

A way out of Middle Ages energy sources. (Ch. Stremmenos)**

Energy is a very fundamental physical property of the Universe. It is defined, generically, as the ability to produce work; it can take many forms: kinetic, thermal, chemical, biochemical, electromagnetic, nuclear; may originate from matter: remember the Einstein equation $E = mc^2$. It is also contained, in a primitive form and enormous quantity, mathematically estimated to be of the order of 10^{113}J/m^3 , in the quantum vacuum. Richard Feynman, addressing to his students in front of an empty cup of tea made the famous statement: "There is enough energy in this empty cup to evaporate all the water in the oceans of our planet!" Due to the many forms, our knowledge of all its properties is limited but its fundamental property, the conservation law, is well established. In other words, energy is neither created nor destroyed, but only transformed. Thus, all methods exploiting energy, convert one form of energy into others more useful for our needs: thermal engines generate mechanical work or electricity in turn available for a very high number of applications. By regarding the universe as a closed system, energy is constantly circulating: it flows with mechanisms predictable from quantum mechanics, in part experimentally confirmed, from the quantum vacuum to matter; is converted to one of the energy forms creating work and useful interactions; finally, spreads back to the quantum vacuum.

The ancient Greeks, even without a detailed knowledge of its properties, well understood not only the fundamental contribution of the energy to the evolution, the growth of the human society, the development of civilization, but also, prophetically, that, as for all natural properties, good and evil coexist: "οὐδὲν καλὸν ἀμιγῆς κακοῦ" ! In the Greek mythology, this is symbolically represented by the Titan Prometheus giving to the mankind the fire, the energy! The Head of Gods, Juppiter, well aware that this great physical potential is available to man not only for proper use, to warm up and to cook, but also for improper use and abuse: guns, wars, ecological disasters, atomic bombs, finally enchains the Titan. It is historically proven that Zeus was right!

To the middle of the last century, humanity has produced all useful energies from the Coulomb and the kinetic energies of the atomic nuclei and peripheral molecular electrons. The combustion of wood and fossils, coal oil, methane, is the common, the chemical way, for producing energy, mainly thermal. Moving from the periphery of the atom and the chemical energy, to the internal structure of the atomic nucleus, the interparticle distances reduce by six orders of magnitude and the energies required for or generated by nuclear reactions increase by an equal amount. Only in the sun and, more generally, in stars, where the appropriate conditions, high gravitational forces, exist, the nuclear energy is produced naturally. By radiation on earth is exploited in different ways: synthesis of chlorophyll, wind, hydroelectric, photoelectric energies, deposits of fossil fuel.

At the end of the second world war, due to the great interest on artificial ways for producing high power density nuclear energy, richly financed, mainly for military reasons, nuclear energy, as predicted by Einstein, $E = mc^2$, was finally exploited, but at the catastrophic cost of killing many other human beings: Hiroshima and Nagasaki !! Fermi, through the fission of the atomic nucleus, has later allowed the peaceful use of the nuclear energy, but added new types of problems for humanity, which have become evident at a later stage: Chernobyl, Fukushima, radioactive waste. The instrumental orientation of research to the range of the high energies, has in some way altered the evolution of science, which, with the discovery of radioactivity by M. Curie, the natural link between chemistry and nuclear physics, was gradually evolving from the atomic periphery to the nucleus. To the detriment of human mankind, a sort of unnatural gap and a serious cognitive deficit was created; the search of low power density nuclear energy sources, potentially useful for humanity, put in the background. To summarize, the equivalent would be to think using the lightning for all sorts of applications!

Juppiter, would not hesitate to put in chains and send to Tartarus forever, the new Prometheus, including scientists and warlords.

Starting from 1989, with the work of the pioneers Fleischmann and Pons, suggesting a new approach to draw energy from the atomic nucleus, through cold fusion or LENR (Low Energy Nuclear Reaction), a new possibility has emerged, which, besides being more friendly to the environment and to the mankind, could, potentially, contribute to the solution of the important economic problems of our Global Society. The climate change of the planet is included.

