13th International Workshop on Anomalies in Hydrogen Loaded Metals

Abstracts

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**Workshop Patrons**

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**Organizers**

William Collis
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Thank you!
Phonon-mediated nuclear excitation transfer

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A nucleus in motion will experience a boost corrections to the strong force, which provides the physical basis for an unexpected and sizeable phonon-nuclear interaction. Due to the absence of phonon modes with energies commensurate with nuclear transition energies in the keV region, we would not expect to see nuclear decay via one-phonon or few-phonon decay channels. Consequently, the lowest-order physical process which is potentially observable is excitation transfer, where the nuclear excitation at one site is transferred to a nucleus initially in the ground state at another site.

Excitation transfer has long been studied in biophysics, where the transfer of electronic excitation in a large molecule occurs in photosynthesis.

We have pursued models for phonon-mediated nuclear excitation transfer for electric dipole (E1) and magnetic dipole (M1) nuclear transitions. The lowest-order indirect coupling derived directly from our models is quite weak, and in the case of M1 transitions does not appear to be in agreement with recent experimental results in our lab. The reason that this indirect coupling is so weak is that it is hindered by destructive interference. If excitation transfer has been observed in the lab results, then it means that in some way the destructive interference has been reduced.

We proposed years ago that loss could remove the destructive interference which hinders indirect coupling in the case of up-conversion and down-conversion. The same approach would be expected to work in the case of excitation transfer. We have analyzed the impact of loss for E1 and some M1 cases, and find that it is possible to increase the indirect coupling significantly. However, it is unclear whether the effect is sufficiently large to allow for a quantitative connection with our recent experiments.

Quite recently we have understood that destructive interference would be reduced for excitation transfer, and also for up-conversion and down-conversion, if the basis state energies shifted off of resonance. This proposal is currently under investigation.

We note that a modification of the decay channels and rates is possible for off-resonant states. This is proposed to account for the anomalous incremental change in the Fe-57 14.4 keV gamma relative to the Fe K-alpha seen in our excitation transfer experiments. We note also that an analysis of the electromagnetic interaction off of resonance indicates the possibility of an unexpected emission associated with the electromagnetic interaction between nucleons. This is proposed to account for an increase in the 14.4 keV gamma signal seen in some of our experiments.
Quantum mechanics was found to be incomplete until recently the ability to model the structure of elementary particles and the components of the baryons produced a nuclear structure for deuterium consistent with nuclear short range correlation data from accelerator experiments [1] [2]. The model aids in understanding the strong force with a structural model for baryons that can be used to help explain at least one of the FCC lattice driven D-D fusion processes. What has to be exposed is the nuclear energy loss mechanism that leaves no residual radioactive products. The process involves a coupling of the charge distribution adjustment supporting the increased mass defect in the fused state to an energy loss mechanism supported by the metal lattice. The requirements on the lattice for D-D fusion are strict and appear to be limited to the Ni/Pd FCC lattices. A mechanical understanding is also required of how elevated local concentrations of deuterium are achieved while avoiding being trapped at defect sites to allow either a slow release of energy or rarely the highly energetic and damaging reactions. In addition to the optical and experimental anomalous heat data, the metallurgical requirement for the process is refined by using a combination of thermodynamic diffusion and partial molar volume data, positron annihilation characteristics of deformed metals, defect kinetics, electronic band structure, and logical exhaustion to identify the kinetic structure that can drive nuclear fusion. Both the nuclear and the metallurgical processes are dominated by quantum mechanical behavior that cannot be modelled classically and as a consequence has slowed the understanding of these solid state processes.
Beyond the hydrogen loading

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While the experimental and technological attention is focused on the operational methods for hydrogen loading in metals and on the observed anomalies with respect to the well-established rules, we aim to remark that these methods and these consequences can be seen as a part of a more general problem. In fact, the most of the experiments and deductions of material sciences are based on the assumption that space-time is flat and isotropic (Minkowskian). After discarding this assumption, a theory of Deformed Space Time (DST) was developed in the last tens of years. Following this theory, experimental results were obtained which are not predicted by the Standard Model. The DST-theory concerns the fundamental interactions, in particular the nuclear ones, that can play the main role in the observed anomalies.

In order to consider a nuclear reaction as a DST-reaction, four main phenomenological features were deduced: occurrence of an energy threshold; change of atomic weight; absence of gamma radiation; anisotropic emission of nuclear particles in intense beams having very short life span.

From the experimental point of view, rather than looking for fortuitous events realizing the conditions for DST-reactions, a more systematic research can be undertaken by following the four general rules. In particular, the occurrence of thresholds can correspond to a latency time, necessary to reach the energy density necessary to deform space-time. The absence of gamma radiation is no more a sign that nuclear reactions are not present; in fact, elements can be found which were not present before the reaction. The nuclear emissions, which are anisotropic and impulsive, can be difficult to detect with the traditional methods, thus inducing incertitude on the occurring reactions. Finally, rapid variation of energy density is an experimental common factor of DST-reactions.

