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Research Article

Erzion Model Interpretation of the Experiments with Hydrogen Loading of Various Metals

Yu. N. Bazhutov*

Terrestrial Magnetism, Ionosphere and Radiowave Propagation Institute RAS (IZMIRAN), 142190 Troitsk, Moscow, Russian Federation

Abstract

A short review of Cold Nuclear Transmutation for 22 years after its discovery is presented. I describe the main physical results of the Rossi–Focardi experiment and our experiment with hydrogen loading of various metals. I propose the Erzion Model of Catalytic Nuclear Transmutation as the theoretical explanation of the generation of excess heat, new chemical elements and isotopes, X-rays and neutron radiation in these experiments.

Keywords: Erzion model of catalytic nuclear transmutation, Hydrogen loading of various metals

1. Introduction

Twenty-three years ago Martin Fleischmann, Stanley Pons and Steven Jones declared the opening of a new nuclear physics phenomenon – cold nuclear fusion (CNF) [1,2], capable of becoming in the near future the basis for a new simple, safe and efficient form of nuclear power. In March 23 at the press conference in the University of Utah, Martin Fleischmann and Stanley Pons announced a simple electrolysis experiment with heavy water and excess heat up to 3 W with 1 W of input power.

To understand the mechanism of this new effect, it is possible that the most significant there were the results obtained in the Bombay Atomic Center by nuclear physicists of 11 independent groups, which a year later showed that the excess energy in high current heavy water electrolysis are observed with a very abnormal ratio of the neutron to tritium yield, relatively to a standard mechanism for nuclear fusion [3]. The yield of tritium relative to energy output is 1000 times smaller, and the neutron flux is suppressed, even a million times (3–11 orders of magnitude of suppression in different groups). After this, the researchers realized that they were dealing with a new mechanism in nuclear physics, and changed its name from CNF to CMNS or CNT.

By now the international CMNS community has discovered many different methods of stimulating this process. These methods include the use of laser illumination; thermodynamic and ultrasonic cavitation; temperature and pressure cycling in the gas phase; using plasma electrolysis, etc. Piantelli and Focardi spent 20 years investigating the mechanism

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*E-mail: erzion@mail.ru

of nickel loaded with usual hydrogen, and had some success [4,5,11]. The Italian engineer Rossi saw the simplicity of the Piantelli cell and invested his own capital in this process. Together with Focardi, Rossi has been able to make an industrial variant of this cell even without a true understanding of the physical mechanism of it [9,10]. Thus, Rossi and Focardi may had great success in energy production, though perhaps not yet in the most optimal variant of it.

On 14 January 2011, the University of Bologna physics department held an online conference in which scientists and journalists were shown a working prototype of the reactor with a capacity of 12 kW, operating on the principle of cold nuclear transmutation [8]. Analysis with a spectrometer at the University in Uppsala, Sweden, showed that the initial powder consists mainly of pure nickel, while the used powder contains a number of other substances – 10% copper, 11% iron, and smaller percentages of cobalt and zinc. "Given that copper is not one of the additives used as a catalyst of copper, isotopes Cu^{63} and Cu^{65} can only be obtained during the nuclear process. This is evidence that nuclear reactions took place,"said Kullander. Swedish researchers concluded: "Given 25 kW from the container volume of 50 cm^3 any chemical process should be excluded. There is only one alternative explanation for the fact of the measured energy. This is a new nuclear process."

On 6 October 2011 A. Rossi demonstrated a large set of E-Cat (37 modules, 3 cells each) with an output of thermal power $\sim$ 1 MW [6,7]. On October 28, 2011, Rossi showed his first megawatt reactor for its first client, and the client's engineers and scientists, checked his work. Due to some problems reactor produced 470 kW of continuous power for 5.5 h in self-sustaining mode [12]. Due to the use of a fully autonomous mode the reactor could not be run at full capacity, but what he did was quite impressive. He demonstrated for 5.5 h with the heat production capacity of 470 kW, a self-sustaining mode.

In our similar experimental studies (in a separate report presented at this conference) with hydrogenation and heating of various metals, we have conclusively identified the generation of X-rays, neutron radiation and we also obtained the possible indication of new isotopes and chemical elements generation.

2. Interpretation of Our Results and the E-Cat Results within Erzion Catalysis Model

To explain the phenomenon of Cold Nuclear Transmutation (CNT) over the 23 years about a hundred of theoretical models have been proposed. However, most of them only explain the mechanism of removing a potential barrier for nuclear fusion. Others suggested more radical new channels of nuclear reactions, thus providing a process CNT. The Erzion Catalysis Model [13–15], which appeared as early as 1990 is one of them.

The result of the E-Cat work and our similar experimental studies (in a separate report presented at this conference) with hydrogenation and heating of various metals give a natural explanation in the framework of the Erzion Catalysis Model, assuming the existence in nature of new hadrons – Erzions proposed even earlier (1982) in order to explain a number of cosmic ray anomalies [16,18–20].

