluid pipe of sample vessel. This design can ensure the thermal signal change of reference vessel induced by fluctuation of fluid temperature being prior to the response of sample vessel of SEC (see the left picture of Figure 1). Before regular calorimetry, a temperature step is applied on purpose, two thermal pluses of reference vessel and sample vessel occur successively. Deconvoluting these two pluses and obtain the response function of the calorimeter. In practical calorimetry, the waveform of convolution of thermal signal of reference vessel is much like the signal of sample vessel induced by fluctuation of fluid temperature as shown in the right picture of Figure 1. The sample vessel's signal minus the convolution signal can eliminate most of thermal noise.

As shown in the Figure 1, the preliminary test shows that the noise can be reduced by more than 2 orders of magnitude, which is physically equivalent to the water bath temperature stability changing from 0.005°C to better than 0.000035°C. At the same time, the detection limit of the large volume calorimeter is extended from order of 0.1 W to order of mW, and the measurement sensitivity and accuracy are greatly improved. This calorimeter can be used widely in cold fusion studies.

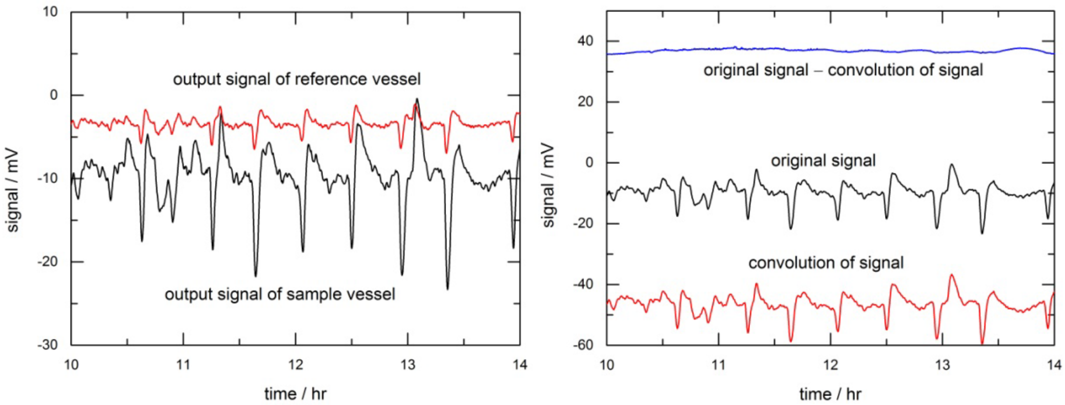

Fig. 1. Preliminary application of convolution denoising. The left picture is the output signals of the reference vessel and the sample vessel; The right picture is the convolution of the output signal of the reference cell and the difference between the two. It can be seen that after convolution processing, the reference cell signal can mostly cancel with the sample cell signal (for example, the peak-peak near 13 hr is 21 mV or 280 mW, after processing, it becomes 0.14 mV or 1.8 mW, only 0.7% of the former).

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Direct Conversion Into Electricity: Replications

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The technology of "fusion diodes" was proposed several years ago to convert the energy of nuclear reactions taking place in condensed matter into electricity.
For 4 years, positive results have been obtained by several teams and patents filed.
The author summarizes this work and presents the results of his replication experiments.

The Theorist's Role in Unravelling Cold Fusion Physics

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If we are to unravel the cold fusion process, we need to comprehend it at a more fundamental level than calorimetry. Consider the possibility that cold fusion might consist of the three sub-processes:

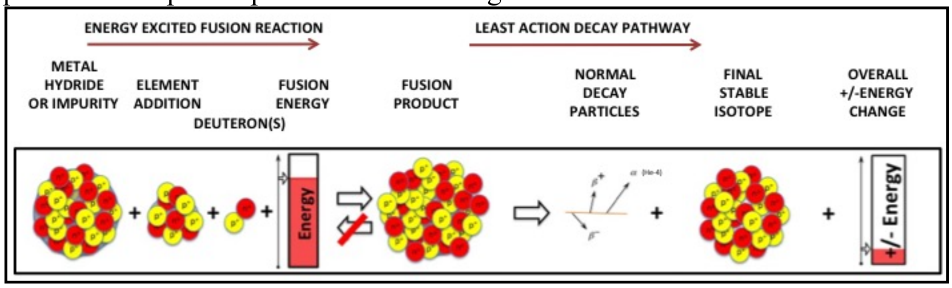
Process Rank	Process Description	Reference
Tertiary process	Excess heat generation	Fleischmann and Pons
Secondary process	Nuclear transmutations	Mizuno and Miley
Primary process	Energy accumulation & storage	LANP model