The DST-theory can thus be the leading theory in the design of the experiment and in the interpretation of its experimental results.
In our work on the Electron Deep Orbits (EDO), we started with a complete analysis and an extension [1] [2] of the most developed works [3] [4] based on Dirac and Schrödinger relativistic equations. Doing this, we discussed and countered the most common arguments found in the literature against EDOs. Next, as Special Relativity seemed an essential element for obtaining EDO solutions, we showed [5] that it is actually the source of EDOs. Extending this work, we undertook a study [6] on magnetic interactions near the nucleus, some of which cannot be taken into account by the one-particle Dirac equation. This study included a review of the important known works existing in the literature on this topic. We showed magnetic potentials to have very high energy near the nucleus and, as a consequence, we could expect the Heisenberg Uncertainty Relation (HUR), as related to the deep-orbit electron, to be respected in this zone. Nevertheless, we recently [7] adopted a new strategy: to directly address the HUR as a starting point, while considering an electron confined in a sphere of radius \( r \). From HUR, we can evaluate the relativistic coefficient \( \gamma \) corresponding to the confinement energy of the electron, as a function of \( r \), and we can establish that the electrons in deep orbits are highly relativistic (\(~100\) MeV). Furthermore, a relativistic correction to the static Coulomb potential leads to an effective dynamic potential \( V_{\text{eff}} \) capable of confining such electrons. So HUR, which seemed an impediment for the EDO’s, provides its proper resolution thanks to Relativity. Taking into account \( V_{\text{eff}} \) as well as other intense EM interactions near the nucleus, we also deal with the issue of stability of the EDOs. Many calculations performed in semi-classical way, with various combinations of (attractive/repulsive) potentials, allow us already to expect high-energy resonance near the nucleus. Our present study recalls and proposes to progress on certain issues, such as:
- What is the behavior of \( V_{\text{eff}} \) as a function of distance to the nucleus?
- How do combinations of different EM (attractive/repulsive) potentials lead to a resonance near the nucleus?
- What are the relativistic corrections of EM interactions, for highly relativistic electrons?
- How does one take into account the strong radiative corrections near the nucleus?
- Are the resonances, determined by local minima of energy, consistent with the previous results obtained by the Dirac equation, especially those of the binding energy of the EDOs? If not, how and why do they differ?
- If considering the general solution of a relativistic quantum equation to take the form of a linear combination of regular and deep solutions, what are the relative weights of the combination and the respective probabilities? On the other hand, if considering the possibility of two independent families of solutions (regular/EDO), how does one discriminate between them, while respecting QM rules?

References


On the role of Super Abundant Vacancies (SAV’s) in hydrogen loading and production of the Fleischmann Pons Heat Effect

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Background.

My (MM) attention was guided to the so called Fukai phase (or phases) by Peter Hagelstein some time in the mid ’90’s. We invited Fukai to visit SRI and went painstakingly through the concept. From both a theoretical and experimental perspective it was apparent that these Super Abundant Vacancies (SAVs) might contribute to an explanation of nuclear effects in condensed matter, and hence to Condensed Matter Nuclear Science, CMNS. For a long time the problem has been: (how) do these phases form at the temperature, pressure (and time) of our LENR experiments? The response of many (including knowledgeable leaders of the LENR community) was: “these phases have never been seen under ambient conditions and are therefore irrelevant to CMNS”. We will argue differently by example.

The so called Fukai phases (there are 3) are the thermodynamically stable state of many if not all FCC metals under the condition of high hydrogen chemical potential. We hypothesise that these SAV’s are the Nuclear Active Environment (NAE). Formation of SAV’s requires self-diffusion of lattice atoms to a free surface to create the vacancy structure. This is a slow process that is responsible for the long initiation time of Fleischmann Pons Heat Effects (FPHE) in bulk matter. Several means are available to rapidly bring the SAV = NAE, into existence for our experiments; some have used these methods before, others are using them now, some unknowingly. What is needed is to pre-position atoms closer to their (Fukai) equilibrium sites and/or to introduce an activity gradient for metal self-diffusion and provide space to “park” the atoms diffusing away from proto-vacancy sites that are much closer than the bulk free surface. FPHE: NAE = SAV = SPD + D. We will explain.
Does the quantization of the proton magnetic moment explain LENR?

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About one and a half year after the start of Nuclear & Particle Physics version 2.0 there are now several experimental confirmations for the new model. After a careful extrapolation of the proton 4D radius \((0.8376530063/2 \text{ fm})\), we were able to deduce the magnetic base mass of the proton. After the correction of the mass by the known magnetic moment perturbation a tiny amount \((272'406 \text{ eV})\) of the proton mass energy was left unexplained. It turned out that this amount is exactly defined by a \(\text{SO}(4) = \text{SU}(2) \times \text{SU}(2)\) conform alpha quantization.

Proton 4D \(\alpha\)-quantization: \((1-(\alpha/\pi^*16))^2\)

Proton magnetic base mass: \(M_{\text{proton}}(\text{eV}) = \mu_p^2 \times 4 \times 10^6 / (\alpha \times r_p^3 \times e) = 926'603'086.8\text{eV}\)

Proton magnetic perturbation “p-1Dimension” = \(0.9959335244\); For full moment : \((p-1\text{D})^3 = 0.9878501147\)

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Tab 1. The first 32 quantum steps of energy a proton may release:

A first review of old experiments gave two hits: Both Iglev[1] & Lipinski [2] reported the highest proton resonance at 1000eV. The above tabulated values are 4D equivalent energies that are valid for emitted radiation energy. In a kinetic experiment with non relativistic protons only half of the \(\text{SO}(4) = \text{SU}(2) \times \text{SU}(2)\) responds to a proton event, because in 4D physics the “kinetic mass” is flowing inside and outside of the center of mass surface. Thus the 1000eV perfectly matches the first proton quantization step.
Two months ago there was a big surprise! We, the first time, had access to a long running LENR experiment that allowed to measure gamma radiation over weeks. At first sight we had no explanation for the seen lines, that were nowhere conform with known lines. Then I detected that the central peak exactly corresponded to the predicted neutron 4D energy hole wave resonance. After that we started to count the peaks between 20 & 80 keV and found that they exactly correspond to the expected proton quantization. We thus see a modulation of a Neutron wave by the proton momentum quantization.

Fig.1 Spectrum from a running LENR experiment measured by Russ George LFH

The last prove for the proton magnetic mass has recently been given by CERN's LHC. The CERN claimed Higgs event at 126GeV is an exact resonance of the proton magnetic mass. If you multiply the above $M_{\text{proton}}$ with $1/\alpha$ and $(p-1D)^2$ then you get (125.95GeV). CERN measures exactly what is expected from 4D physics rules, that tell how magnetic mass is converted (See also [3] for an alternative derivation of the rule.).