Erzions are a pair of stable heavy mesons (E^0, E^-), the existence of which has a strong foundation in the framework of the Mirror Model [14,15,17]. A consequence of the quantum numbers of the Erzion doublet has a nuclear force of repulsion in the interaction with ordinary nuclei. Thus, the meson – Erzion cannot be captured by nuclei, and only with the nuclons can form a stable bound singlet state Erziobarion or 5-quark bag, which we called as Enion (E_N = {U *, u, u, d, d}). As can be seen in Fig. 1, this particle can be dissociated or a charged pair ($E_N = E^- + p - \Delta E_1$), or in a neutral pair ($E^0 + n - \Delta E_2$) upon receipt by it of additional energy (ΔE_1= 7,80 MeV) or (ΔE_2= 6.15 MeV).

The basic model of the Catalytic Erzion Nuclear Transmutation (CENTM), created specifically to explain the phenomenon of cold fusion (or rather the Cold Transmutation of nuclei), is the assumption of the existence of matter in the bound state of Enions and nuclei with a very low concentration ($C \sim 10^{-15}$ per nucleon). The bound energies - E_b= (1–100 eV) are very small. The Enion can bind to nuclei of some elements (donor isotopes) and can be stored for a long time for them to release due to a collision or impact of electromagnetic radiation. Enions are of relict origin, and came to earth mainly in the primary cosmic radiation.

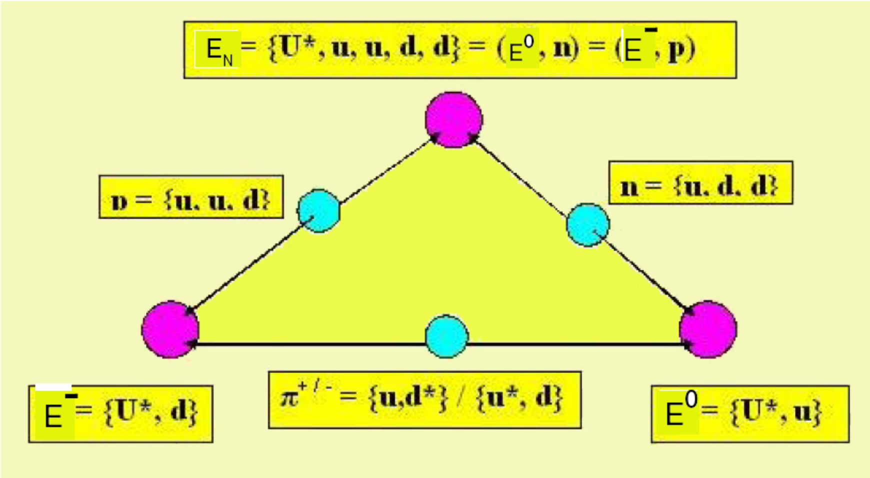

Figure 1. The Erzions and Enion structural quark scheme.

As previously reported, the Erzion nuclei cannot exist in principle and therefore Erzion and Enions can only participate in the exchange nuclear reactions (not capture) with preservation of “Erzion numbers”. Thus, Enions can become Erzion (E^-or E^0), and Erzion changes sign or charge ($E^- \Rightarrow E^0$; $E^0 \Rightarrow E^-$), or convert to E_N.

In principle, any possible implementation of the six Erzion-exchange reactions ($E_N \Rightarrow E^0, E_N \Rightarrow E^-$, $E^0 \Rightarrow E^-$, $E^0 \Rightarrow E_N$, $E^- \Rightarrow E^0$, $E^- \Rightarrow E_N$) [21].

3. Nuclear Transmutation and Calorimetry

Nuclear catalysis for metal hydride experiments is provided by heating nickel hydride to a high temperature (~700 K) at which due to the collision mechanism on the lightest donor isotope – proton ($E_{\text{bond}} \sim 1.5$ eV) Enions can become free, which has, in turn, triggers catalytic chain Erzion exothermic nuclear reactions [17].

At the 5th RCCNT conference in 1997 my report “Local and global transmutation of nuclei in Erzion model” was presented and later published in the Proceedings of RCCNT-5 [22]. I looked at the successive chain of nuclear transmutations, not only for all isotopes of the primary chemical element titanium (Ti), but in all of its daughter isotopes in the 14 stages of such a transmutation. Here it is done the same job, but for the original set of all stable isotopes of nickel. The fact is that for large nuclear sections of nuclear reactions of Erzion catalysis the daughter nuclei are accumulated at a very small (micron) distance from the primary reaction, and the frequency of their accumulation is huge (in the gigahertz range), so it quickly achieves a high concentration of daughter isotopes in this small volume, and effectively begins to produce second stage transmutation chains, third stage, and so on. Let us consider only two steps of the nickel nuclear transformations.