Despite the deafening silence of the media, the subtle, hidden, opposition in defense of existing economic interests, the unjustifiable indifference of the governments, the importance of the “cold fusion” or “solid-state nuclear reactions”, has been strongly supported by few research groups, scientific and industrial institutions active in the field. Today, the most interesting process for investigations appears to be the absorption of hydrogen in nickel, first investigated in detail by Piantelli, Focardi and Habel, Nuovo Cimento, 1994, 107,

Research on Cold Fusion or LENR, has continued in several universities: Moscow, MIT, Japan; government agencies: NASA, China, India, ENEA; industrial companies: Airbus, Nissan, Mitsubishi; confirming, in a few cases, improving: Parkhomov, Moscow; Martin Fleischmann Memorial project, MIT; the energy conversion factors. Quoting Aristotle: ΦΥΣΕΙ ΤΟΥ ΕΙΔΕΝΑΙ ΟΡΕΓΕΤΑΙ ΑΝΘΡΩΠΟΣ, the human thirst for knowledge, starting from the early 90's, we have been attracted by these investigations; built independently our own cells for measurements, performed a series of investigations on Pd - Deuterium and Ni - Hydro- gen. In this connection, we remind with pleasure the collaboration and the comparison of our experiments with Sergio Focardi and Andrea Rossi.



A few details on google Christos Stremmenos. Our main result was the clear evidence that the atoms of the metal surface are mainly involved in the process, suggesting that the LENR effect could be enhanced by replacing the laminar with a powder form of the metal. In our experiments the grain size was kept in the range micro - nanometer. By adding an appropriate catalyst, Rossi - Focardi have improved the process which later evolved, finally producing the E-CAT (Energy Catalyzer) by Andrea Rossi, apparently, the leading technology to day. The interest in the process is gradually spreading to the impartial global public opinion.

Independent research groups of three important European universities: Royal Institute of Technology, Stockholm, Sweden; University of Bologna, Italy; University of Uppsala, Sweden, announced, October 6th 2014, the results of their experiments which have lasted for a total of 32 days: «Observation of abundant heat production from a reactor device»:

<http://www.sifferkoll.se/sifferkoll/wp-content/uploads/2014/10/LuganoReportSubmit.pdf>

In a hydrogen atmosphere, from 1 gram of nickel of natural isotopic composition, and 0.11 grams of lithium 7, 1.5 MWh of thermal energy have been produced and confirm the Rossi - Focardi technology, E-CAT.

In my opinion, the following points summarize the current state of cold fusion:

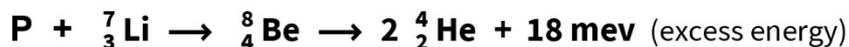
- Nuclear transmutations have been observed in all experiments proving that nuclear processes are involved in cold fusion.
- The energy produced is orders of magnitude greater than any chemical energy from the same substances. The energy efficiency surpasses any other energy source and is comparable to the efficiency of conventional nuclear fission reactions.
- No dangerous radioactivity occurs, both during the reactor operations and in the residues, the ashes, of the reactions, eliminating the problem of the disposal of radioactive waste. The thermal instability, with deviation at high temperatures and the relatively uncertain reproducibility, indicate that the efficiency of the phenomenon is not completely controlled.

Interpretations and hypothesis.

According to the today scientific knowledge, the two main obstacles, which prevent the understanding and even to accept the existence of cold fusion (LENR) are:

- The first: the positive charge of the nucleus of all elements in the periodic system. Hence all pairs of nuclei, repelling electrostatically, cannot approach the critical distances, where the very short-range strong attractive nuclear forces prevail and would allow the nuclei to merge. In other words, the radius of the nuclear repulsion is larger than the radius of the attractive interaction. This spatial gap takes the name of Coulomb barrier.
- The second: the thermodynamic conditions, very high temperatures of millions or billions of degrees centigrade, required to overcome the barrier and obtain the thermonuclear fusion and, by comparison, the low, negligible probability of the cold fusion (LENR) at a few hundred degrees Celsius.
- On the other hand, in our view, the Galileo say, "e pur si muove" applies to the excess of thermal energy produced in the ECAT device. Even though a convincing theoretical interpretation of cold fusion is still missing, arguments have been produced to justify the experimental finding.

In particular, Cook and Rossi have proposed a possible mechanism of the process, <https://arxiv.org/abs/1504.01261>. The basic hypothesis has been to assume as the starting step in the sequence of nuclear reactions, the acetate nuclear reaction between hydrogen and lithium, well known since 1937.