[1] B.I. Ivlev Conversion of zero point energy into high-energy photons
[3] Leonardo Chiatti, Quantum Jumps and Electrodynamical Description
Cold Fusion Synthesis of Helium Isotopes in Interaction of Deuterium and of Hydrogen Nuclei with Metals

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This paper is a continuation of the Author’s presentation made on ICCF-21 conference. In fact experimental results, which were not presented on this conference, will be presented here because there is significant amount of interesting experimental results got by the Author during the recent stage of his cold fusion research. Also new artifacts confirming cold nuclear fusion synthesis of both $^3$He and $^4$He will be presented. Experiments about low temperature nuclear fusion synthesis of both helium isotopes $^3$He and $^4$He in several metals have been carried out. The experiments were performed in vacuum chamber in order precise measurements to be achieved and due to the relatively low concentrations of the interacting gases the amounts of the generated helium and of the released energy (heat) were relatively low. In fact D$_2$ gas in environment of H/H$_2$ gas in the chamber was directed to metal samples and generation of both $^3$He and $^4$He was observed in all experiments as it was supported by mass analysis, which shows relatively high amounts of both $^3$He and $^4$He, and by DC plasma spectroscopy showing peaks typical for both $^3$He and $^4$He. The experiments were carried out in two modes – without plasma and with plasma containing both deuterium and hydrogen ions as in both modes there was cold fusion synthesis of both $^3$He and $^4$He. In the plasma mode the kinetic energies of both D and H ions were determined and it was found that the amounts of both $^3$He and $^4$He increase with increase of these energies. It was found that the pressures of both $^3$He and $^4$He increase with increase of the deuterium pressure. The temperature of the sample holder was measured during the experiments and cyclic dependence on the time was found and also it was fond that this dependence correlates with changes in the amounts of both $^3$He and $^4$He in the time. Calculations show significant ratio (released heat):(volume of interacting D and H) and a conclusion about commercial application of the observed process was made. In some experiments external heating of the sample was performed in range 100$^0$C-700$^0$C in order dependence of the cold fusion synthesis on the temperature to be investigated and it was found increase of the amounts of both $^3$He and $^4$He with increase of the temperature. Radiation (including gamma rays and neutrons) was measured in all experiments and no increase of the radiation above the normal background was found. The experimental results provided above are explained with an earlier developed quantum mechanical theory based on interaction of both D and H nuclei with heavy electrons that are localized in solids. The theoretical outcomes are consistent with the above experimental results. The theory is valid for all solids, however it determines that the above nuclear fusion reactions can have places only in solids having certain properties.
Affordable 'Hot and Dry' Reactor-Calorimeters For LENR Research.

Alan Smith, Ecalox Ltd, UK.

Building and refining a low-cost 'lab rat', the condensed matter research equivalent of the bacteriological Petri dish has been central to this author's efforts for the last 3 years. The system described is the fifth generation of 'hot and dry reactors with an internal volume of 150 ml, capable of working reliably for months at temperatures up to 1000°C or even beyond. The readily available materials for these devices cost less than the price of a good lunch. We show that construction of what are in effect refined tube furnaces is simple and straightforward, demanding only hand tools and a vertical drill.

While economy and ease of construction is always desirable it is recognised that if it is achieved at the cost of sensitivity and accuracy then the end product is not useful. However, careful builders can use this method to construct multiple reactors with very closely matched heating and cooling curves, and a sensitivity to energy inputs in the basic system of 8°C/watt or better. Methods of calibration and data-collection are also described with examples including the use of ohmic heaters. While this system does not compare with those costing perhaps 100 to 1000x as much we contend that the ability to construct multiple reactors on a modest budget makes them a valuable tool for screening candidate fuels while the non-metallic housing offers improved chances of detecting low-energy emissions.
How Can We Make an Inexpensive, Reliable Transmutation Experiment? (Past mistakes of LENR research)

George Egely, Hungary

The aim of the paper is to have step-by-step guidance to reliable transmutation experiments. Previously most transmutation/heat generation experiments were restricted to a very narrow path: a metal lattice (Ni, Pd) loaded by deuterium or hydrogen. The yield, in terms of transmutation and heat generation was usually low, not up to industrial feasibility.

This paper will show two different paths with more flexibility in terms of choice materials, and engineering solutions leading to higher yield and lower cost that is nearer to commercialization.

Both of them apply two-phase states and microscopic dust particles. The first group is colloids embedded into hot, turbulent, liquid electrolyte (alchemy, biological transmutation), and/or molten lava). The second group has dust particles floating in an oscillating plasma.

1) Colloid suspensions

The first group of modest experimental parameters is hot, boiling liquid with suspended dust. It takes days to have observable results. Yet this is the oldest, traditional and mostly forgotten experimental foundation of simple transmutation experiments. The lecture will present pictures and test results of such an inexpensive traditional experiments. No electricity is involved.

2) Dust in oscillating plasma

The easiest dust fusion experiment is the so-called “Oshawa” experiment. It is essentially an arc discharge between carbon rods. The transmutation products are collected under the arc and the dust is created by the cathode surface erosion.

The method has been improved by E. Esko. The arc discharge takes place in a low-pressure (~50 Torr) quartz tube with arbitrarily added dust between copper electrodes.

However, the least expensive dust fusion experiment can be carried out with a household microwave oven. A quartz tube is placed into a local field maximum area preferably on a mica stand. Fine charcoal is an ideal powder for the first experiments. In the lecture, a 10-minute experiment will be shown to demonstrate the process in an uncut video.

The cost of the experiment is under 10US$ yet it is reliable when the right technological parameters are met.