In this presentation, we develop a methodology for measuring the secondary process, and in particular observing the time history of individual nuclear transmutation events.
The experimental hypothesis is: *LANP theory predicts the order in which specific nuclear transmutations occur in a thin film nickel electrode.*

The experiment is designed to also answer four questions:

- Exactly what types of nuclear transmutations are occuring? Fusion? Fission? Decay?
- How are protons and neutrons implicated? Do they participate? Do they catalyse?
- Do observed transmutation events support excess heat measurements?
- Are both fusion and fission occuring? Can we isolate single transmutation events?

The theorist's view of nuclear transmutations differs from the experimentalist's. While the experimentalist focuses on measuring initial electrode composition and the transmutation end products, the theorist is more interested in the story of how the process developes from natural laws. In this paper we develop an experiment that is designed to observe an isolated nuclear transmutation.



The Least Action Nuclear Process theory is used to develop an experimental hypotheses that specifies the time sequence of initial nuclear transmutations in a thin film nickel electrode made from 99.999% fine Ni-58 and a single, mono-isotopic element impurity such as 99.999% fine Sc-45.
The theory provides energetic calculations for the initial fusion transmutation, followed by a decay proceess along the path having the smallest energy change. The experiment is designed to measure the isotope composition of a thin film (Ni coated glass beads) electrode at intervals determined in pre-experiment trials. The measurements are then compared to LANP model calculations that were prepared during the experiment's planning phase.

TABLE 7 – PURE NICKEL-58 ELECTRODE WITH PURE SCANDIUM IMPURITY AND ONE OR TWO HYDROGEN

Host Metal	Impurity	Protons	Fusion Product	Decay Product	Energy Components: Fusion	Decay	Total
45Sc	+ 45Sc	+ (1)p =>	91Tc =>	91Zr =	0.6224 MeV	11.3995 MeV	12.0219 MeV
58Ni		+ (1)p =>	59Cu =>	59Co =	2.9075 MeV	5.8713 MeV	8.7788 MeV
45Sc	+ 45Sc	+ (2)p =>	92Ru =>	92Mo =	5.8252 MeV	11.3779 MeV	17.2032 MeV
58Ni		+ (2)p =>	60Zn =>	60Ni =	7.5160 MeV	9.2624 MeV	16.7783 MeV
45Sc		+ (1)p =>	46Ti =>	46Ti =	9.8336 MeV	0.0000 MeV	9.8336 MeV
45Sc		+ (2)p =>	47V =>	47Ti =	14.4903 MeV	2.4193 MeV	16.9096 MeV
58Ni	+ 45Sc	+ (1)p =>	104Sn =>	104Pd =	-22.9240 MeV	15.7520 MeV	-7.1719 MeV

Muon catalyzed fusion can ignite lattice-assisted nuclear reactions

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The lattice-assisted nuclear reaction (LANR), also known as cold fusion, is active for long period of time if the process successfully initiated. This long time activity indicates that, the conditions are sufficient for maintaining the reaction. The known reproducibility problem of LANR; therefore, most likely result from the uncertainty of the ignition process. It is hypothesized that muons from cosmic rays ignite the LANR fusion reaction, which then becomes self-sustained. Exposing the reactor with high intensity muon flux, and igniting the fusion by that, could eliminate the reproducibility problem of the LANR experiments.

" Cold Fusion Phenomenon " of Abnormal Exothermic Heat .

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Abstract. Based on the progress of cold fusion research for more than 30 years , it comprehensively describes the relevant research and experimental progress of the predecessors and proposes from the perspective of thermodynamics that ultra-low temperature is used to charge the palladium wire to increase the hydrogen charging rate and the output The empirical formula for calculating the hydrogen charging rate of the palladium wire , and a theoretical solution modelled on the isotope effect in the abnormal exothermic phenomenon .