- In the first step, hydrogen and lithium atoms, merge exothermically, overcoming the Coulomb electrostatic barrier and transmuting into the highly excited, unstable,
- In the second step, the excited beryllium undergoes exothermic fission by splitting into ${}^8_4\text{Be}$ two ${}^4_2\text{He}$ atoms, the so-called alpha radiations, which, absorbed by the reactor walls, contribute globally to the yield of high thermal energy, without the presence of ionizing radiations.

To verify the mechanism, the previously mentioned groups of independent scientists have chemically analyzed all elements and isotopes in the reaction ashes, Natural and Absolute Isotopic Abundance at the Onset and Conclusion of the E-Cat Test,

The significant decrement of the isotope, ${}^7\text{Li}$ shown in Table 1 is explained, but, in parallel, raises several questions:

- What is the role of nickel, the base element in the process?
- How to justify the nickel copper transmutation, which implies overtaking a Coulomb barrier?
- Which types of deactivation occur in the system?

For partial answers to the questions, we draw the attention to the recent report of the two Swedish scientists, Rickard Lundin and Hans Lidgren: Nuclear spallation and neutron suppression induced by ponderomotive force waves. The basic idea is that the ponderomotive forces at resonance frequencies tear neutrons from elements such as deuterium and lithium, which are next captured by nickel, releasing energy, as required by well-known physical laws. In summary it is not a new physics, but a little known physical effect that describes the interaction of matter with electromagnetic fields, creating Miller's ubiqunderomotive forces. This would be the key to explain the release of energy and the isotopic changes occurring in the LENR. The two high-profile researchers and members of the Swedish Academy, speakers at the Nobel Prize award in Physics and Chemistry, commented Verbatim: "This report demonstrates, theoretically and experimentally, that nuclear power production can be housed in reactors rather small, operating at modest temperatures ($\approx 900 - 2000\text{ }^\circ\text{C}$), and producing sustainable power in the order of 1 to 10 kW, with a minimum, a few grams per year, fuel consumption." The high power output, delivered by a small amount of fuel, shows that the nuclear process has a great potential. Properly used the process could become an unlimited and sustainable source of energy. By combining the two approaches: Cook-Rossi and Lundin - Lidgren, a description of the nuclear process appears possible with one important exception: the change in the isotopic composition of the elements, due to the transfer of neutrons, is explained, but the formation of new elements, for instance copper and zinc from nickel, repeatedly observed in our experiments, requiring proton transfer, the overcoming of "Coulomb barriers", remains unexplained.

Randell Mills takes an entirely different approach based on a well-known classical electrodynamic phenomenon, called inductive resonance between two macroscopic circuits. These are two coils of insulated wire: if one is supplied with alternating current, the other one also receives at distance, electricity from the first. Mills transferred this phenomenon to the atomic scale, assuming that the atom of hydrogen with its electron in a circular orbit around its nucleus, on a microscopic level is similar to the first coil and transfers its energy to the surrounding area, the 2nd coil resonant by induction. However, if the hydrogen atom was at the lowest energy state, it could not resonate with the surrounding environment. Randell Mills, argues that the fundamental state with the main quantum number $n = 1$, (Bohr, Schrödinger), is not the lowest energy state for hydrogen. The lowest energy according to Mills, is reached, by assuming transitions to states with fractional quantum numbers $n = 1/2, 1/3, 1/4, \dots, 1/137$ (lower limit) producing abundant energy, in the form of photons and heat. This energy forcibly torn by catalytic route from the hydrogen is then transferred to its contour ! The final situation therefore, would be the irreversible formation of dark matter of mini - atoms called "hydrino", not emitting more photons. Although Randell Mills, is supported by a large number of international patents and demos in qualified environments, the theoretical basis of its proposal for the most productive generation of non - polluting energy, both thermal and electrical, has been fiercely challenged by the vast majority of the scientific community. One of the important points of Randell Mills theory remains and stress the importance of the atomic environment for the process.

In this respect, the role of the contour of the interactive atom, in primis of the hydrogen atom, very generally, can be classified as follows:

- Crystal lattice and materials with static and dynamic interactions.
- Oscillating electromagnetic fields and interacting by resonance.
- Coulomb and prohibitive electrostatic barriers.
- Magnetic fields: border of the interactions and plasmas.