It takes about a half day of preparation to get started. Obviously far more sophisticated, multi-resonant devices can be created along these lines. Such a fusion reactor will also be shown in a 5 minute video.
There are a number of “anomalies” in nature that are unsolvable in terms of mainstream science. However, they can be explained by LENR, namely dust and colloid fusion. The aim of this paper is to describe them. They are the following:

a) The solar corona enigma: while the corona is about 150 million °C, the surface temperature is only 7,000 °C. Lawson’s criteria for hot fusion is not met in the corona, so according to mainstream science, no fusion heat is produced yet it is apparent that the corona heats the surface, not the way around! This is a blatant violation of the 1st and 2nd laws of thermodynamics. This dust fusion LENR process is the workhorse of the universe: All active stars are run by this process. Dust is collected from the interstellar space by the gravitational mass of stars. Even nebulae (interstellar dust clouds of gigantic sizes) are powered by this process. The process is run by ordinary hydrogen (protons). There is no need for heavy hydrogen isotopes, like for hot fusion. Heavier elements can be transmuted in the corona as well.

b) Mysterious energy source within the solar system: The moons of Saturn - Enceladus, Titan and Europa, the moon of Jupiter - are heated continuously from inside. These moons ooze hot geysers from under a layer of ice 30 km thick. The geysers contain very fine silica dust, a necessary technical condition of catalyzed fusion – LENR. Moreover, they emit nitrogen continuously, which is not found on “dead” planets. The heat source is not gravitational (tidal), because their orbit is circular.

c) The giant gas planets, Jupiter, Saturn, radiate twice as much heat as they receive from the Sun.

d) Volcanic activity: The internal source of the heat for the Earth, and Io, and their chemical composition cannot be explained by mainstream science.

e) Geochemical anomalies

3) Certain elements are found only together and only in a spatially limited way, like the ores of Cu, Ag, Au. It is likely that they were formed together due to transmutation, and here on Earth.

4) Helium is formed in vulcanism

5) Biological transmutation – change of isotope ratios.

All the above enigmas are ostensibly due to a catalytic LENR process. In plasmas it is dust fusion; in hot molten rocks it takes place on liquid/solid colloidal particles. Formation of new elements/transmutations is expected near the crust of Earth. Transmutation commences where one solid colloid phase appears. Therefore certain groups of elements are found together because they are formed together.
The numerous and diverse current activities on Low Energy Nuclear Reactions (LENR) have two major goals, scientific understanding and commercial exploitation. They are related, since understanding will make commercialization faster and more efficient. LENR will not be understood until the mechanisms that lead to such reactions are known, and their rates quantified. Hence, we focus on LENR mechanisms in this paper. There are two major related questions: (a) will one mechanism be able to explain all of the diverse observations in LENR experiments, or are multiple mechanisms needed to understand the many observations, and (b) do the mechanism(s) involve only one reaction step, or is a sequence of chemical and nuclear steps required to produce the measured results? Both questions are considered in this paper.

The three decades of laboratory research have produced a list of about two dozen diverse observations on the character and results of LENR. Heat that cannot be explained by chemistry is high on that list because of the many measured results and the potential practical importance. By itself, heat data does not indicate specifics about LENR mechanisms, other than their being nuclear. Helium-4 production, and its correlation with heat, has been measured in several experiments. That relationship points to fusion between two deuterons as being a potential mechanism. Generation of Helium-3 and tritons is also indicative of possible mechanisms. LENR involving heavier elements might require other mechanisms for their explanation. Transmutation data from Iwamura, which involves the addition of deuterons to heavier elements, is particularly challenging. The same is true of the transmutation results for elements across the periodic table that was obtained by Miley and Mizuno. Those data also raise questions of (a) the possible involvement of real or pseudo neutrons and (b) secondary fission reactions.

The second issue is about the number of steps involved in LENR. One non-nuclear step might be the creation of nuclear active regions either before or during an LENR experiment. Some LENR theories involve the formation of “compact objects”, which have sizes and binding energies intermediate between those of atoms and nuclei. The formation of such objects would not involve nuclear reactions, and could be responsible for part, or even all of the heat seen in LENR experiments. However, compact objects might go on to participate in nuclear reactions. There is a precedent for such behavior in muon-catalyzed fusion, an understood process. So, helium might be produced by a two-step process, the first without any nuclear reaction and the second being a nuclear reaction. There are also ideas that helium might be due to two nucleon or nuclear reactions in sequence. The magnitude of the Heat-Helium correlation might be explained by a two-step mechanism. Determination of the number of LENR steps in critical.
Self-similar formation and application of coherent correlated states of charged particles – the key to understanding and using of LENR

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In the report the universal method of very significant (up to $10^{10}$… $10^{100}$ and more times) increasing of the tunnelling probability and very essential optimization of nuclear interaction by using of coherent correlated states [1-10] formed by weak controlled external action on these particles is discussed. The main factor of such a process is connected with the self-similar synchronization of weak fluctuations in the quantum superposition state of a particle and the generation of giant long-term fluctuations of momentum and kinetic energy sufficient for realization of effective LENR. The most important characteristic of such states is the possibility of the existence for a long time a giant fluctuation of the kinetic energy.

This mechanism explains all observed detected features of successful nuclear experiments conducted in numerous laboratories at low energy:

a) Anomalously high probability of these reactions at low energy of interacting particles;

b) Very significant suppression (as compared with similar reactions at high energy) of the accompanying gamma radiation;

c) Complete ban on "radioactive" channels of nuclear reactions and total absence of radioactive daughter isotopes, which may be formed in analogous reactions occurring without the use of coherent states correlated.

The possibility of forming an effective coherent correlated states under the influence of a pulsed [1-5,8-11,12] or periodic [4-9,11,12] electromagnetic fields on particles (including action of damping and fluctuations [6]) is also considered in this paper. The efficiency of this process in the motion of low-energy particles through periodic structures (including the motion of particles in the crystal lattice field in the channelling regime [11,12]) is considered in detail.

It is important to note that the method of coherent correlated states allows us to explain, justify and numerically consider all known low energy nuclear reactions paradoxes without applying new radical hypotheses, basing only on the powerful foundations of modern quantum theory and nuclear physics.

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The mechanism of effective LENR in weakly ionized gas under the action of optimal pulsed magnetic fields and the problem of LENR at lightning

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The problem of the tunneling of particles with low energy through a potential barrier due to the use of coherent correlated states (CCS) formed under controlled action of pulsed magnetic field is considered. It is shown for the first time that the process of the formation of a CCS, as well as the maximum \(|r(t)|_{max} \to 1\) and averaged \(<|r(t)|> \to 1\) amplitude of the correlation coefficient and the corresponding tunneling probability

\[ D_{r>0} \approx \exp \left\{ -\frac{2\sqrt{1-r^2} K \ell(E)}{h} \int \sqrt{2M (V(q) - E)} dq \right\} = (D_{r=0})^{G^2r^2} = \sqrt{D_{r=0}}, \]

are characterized by a nonmonotonic (resonance) dependence on the parameters of the forming magnetic field pulse. Here \(G = 1/\sqrt{1-r^2}\) is the coefficient of correlation efficiency.