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Non - accelerator measurement of the long - range quark - lepton interactions in solids

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The primary task amongst other nuclear physics fundamental tasks is experimental measuring of nuclear force interacting between nucleons (protons and neutrons) and their dependence on nucleons' distance in between. The discovery of the neutron by Chadwick in 1932 may be viewed as the birth of the strong nuclear interaction. In 1935 Yukawa have tried to develop a theory of nuclear forces. The most important feature Yukawa's forces is that they have a small range (~ 10^{-15} m). However, up to present time phenomenological Yukawa potential can not be directly verified experimentally. We should remind that the strong nuclear interaction - the heart of the Quantum Chromodynamics (QCD) which is the part of the Standard Model (SM). According to SM the nuclear force is a result of the strong force binding quarks to form protons and neutrons. Residual part of it holds protons and neutrons together to form nuclei. There are common place in nuclear and high energy physics that the strong force does not act on leptons. Our non - accelerator experimental results show the violation of this strong conclusion. Our report is devoted to study the low - temperature 2K (reflection and luminescence) spectra of LiH (E_g=4.992 eV) (without strong interaction in hydrogen nucleus) and LiD (E_g = 5.095 eV) (with strong interaction in deuterium nucleus) single crystals which are different by term of one neutron from each other. The experimental observation of isotope shift (0.103 eV) of the phononless free excitons emission line in LiD crystals is a direct non - accelerator manifestation of the long - range nuclear interaction on the leptons. We must emphasize that LiD crystals have a maximum strong coupling constant a_s, which, according to our estimates, is equal 2.4680. According to the proposed model the main mechanism of the long - range neutron quark - lepton interaction is their magnetic - like long - range interaction. Moreover, we have measured the dependence of the nuclear force on the distance between nucleons in deuterium nucleus, which, as would expect, has a nonlinear character of dependence on distance. Since the isotope effect is a direct manifestation of the mass effect in microphysics, it is natural expect here the origin of mass in Nature. In this regard, we note that the measured appearance of masses in massless fermions in graphene is directly proportional to the energy of interband transitions opened by the isotope effect. The hypothesis of theorists about the emergence of mass due to the self-action of gluons - a kind of cannibalism of gluons - sounds very plausible. Present report continuos to develop between nuclear, high energy and condensed matter physics. The obtained experimental results can open new avenue in nuclear and elementary particles physics.

Optical Observation of Spontaneous Heat Burst Phenomena during Hydrogen Desorption from Nano-sized Metal composite

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We have been conducting research on anomalous excess heat (AEH) generation phenomena using hydrogen and nano-sized metal composite. Up to the present, we succeeded in observing the AEH that cannot be explained by the chemical reaction [1,2]. In addition, we often observed heat burst phenomena, in which the temperature of the heater suddenly rises [2]. Observing this phenomenon in detail is one of the ways to understand the mechanism of the AEH production. Recently, experiments have been conducted by adding light radiation to temperature measurement [3]. In the present work, we report on the latest results measured by a group of photodetectors. The sample mainly examined is a Ni/Cu nano multilayer film which is deposited on Ni substrates by sputtering.

The experimental process is as follows. First, two films are fixed on both sides of a ceramic heater in a sample holder installed in the vacuum chamber. Next, the samples are sufficiently baked out in a vacuum, and then H_2 gas is introduced into the chamber to 200 Pa, the heater temperature is kept at 250 C for about 15 hours to allow the samples to absorb hydrogen. Finally, we heat the samples up and keep the heater input power constant, while evacuating the chamber to release hydrogen from the samples: This induces the AEH generation.

In the experiment, the heater temperature was continuously measured together with the light radiation emitted from the surface of the sample. Attempted was the simultaneous detection of light radiations when the heat burst occurred. Used photodetectors are TMHK-CLE1350 (wavelength 3-5.5 μm) for mid-IR, an FTIR spectrometer Hamamatsu C15511 (1.5-2.5 μm) for near-IR, and a spectroscope Hamamatsu C10027 (0.3-0.9 μm) for visible light.

Fig. 1 shows typical heat bursts occurring spontaneously: a plot of the temperature and radiant intensities as a function of elapsed time. Red, green, brown and light-blue lines are heater temperature, radiant intensities measured in mid-IR, in near-IR and in visible light, respectively. Many sudden increases are clearly seen in every line and they are temporally synchronized, even though the heater input power is constant. This suggests that there is sudden energy generation in the sample, part of it is dissipated quickly by radiation from the surface and is partly propagated to the inside as to rise the heater temperature.