Our search for quantitative parameters to define the influence of the atomic contour and design the appropriate experiments and the excess energy, so far has not provided a definite answer. A very general approach has been taken by Vladimir Dubinko: "Quantitative model of the E- CAT based on the LAV theory", Energy 2.0 Meeting, November 21, 2015. The main effect of the environment would be to make the electronic coordinates R and momenta P correlated quantities.

The correlation coefficient:

$$C = \frac{1/2 \langle RP + PR \rangle}{\langle R \rangle \langle P \rangle}$$

requires a reformulation of the Heisenberg principle

$$\Delta R \Delta P \geq \hbar_{\text{eff}}$$

with the effective Planck constant \hbar_{eff}

$$\hbar_{\text{eff}} = \frac{\hbar}{\sqrt{1 - C^2}}$$

Note that in the limit of fully correlated quantities

$$C \rightarrow 1$$

$$\hbar_{\text{eff}} \rightarrow \infty,$$

and the Gamow factor for a particle of energy E which is obtained by integrating the quantum probability of penetration from the nuclear dimension to the contact point of the barrier V(R) R_c

$$G \approx \text{Exp} \left[- \frac{2}{\hbar_{\text{eff}}} \int_{R_0}^{R_c} \sqrt{2 \mu (V(R) - E)} dR \right]$$

Specifically the correlation coefficient, "acts" on the Coulomb barrier and the excess energy in the two borderline cases as follows. In the first, fully uncorrelated case, the Coulomb barrier behaves according to the classical laws of electrostatics and requires enormous energy values to overcome it, e.g. the thermonuclear fusion for the hydrogen atom. In the second, fully correlated case, when the "correlation coefficient" assumes all values between zero and one, meaning more or less strong interactions with the boundary, the barrier becomes more or less penetrable, or, in jargon, more or less transparent. Thus with this approach, the penetration of the Coulomb barrier around the Ni nucleus would be interpreted, from the proton of the hydrogen confined in the octahedral cage of the crystalline lattice to the Ni atom, i. e. the cold fusion of Ni.

We conclude optimistically. In particular, we draw the attention to the new technology E-CAT.sk, recently developed by Rossi and successfully, publicly proved in the US, to show clearly the large increase of the produced thermal energy, its high density and to open a new excellent perspective for producing low cost electric energy.

New promising methods are currently investigated by Rossi and his research group to exploit, by photovoltaic effect, or other, more advanced methodologies the light emitted by the E-CAT.sk. A way out of Middle Ages energy sources appears to be ante portas! in a relatively little time, due to the intense ferment in international research, and the urgent need for clean and low - cost energy, to save the planet from the climate change and the economy, from the global crisis.

Table 1. Measured and natural occurring abundances for Li and Ni ions in fuel and ash, respectively.

Ion	Fuel		Ash		
	Counts in peak	Measured abundance [%]	Counts in peak	Measured abundance [%]	Natural abundance [%]
⁶ Li ⁺	15804	8.6	569302	92.1	7.5
⁷ Li ⁺	168919	91.4	48687	7.9	92.5
⁵⁸ Ni ⁺	93392	67	1128	0.8	68.1
⁶⁰ Ni ⁺	36690	26.3	635	0.5	26.2
⁶¹ Ni ⁺	2606	1.9	~0	0	1.8
⁶² Ni ⁺	5379	3.9	133272	98.7	3.6
⁶⁴ Ni ⁺	1331	1	~0	0	0.9

****Biographical note**

Christos STREMMENOS is a retired Professor of the Department of Physical and Inorganic Chemistry of the Faculty of Industrial Chemistry in the University of Bologna. He has served as Ambassador of Greece in Italy (1982-1987), and has been awarded the title of “Cavaliere di Gran Croce al Merito” of the Italian Republic. In the University of Bologna, and in the National Technical University of Athens he has taught Molecular Spectroscopy, Applied Spectroscopy and Photochemistry. From the beginning of his academic career to the assumption of his duties as Greek Ambassador, his research work was in the field of spectroscopy of solid and liquid crystals, of their static and dynamic structures. After his mission at the Embassy of Greece in Rome was completed, he started to work in the field of nuclear reactions between nickel and hydrogen or deuterium, trying to reproduce the Fleischmann - Pons experiment and achieving reliable results.