We have obtained the critical condition for the optimal combination duration and amplitude of the magnetic pulse for each concrete kinds of nuclear reactions, at which the efficiency of LENR reaches its maximum value. Even with a slight deviation from this condition, the reaction becomes impossible!

This result shows the incorrectness of the intuitive idea that the probability of tunneling always increases with increasing amplitude of the impact. The obtained conclusions, in particular, can be used to explain the random (unpredictable) results of experiments on the optimization of energy release due to nuclear reactions carried out using impulse action with uncontrolled fluctuations in amplitude and duration.

The results of theoretical analysis [1] are compared with the data of numerous successful experiments on observation of neutrons and alpha particles during both controlled (Lab) and natural (lightning) electric discharge in air and different gases.

Chemical and Nuclear Catalysis Mediated by the Energy Localization in Hydrogenated Crystals and Quasicrystals

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Catalysis is at the heart of almost every chemical or nuclear transformation process, and a detailed understanding of the active species and their related reaction mechanism is of great interest. An important parameter of the reaction kinetics is the activation energy, i.e. the energy required to overcome the reaction barrier. The lower is the activation energy, the faster the reaction rate, and so a catalyst may be thought to reduce somehow the activation energy. Dubinko et al [1] have shown that in a crystalline matrix, the activation energy may be reduced due to localized anharmonic vibrations (LAVs) of atoms, LAV can be excited thermally or by irradiation, resulting in a drastic acceleration of chemical reaction rates driven by thermally-activated ‘jumps’ over the reaction barrier due to the time-periodic modulation of the barrier height in the LAV vicinity.

At sufficiently low temperatures, the reaction rate is controlled by quantum zero-point vibrations (ZPV) rather than by thermal fluctuations. Large amplitude atomic motion in LAVs may result in time-periodic driving of adjacent potential wells occupied by hydrogen ions (protons or deuterons) upon hydrogenation. This driving is shown to result in the increase of amplitude and energy of zero-point vibrations (ZPVs). Based on that, we demonstrate a drastic increase of the D-D or D-H fusion rate with increasing number of modulation periods evaluated in the framework of Schwinger model [2], which takes into account suppression of the Coulomb barrier due to ZPVs, which is further enhanced by LAVs. In this context, we will present numerical solution of Schrodinger equation for a particle in a non-stationary double well potential, which is driven time-periodically imitating the action of a LAV [3]. We show that the rate of tunnelling of the particle through the potential barrier separating the wells can be enhanced enormously by the driving in a certain frequency range.

We will present atomistic simulations of LAVs in the crystal lattice of Ni, Pd, Ti-Zr-Ni and in their quasicrystalline nanoclusters.

We will present experimental results on the interaction of the Ni, Pd and Ti-Zr-Ni crystals and quasicrystals with hydrogen and deuterium under thermal equilibrium and under gamma irradiation, which is introduced as an efficient tool for the athermal production of LAVs.

Cold fusion: superfluidity of deuterons.

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The nature of cold fusion (CF) is considered. It is supposed that the reaction of deuterons merger takes place due to one deuteron, participating in the superfluid motion, and one deuterons, not participating in the superfluid motion, participate in the reaction. The Coulomb barrier is overcome due to the kinetic energy of the Bose-condensate motion is very large. The Bose-condensate forms from delocalized deuterons with taking into account that the effective mass of delocalized deuterons is smaller than the free deuterons mass.

The effective mass of deuterons must satisfy the condition

$$m^* < 1.5 \frac{\hbar^2}{kT_0} n^2$$

where $n$ is the concentration of the delocalized deuterons, $T_0$ is the temperature of the Bose-condensate. Using the values $T_0 = 300 K$, $n = 10^{22} sm^{-3}$, obtain the estimation

$$m^* < 2 \cdot 10^{-26} g \approx 0.006 m_d$$

The Bose-condensate moves in a magnetic field with a speed $v_{sl}$, defined by ratio

$$en_s v_{sl} r = - Q_{ik}(r - r') A_k(r') d^3 r'$$

where $n_s$ is the concentration of particles of the Bose-condensate, $A_k \ r$ is the vector potential of the electromagnetic field. The function $Q_{ik}(r)$ is defined from microscopic analyze of the motion of the Bose-condensate. The motion of the Bose-condensate is considered in the framework of the London’s electrodynamics. This approximation allows obtain the linear on the field term in the expression for the power, exuding in the reaction. Exuding in the cylindrical form sample power is equal to

$$W = \frac{2\pi r_d^2 B_0 c}{e} h r_0 P_0 n_d E_0$$

Here $r_d$ – the deuteron radius, $B_0$ – the value of vector $B$ of the external magnetic field, $c$ – the speed of light, $e$ – the electron charge, $h$ – the high of the cylinder, $r_0$ – the radius of the base of the cylinder, $P_0$ – the probability of reaction with collision of two deuterons, $n_d$ – the concentration of deuterons in the lattice, $E_0$ – output of the energy in one nuclear reaction.

We obtain the estimation $W \approx 10^9 erg/s$ for the sample with $h = 10 sm$, $r_0 = 1 sm$, in the field $B_0 \approx 0.5 Gs$ under $n_d \approx 10^{23} cm^{-3}$, $P_0 \approx 10^{-5}$. This estimation is coincided with the experimental data [1] by the order.