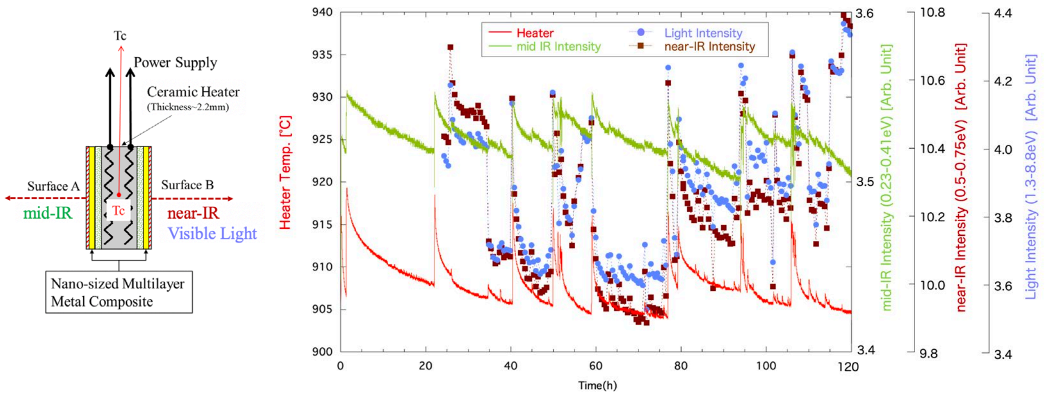

Fig.1 Typical heat bursts occurring spontaneously

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Low energy nuclear reactions with emission of two photons

Pankaj Jain

We propose a new mechanism for inducing low energy nuclear reactions (LENRs). The process is initiated by an electromagnetic perturbation. The initial two body nuclear state emits a photon and forms an intermediate state which makes a tran- sition into the final nuclear state with emission of another photon. We need to sum over all energies of the intermediate state. Since the energy of this state is unconstrained we get contributions from very high energies for which the barrier penetration factor is not necessarily small. By considering fusion of H(1) and H(2) to form He(3), we determine the conditions under which this mechanism leads to fu- sion at observable rates. We show that this mechanism works only inside a medium and not in free space. We show that a clear experimental signature of this process is emission of two photons in coincidence whose total energy is related to the Q value of this process. Hence this process can be confirmed or ruled by presence or absence of such photons in the final state.

Health Risks of Microplasmoids in Transmutation/Energy Generation Experiments and Devices

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Harmful microplasmoids are produced by electrolysis and discharge experiments and devices used for transmutation and energy generation. In 1992, Matsumoto registered strange tracks of microplasmoids on nuclear emulsions in a palladium and heavy water electrolysis experiment[1]. Since then, microplasmoids tracks have been discovered in a variety of kinds of devices by many research groups. However, many groups are not aware of this kind of radiation and the existence of this state of matter. These microplasmoids are a health hazard and should be shielded for and detected.

Urutskoev and others have documented that these microscopic objects can fly out of and impinge on animals or other living organisms and cause cellular and genetic damage. In a recent article, E.A Priakhin, L.I. Urutskoev presented the results of an extensive study of the strange radiation on cells and plants[2]. It is still uncertain about how these results can be applied to understanding the harmful effects flying microplasmoids on humans and large animals. But an important result was that the analysis of the effects of several shielding materials showed that aluminium foil may not be a good material for shielding as some have described. For example, the experiments with aluminium foil shielding proved to be more harmful to onion root growth than the unshielded experiments. This suggests that the plasmoids might be energized or grow bigger when passing through the foil or that perhaps the objects changed state from being darker to whiter.

Recently, I've proposed trying to use energized shielding materials[2][3]. However, as Ken Shoulders described, these objects may change state as they travel and pass undetected through shielding materials and device containers but then change state to cause damage in expected places. Also, materials may change state to the plasmoid state and cause damage in materials as they move, transmute atoms, and emit harmful radiation. I believe that in many experiments, this plasmoid state material may remain undetected for long periods of time, even years, but still pose health risks and damage equipment. For safety, good shielding methods should be devised, and methods of detecting the presence of the matter in a plasmoid state should be devised.

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LENR Transmutation of Stable Sr and K isotopes in Activated Microbiological Syntrophic Anaerobic Association

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In our previous works [1-4], the effective method for accelerated deactivation of the Cs^{137} isotope during nuclear reaction of transmutation $Cs^{137}+p=Ba^{138}$ in growing microbiological cultures was presented.