It can be understood why mainly occur the reactions

$$B_d + d + d \rightarrow ^4He + B'_d + 23.8 MeV$$

Here $B_d$ and $B'_d$ are the states of the Bose-condensate before and after the collision of one deuteron, belonging to the Bose-condensate, and one deuteron, not belonging to the Bose-condensate. Gamma-quantum does not stand out in the reaction (5) due to the large amount of particles of the Bose-condensate change their velocities. The momentum and the energy under the reaction (5) condition conserve due to this fact.

It can be understood why the CF-reactions occur in palladium and titanium only. This fact is connected with the effective masses of delocalized deuterons in palladium and titanium are small.

System Metals/Hydrogen using induction heating: Reactors and some experimental results

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General presentation of induction heating and its parameters. Simple reactors, built by the author, as open thermal systems heating nickel wires and other metallic wires Au, Cu, W, Ti, wire is wrapped around a soft iron core that transfers Eddy currents to heat by Joule effect. A very high temperature is then reached by the wire. The reactor, a glass tubing inside the solenoid of an induction machine, includes a thermocouple attached to the iron core, a pressure sensor, and valves to control gaseous atmosphere of Air, Argon, or Hydrogen. Power used by the machine is also recorded.

Results in the form of time/temperature recording, radiations detection (gamma), visual light emission, and observation of wires surface will be presented. We will discuss Advantages and disadvantages applied to LENR research.
1. Several authors predict that $\alpha$ particle structures could be present in atomic nuclei. Convincing arguments of such structures are provided by systematics of the binding energies of the even-even nuclei with equal number of protons and neutrons.

2. According to my theory, the nuclei of the various elements are constituted with $\alpha$ particles and other nucleons grouped in order to create sub-nuclei linked by four types of bonds called NN, NP, NNP, NPP. The binding energies of Deuterium (NP), Tritium (NNP), Helium3 (NPP), and NN are linked through the following equations:

\[
\begin{align*}
\text{EB Tritium (NNP)} & = 2\text{NN} - 1.25/2 \text{ NP} \\
\text{EB He3 (NPP)} & = \text{NN} + 1.25 \text{ NP} \\
-2\text{NN} & \text{ forming the neutronic part of the binding energy of } \alpha \text{ particle.}
\end{align*}
\]

3. It will be shown in the following that the hypothesis of $\alpha$ structures in the n-$\alpha$ nuclei can indeed describe the binding energy systematics. In such an approach, the system in its ground state behaves like a crystal, with stationary configuration and shape and with defined bond values between the various $\alpha$ particles. The examples provided are Mo 92, 94, 95, 96, 97, 98, 99, 100 and Tc 97, 98, 99.

The hypothesis I develop founds its background in the structure of the neutron and the proton I propose in my document posted on the internet one finds under www.philippehatt.com.

4. The values used for the calculations of the binding energy are the following:

\[
\begin{align*}
\text{EB } \alpha & = 28.325 \text{ MeV} \\
\text{EB } \text{NN} & = 4.9365 \text{ MeV} = 8.875 \text{ lines} \\
\text{EB } \text{NP (}= ^{\frac{3}{2}}\text{H}) & = 2.2246 \text{ MeV} = 4 \text{ lines} \\
\text{EB } \text{NNP (}= ^{\frac{3}{1}}\text{H}) & = 8.4818 \text{ MeV} = 15.25 \text{ lines} \\
\text{EB } \text{NPP (}= ^{\frac{3}{2}}\text{He}) & = 7.7180 \text{ MeV} = 13.875 \text{ lines}
\end{align*}
\]

EB $\alpha$ and EB NN are defined in my documents on internet. Also, the definition of the lines and their relationships with their values in MeV is given.

The values of binding energy used are determined as follows. Example: EB Deuterium (2.2246 MeV) = 4 lines x 0.511 MeV x 1.088375857 (conversion factor). This conversion factor is used all the time for the facility of calculations but is eliminated in the final distribution of the binding energy of each nucleus.

5. Two remarks:

Geometrical structure of atomic nuclei: In my theory the binding energy of the nuclei has an unidimensional value, broken down by EB $\alpha$, NN, NP, NNP, NPP. My work is not addressing the three-dimensional model of nuclei in the sense that I am not looking for a structure of these nuclei but rather for the distribution of binding energy within them. Nevertheless, my work could be
complementary to those dealing with this topic. A comparison with 3D nuclei models could be relevant.

It is important to know the distribution of the binding energy in each element at the beginning and the end of a LENR fusion/transmutation reaction in order to follow that process.
Jacques Ruer

Hydrogen has specific characteristics that must be taken into account during the design phase of an experimental setup as well as during the analysis of the results of the experiences. This paper reviews some particular features:

- Hydrogen can permeate through many materials including metallic walls at high temperature. The gas may be present in appreciable quantities at unsuspected locations in the apparatus.
- The thermal conductivity is relatively high. Heat loss by conduction in the gas can be substantial even at a low pressure depending on the dimensions of the gas space.
- If a hot surface is exposed to hydrogen at a low pressure, the gas can dissociate into monoatomic form. The recombination on another surface releases some heat that can be mistaken with anomalous heat.
- If overlooked, these effects can introduce systematic errors in the measurement of heat fluxes in experimental devices filled with hydrogen.

In order to illustrate the specific aspects of hydrogen a comparison is made between hydrogen and nitrogen. Schematic experimental layouts are utilized to quantify the potential influence of this gas on the results.
Several types of experiments on LENR anomalies were performed at the ARGAL laboratory in Bareggio, in particular using thin films of palladium in H$_2$ or D$_2$ atmosphere at various pressures. The laboratory is equipped with instrumentation suitable for the detection of neutron and gamma emissions with a He3 detector and a multi-channel detector with a 3-inch NaI crystal. All the experiments carried out have been monitored with these instruments and in many cases it has been possible to find a neutron emission attributable to nuclear events inside the reactor. Some anomalous events were short-lived, others were prolonged for several minutes. Apart from a particular case, the events were modest. In any case, the evidence found shows once again the nuclear nature of the LENR phenomena, in the past highlighted by clear episodes of nuclear transmutations in similar conditions where it was possible to analyze the material with the appropriate techniques at the end of the experiment.
First evaluation of coated Constantan wires comprising *Capuchin knots* to increase anomalous heat and reduce input power at high temperatures.

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Anomalous Heat Effects (AHE) have been observed in wires of Cu_{55}Ni_{44}Mn_{1} (Constantan) exposed to H_{2} and D_{2} in multiple experiments along the last 8 years. Improvements in the magnitude and reproducibility of AHE were reported by the Authors of the present work in the past and related to wire preparation and reactor design. In facts, an oxidation of the wires by pulses of electrical current in air creates a rough surface featuring a sub-micrometric texture that proved particularly effective at inducing thermal anomalies when temperature exceeds 400 °C. The hunted effect appears also to be increased substantially by deposing segments of the wire with a series of elements (such as Fe, Mn, Sr, K, via thermal decomposition of their nitrates applied from a water solution). Furthermore, an increase of AHE was observed after introducing the treated wires inside a sheath made of borosilicate glass (Si-B-Ca; BSC), and even more after impregnating the sheath with the same elements used to coat the wires. Finally, AHE was augmented after introducing equally spaced knots (the knots were coated with the mixture of Fe, Mn, Sr, K) to induce thermal gradients along the wire (knots become very hot spots when a current is passed along the wire). Interestingly, the coating appears to be nearly insulating and it is deemed being composed of mixed oxides of the corresponding elements (mostly FeO_{x}, SrO). Having observed a degradation of the BSC fibers at high temperature, an extra sheath made of quartz fibers was used to prevent the fall of degraded fibers from the first sheath; recently the 2 sheaths assembly has been replaced with a hybrid single sheath developed by SIGI-Favier (i.e. made of both glass and quartz fibers). The treated wire, comprising knots and sheaths, was then wound around a SS316 rod and inserted inside a thick glass reactor. The reactor operates via direct current heating of the treated wire, while exposing it to a 5-2000 mBar of D_{2} or H_{2} and their mixtures with a noble gas (*in these conditions electromigration phenomena are supposed to occur*). In 2014, the Authors introduced a second independent wire in the reactor design and observed a weak electrical current flowing in it while power was supplied to the first. This current proved to be strongly related to the temperature of the first wire and clearly turned to be the consequence of his *Thermionic Emission* (where the treated wire represents a *Cathode* and the second wire an *Anode*). The presence of this thermionic effect and a spontaneous tension between the two wires did strongly associate to AHE. All these observations were reported at various Conferences, and tentative explanations were provided for the observed effects. The presence of thermal and chemical gradients has been stressed as being of relevance, especially when considering the noteworthy effect of knots on AHE. The ICCF21 Conference held on June 2018 marked a turning point, and the scientific community did show a notable interest on the effects of knots and wire treatments, further increasing the confidence on the described approach. From that moment, attempts to further increase AHE focused on the introduction of different types of knots, leading to the choice of the *“Capuchin”* type (see fig.). This knot design leads indeed to very hot spots along the wire and features three areas characterized by a temperature delta up to several hundred degrees. Efforts were also made to better understand...
the thermionic effect of the wire, and the spontaneous tension that arises when a second wire is introduced close by (anode). Eventually a large AHE rise was noticed when introducing an extra tension between the active wire (cathode) and the second wire (anode) through an external power supply; a truly remarkable effect, despite his short duration due to the wire failure attributed to an AHE runaway able to melt it. Eventually the authors have observed a stunning similarity of the best performing reactor design and a thermionic diode where the active wire represents the cathode and the second wire the anode, whereas the electrodes are separated by fibrous layers impregnated with mixed oxides comprising Iron and alkaline metals. This observation allows to speculate on a thermionic power converter able to generate electricity through the thermionic emission of a cathode heated by AHE and collected by an anode (colder and/or featuring a different work function with respect to the cathode). The presentation, summarized in this abstract, reports the latest AHE results obtained from a new reactor design comprising capuchin knots and hybrid sheaths manufactured for the purpose.

**FUNCTIONAL THEME OF THE CELANI COIL (FIRST TEST)**

![Diagram of the coil with numerical sequence indicating the current path in the wire.]

**TEST CONDITIONS**
- FREE AIR
- Ø WIRE = 193 MICRON
- I = 1800 mA

**NOTE**
- THE CONSTRUCTION OF THE COIL TAKES PLACE BY NOTING THE WIRE WITH THE "CAPPUCCINO" METHOD

**Fig. 1** Photo, in DC, I=1900mA, of a piece of Constantan wire having a diameter of 193 µm. Capuchin knots with 8 turns. Temperatures estimated by color. The dark area is at temperature <600°C, the external helicoidal section is at about 800 °C, the inmost section, linear, up to 1000 °C in some areas.
In this paper we show new local relations which from which generic global equations, using point functions can be derived. These new global relations are more accurate than the Garvey/Kelson and Janecke/Masson equivalents. We show how superfluous parameters can be eliminated from the point functions using interpolation resulting in better predictions, a technique which may have applications in generic regression methods.

<table>
<thead>
<tr>
<th>Local Relation</th>
<th>Global Relation (2275 isotopes)</th>
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<tbody>
<tr>
<td>Diagram</td>
<td>Std Error kev</td>
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<tr>
<td>GKT</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td>Classic Garvey Kelson transverse local relation</td>
</tr>
<tr>
<td>New</td>
<td>97</td>
</tr>
</tbody>
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1) G. T. Garvey et al., "Set of Nuclear Mass Relations and a Resultant Mass Table" Rev. Mod. Phys. 41, S 1 (1969)
This presentation addresses the importance of observed anomalies in hydrogen-loaded metals for formulating a better theory of the atomic nucleus. Norman Cook, in his book “Models for the Atomic Nucleus” states that there are dozens of specialized models, each explaining some aspect of the nucleus, but no unification between these models has taken place, so that the question as to the precise nature of nuclear structure remains wide open. Whether the neutron is a fundamental particle was discussed at the 7th Solvay conference in 1933 and there the crucial decision in physics was made that the neutron was indeed to be regarded as a fundamental particle. This decision over the years resulted in what we now call the “Standard Model.”