At the present time we are solving the problem of accelerated transmutation of another very dangerous radioactive Sr^{90} isotope. The paper presents the results of study of a possible mechanism of $Sr^{88}+p=Y^{89}$ transmutation of a stable Sr^{88} analog of the same radioactive isotope. The research was carried out on the basis of optimal anaerobic syntrophic associations grown on waste from the food and light industries.

A typical series of experiments lasted 21 days under anaerobic conditions and using special external distant control methods, and the result of the experiments is a significant decrease in the concentration of strontium, as well as an increase in the concentration of ytrium isotope.

In addition, a significant increase in the concentration of calcium was found as a result of the $K39+p=Ca^{40}$ as well as a decrease in the concentration of potassium.

In our opinion, these reactions were stimulated by the same processes of optimization of nuclear reactions at low energies due to the formation of coherent correlated states in growing microbiological associations [5,6], as in the case of Cs^{137} isotope tansmutation.

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Closing the gap between the fields of nuclear quantum dynamics and condensed matter nuclear science

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Key parameters of nuclear reactions such as the half-lives of alpha emitters or the rates of fusion reactions have traditionally been considered to be unaffected by their environment. However, as has been noted since at least the 1960s[1], this assumption only holds in the absence of quantum-coherent effects. Quantum coherence can amplify initially weak couplings between nuclei and thereby lead to modified energy transfer and conversion pathways in strongly coupled systems, analogous to how such effects occur – and have been widely studied – at the atomic scale. Modified energy pathways, in turn, can mean the acceleration of fusion reactions as well as the modification of reaction products. A recent series of papers[2,3,4,5] published in journals of the Nature and Science families experimentally demonstrate changes in nuclear state transitions as a result of stimulating samples with coherent photons. Here I lay out how such findings – which are rooted in the established field of quantum dynamics – are highly relevant for the field of condensed matter nuclear science (CMNS), representing basic mechanisms for the manipulation of nuclear states. I show the connection between this recent line of work and the work of CMNS theorists such as Hagelstein[6] and Schwinger[7] and lay out what connecting pieces – in terms of conceptually simple experiments – are still needed to close the gap between the burgeoning field of nuclear quantum dynamics and CMNS. I expect that closing this gap will enable the systematic investigation of a large number of nuclear anomalies reported in recent decades, and will also be accompanied by a major influx of resources as well as renewed interest in such anomalies.

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The Reversible Thermodynamic Process and its Place in Physics

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Most scientists have, in some quiet moment, reflected on the nineteenth century understanding of the Second Law of Thermodynamics, and asked: Why… if everything in our universe is continually going over into disorder … why is the universe still here? And, how is it that it remains so ordered?

This paper begins by discarding what we think we know about the reversible thermodynamic process, in favour of a fresh view that draws on discoveries and understandings that did not exist in Carnot's, Clausius', and even Planck's world. It draws on biology, chemistry, and physics for its insights, and begins in the manner of all good scientific inquiry, with a question:

Can a reversible process exist in nature?

This presentation concludes that reversible processes do occur in nature, and then goes on to identify four reversible processes that are common in nature and essential to the continuance of our universe.

There are three characteristics that all reversible thermodynamic processes have in common. First and foremost, it is a physical process. This means that it has at least two states and at its most fundamental description these are cyclic. Secondly, because it is a process, all reversible processes do produce a work product. And third, the reversible process differs from any irreversible process because it operates at the very limit of the Second Law of Thermodynamics where no entropy is produced as a result of its operation.

The first of four reversible processes in the natural world is the process that facilitates the **covalent bond**. It is reversible because it exhibits the salient characteristics of reversibility:

- It is a process with two states: the electron's association with each nucleii.
- It exhibits no entropy increase during its operation, and in this regard it is perpetual untill it is disrupted. It reequires no refueling, and expells no exhaust.
- It maintains a work product: the union of two atoms. I want you to see in this example how the *reversible covalent process* is distinguished from the *covalent bond* itself.

The other three reversible thermodynamic processes in nature are:

- **Light in a vacuum** is a reversible thermodynamic process. The process is the alternating sinusoidal conversion of electrical and magnetic energy in accordance with Maxwell's equations. The cycle repeats over and over. It produces a work product: the movement of electromagnetic energy in space-time.
- **Gravity** is a reversible thermodynamic process. Its work product is mass transport in space-time. However, its underlying states and mechanism have not yet been discovered.
- **The stable atoms form and** function, where the reversible process is the force, or system of forces, that maintains the stable atom's form and function in opposition to electro-static repulsion. The work product here is a stable atom.

This paper then goes on to describe what I call the **obligate reversible process** which creates an artificial environment that is suitable for reversible process dynamics. However, in this case, *entropy production occurs in the forcing function that produces the reversible process environment*, and that environment sustains reversible process dynamics where no entropy production occurs. It is proposed that the cold fusion process operates according to these principles.

Some preliminary thoughts on abnormal phenomena of condensed matters loaded with D/H

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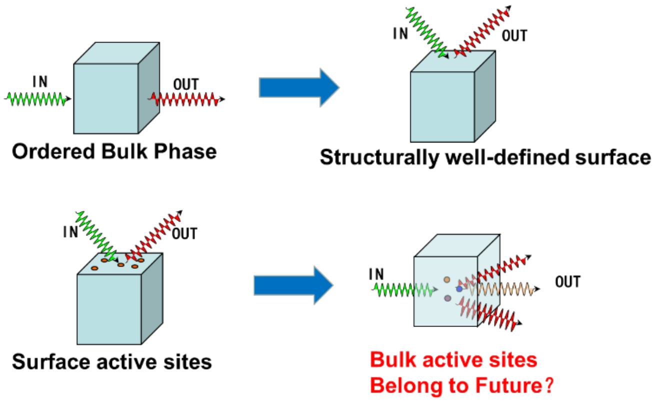
1. The threshold of condensed matter nuclear science (CMNC) is very high

Originally scientists studied condense matters by preparing and characterizing the structurally well-defined and ordered crystals (bulk phase), then the subject was expanded into structurally well-defined surfaces and the top few layers of metal and oxide crystals. It is hard to prepare and characterize the various surface facets.

For catalysis and electrochemical industries, the people have to move forward to prepare good catalysts and electrode materials. it's necessary to get the deep insight of surface reaction mechanisms. As a consequence, much more complex surfaces were prepared to rationally design and create various active sites of adsorption/reaction of heterogeneous surfaces.

Nowadays the people can study the single active sites, single atom(s) supported by metal/semiconductor/oxide/carbon—single atom catalysis (SAC) by tools with very high spatial resolution (angstrom) experimentally and theoretically.



2. Some thoughts on CMNS

- CMNS may result from some nonequilibrium processes in highly D/H loaded metals; e.g., a rapid change in the configuration of host metal atoms could create unique "CMNS active sites".
- To avoid the conflict of the loading and triggering targets, the sharp increase of temperature by the laser, current, or electro-magnetic pulses are obviously helpful because the absorbed D/H has no time to escape from the bulk phase of metal.
- Raising the temperature close to the melting point could be a way to create a special non-equilibrium state that may promote the reaction effectively.
- The small tubes with ultrathin wall, ultrathin wires or nanoarticles of metal/metal hydride are the best for these high temperature/pressure studies. For the small nanoparticles, the surfactant to protect the particle surface must be used.

- The surface contamination must be avoided and many characterization methods and tools under high vacuum condition must be developed to extract the week signal contributed from the surface.
- Not only normal condense matter but also abnormal (‘soft’) condensed matters may support nuclear reaction, which may need to have stimulated surface phonon emission or coherent shaking of surface and/or sub-surface atoms periodically. The localized anharmonic vibrations might be one of the possible ways to realize the localized excited surface phonon, which could be triggered by thermal heating, THz pumping, gas pumping or inflating, etc. The abnormal phenomena may be more distinct when the condense matter is getting ‘soft’ in a non-equilibrium state when the condense matter is input with energy flux.
- The combination of hot and cold fusion may reduce the threshold of technical parameters especially the temperature for ICF.

3. Brief Summary

- To avoid the conflict of the loading and triggering targets, the sharp increase of temperature by the laser, current, or electro-magnetic pulses are obviously helpful because the absorbed D/H has no time to escape from the bulk phase of metal.
- One of the extreme trigger methods could be the utilization of inertial confinement fusion (ICF) facility. The highly D/H loaded metal nanoparticles are filled in the target ball then it is compressed to extremely high densities and temperatures by the initiating laser beams. The sufficiently high density and temperature are achieved before the target disassembles. The combination of hot and cold fusion may reduce the threshold of technical parameters for ICF.