What if the neutron is not a fundamental particle?

Our proposal for a Structured Atom Model (SAM) is based on the proton-electron concept for the nucleus, rather than the current proton-neutron concept of the Standard Model. Evaluating this proton electron model versus the proton-neutron model, we conclude that physics can be greatly simplified with no need for a postulated “strong nuclear force” and no “self-binding energy” associated with the “neutron.” A paper by Carl Johnson makes this case, calculating precise atomic mass numbers and arguing how a modified mass defect chart indicates specific structure within the nucleus.

The 1970 Solvay conference had the theme: “Symmetry Properties of Nuclei”. Here the alpha particle model was proposed, among others. SAM evolved this idea further by recognizing three geometric groupings, numbered 2, 7 and 12 which represent the elements Deuterium, Lithium and Carbon. Using the principle of ‘densest packing’ and a few simple rules, SAM naturally evolves all elements and their isotopes. The model can show exactly where the nucleons are placed and whether to consider them a “neutron” or proton. Thus, we have discovered the structure of close to 50% of the natural elements, with the other half remaining to be completed. SAM can potentially fulfil a key role in the process of innovation in Physics, one that explains how, why and when “cold fusion” occurs. We are in the process of making predictions of specific isotopes resulting from LENR processes. We would like to invite anyone in the field doing experiments, who is willing to cooperate and verify or falsify predicted results, to contact us.
An analysis of Piantelli's Cloud Chamber Results

William Collis

This purpose of this report is to interpret and discuss the Wilson Cloud Chamber tracks recorded (but not published) by Prof. Francesco Piantelli in the 1990s. Piantelli placed a nickel rod in the Cloud Chamber which had for some months previously created ~70 W of excess heat. In the photograph below we see a single track. Such straight tracks are caused by charged particles. Their length indicates energy (not linearly). The kink confirms that the particle is heavy (i.e. a nucleus) and changes direction slightly after a collision with gas nucleus.

Li⁵ is one of 2 isotopes (out of > 3000) which can decay by both alpha and proton emission. It is the only proton emitter (out of > 171) that does not also produce positrons or gammas. The expected energies of the emitted charged particles correspond approximately to the range of the Cloud Chamber tracks.

The paper will speculate on the possible origins of the Li⁵ (which has a very short half life).
Potential Design of a LENR Power Generator

Jacques Ruer

The results obtained during the R&D program and recently published give the basic information that makes it possible to design a reactor able to deliver useful electrical power. The results are briefly reviewed in order to extract the information required to calculate the main features of the reactor. It is shown how a LENR reactor with a sufficient size can generate enough heat to maintain its internal temperature and deliver a surplus of energy.

Heat recovered at a temperature higher than 250°C to 300°C can be converted into mechanical power. In order to illustrate a potential solution using a ORC turbine is described.
A sample of nickel on which a thin layer of palladium was deposited electrochemically, immersed in a hydrogen atmosphere at a pressure of about 950 mbar, showed an unexpected ability to absorb hydrogen at room temperature, specifically around 25 degrees Celsius.

A first exposure of the sample to hydrogen showed a decrease in pressure in the reactor higher than the predictable and very modest one attributable to the palladium deposited on the nickel surface; normally this absorption is monitored by a thin film resistance of palladium present in the reactor just to verify the interaction of the hydrogen with the material under test. In particular the macroscopic absorption reduced the pressure of 80 mbar and it can only be attributed to nickel, since the ratio of atoms \( <\text{H}> / <\text{Pd}> \) would have led to an absurd value of about 90. It should be noted that this initial absorption stabilized after about 3 days, with a rather slow exponential progression. By subjecting the sample to vacuum degassing and subsequent loading cycles with hydrogen pressure again at around 950 mbar, a marked increase in the speed of the phenomenon was observed (only 2 hours instead of 3 days), in addition to a progressive increase in the volume absorbed. In the fourth cycle the pressure decrease was higher than 300 mbar, such as to bring the ratio between hydrogen and nickel atoms to a value around 1.2, higher than the threshold considered for the activation of the LENR anomalies in the Palladium.
Electron screening enhances nuclear reaction cross sections at low beam energies. This happens in many astrophysical scenarios, e.g. stellar burning or supernova explosions. Unfortunately, the process is still poorly understood. All currently used calculations are based on the very simple assumption that the electrons distributed evenly on a shell decrease the repulsive potential inside the shell by a constant. Although the measurements in principle obey the predicted functional behavior of electron screening, its magnitude is severely underestimated by the theory when nuclear reactions happen on hydrogen isotopes implanted into solids. I will overview the current experimental situation and propose an alternative understanding of the electron screening process with a possible proof of its validity.
Nuclear emissions under X-ray irradiation of deuterated structures

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Emission of nuclear reaction products (neutrons and protons) from the deuterated structures of textured CVD-diamond, palladium and zirconium under irradiation beam of X-rays using independent methods (neutron detector based on He-3 counters, Si surface-barrier semiconductor detectors and track detector CR-39) were measured. The possibility of stimulation by the beam of X-rays with an energy of 20-30 keV for multi-particle deuterium fusion reactions in solid deuterated targets was shown. Analysis of X-ray fluorescence spectra of the target bombarded by beams of ions, allowed to find them "additional" peaks, the occurrence of which can not be associated with any of the known elements, and requires separate research.
**Catalysis of Nuclear Reactions by Electrons**

Matej Lipoglavsek

Electron screening enhances nuclear reaction cross sections at low beam energies. This happens in many astrophysical scenarios, e.g. stellar burning or supernova explosions. Unfortunately, the process is still poorly understood. All currently used calculations are based on the very simple assumption that the electrons distributed evenly on a shell decrease the repulsive potential inside the shell by a constant. Although the measurements in principle obey the predicted functional behavior of electron screening, its magnitude is severely underestimated by the theory when nuclear reactions happen on hydrogen isotopes implanted into solids. I will overview the current experimental situation and propose an alternative understanding of the electron screening effect with a possible proof of its validity.