At the first stage, the five stable isotopes of nickel are as follows from Erzion-nuclear catalytic exchange reactions:

$$\mathrm{Ni}^{58}(\mathrm{E}^-,\ \mathrm{E}^0)\mathrm{Co}^{58}(\beta^+, \varepsilon) + 2.45\ \mathrm{MeV}, \tag{1}$$

$$\mathrm{Ni}^{58}(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Ni}^{59}(\varepsilon) + 2.95\ \mathrm{MeV}, \tag{2}$$

$$\mathrm{Ni}^{60}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Ni}^{61} + 1.77\ \mathrm{MeV}, \tag{3}$$

$$\mathrm{Ni}^{61}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Ni}^{62} + 4.55\ \mathrm{MeV}, \tag{4}$$

$$\mathrm{Ni}^{61}(\mathrm{E}^-,\mathrm{E}^0)\mathrm{Co}^{61}(\beta^-) + 1.51\ \mathrm{MeV}, \tag{5}$$

$$\mathrm{Ni}^{62}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Ni}^{63}(\beta^-) + 0.79\ \mathrm{MeV}, \tag{6}$$

$$\mathrm{Ni}^{64}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Ni}^{65}(\beta^-) + 0.05\ \mathrm{MeV}. \tag{7}$$

Thus, the first stage brings ever new nine subsidiaries of radioactive and stable isotopes, taking into account the β decay (β^+, β^-- decays and ε - e capture): Fe^{58}, Co^{58}, Co^{59}, Co^{61}, Ni^{59}, Ni^{63}, Ni^{65}, Cu^{63}, and Cu^{65}.

At the second stage these nine radioactive and stable isotopes are the following, based on the Erzion-nuclear catalytic exchange reaction:

$$\mathrm{Fe}^{58}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Fe}^{59}(\beta^-) + 0,53\ \mathrm{MeV}, \tag{8}$$

$$\mathrm{Co}^{58}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Co}^{59} + 4.40\ \mathrm{MeV}, \tag{9}$$

$$\mathrm{Co}^{58}(\mathrm{E_N},\mathrm{E}^-)\mathrm{Ni}^{59}(\varepsilon) + 0.49\ \mathrm{MeV}, \tag{10}$$

$$\mathrm{Co}^{58}(\mathrm{E}^-,\mathrm{E_N})\mathrm{Fe}^{57} + 1,15\ \mathrm{MeV}, \tag{11}$$

$$\mathrm{Co}^{58}(\mathrm{E}^-,\mathrm{E}^0)\mathrm{Fe}^{58} + 5.14\ \mathrm{MeV}, \tag{12}$$

$$\mathrm{Co}^{59}(\mathrm{E_N},\mathrm{E}^0)\mathrm{Co}^{60}(\beta^-) + 1.44\ \mathrm{MeV}, \tag{13}$$

$$\mathrm{Co}^{59}(\mathrm{E_N},\mathrm{E}^-)\mathrm{Ni}^{60} + 1.43\ \mathrm{MeV}, \tag{14}$$

$$\mathrm{Co}^{59}(\mathrm{E}^-,\mathrm{E_N})\mathrm{Fe}^{58} + 0.74\ \mathrm{MeV}, \tag{15}$$

$$\mathrm{Co}^{59}(\mathrm{E}^-,\mathrm{E}^0)\mathrm{Fe}^{59}(\beta^-) + 1.25\ \mathrm{MeV}, \tag{16}$$

$$\mathrm{Co}^{61}(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Co}^{62}(\beta^-) + 0.55\ \mathrm{MeV}, \tag{17}$$

$$\mathrm{Co}^{61}(\mathrm{E_N}, \mathrm{E}^-)\mathrm{Ni}^{62} + 3.04\ \mathrm{MeV}, \tag{18}$$

$$\mathrm{Ni}^{59}(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Ni}^{60} + 5.34\ \mathrm{MeV}, \tag{19}$$

$$\mathrm{Ni}^{59}(\mathrm{E}^-, \mathrm{E}^0)\mathrm{Co}^{59} + 3.91\ \mathrm{MeV}, \tag{20}$$

$$\mathrm{Ni}^{63}(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Ni}^{64} + 3.61\ \mathrm{MeV}, \tag{21}$$

$$\mathrm{Ni}^{65}(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Ni}^{66}(\beta^-) + 2.93\ \mathrm{MeV}, \tag{22}$$

$$\mathrm{Ni}^{65}(\mathrm{E_N}, \mathrm{E}^-)\mathrm{Cu}^{66}(\beta^-) + 0.32\ \mathrm{MeV}. \tag{23}$$

At the second stage and after, the generation of such radioactive isotopes is rather small. But as indicated below for $\mathrm{Ni}^{65}\gamma$-activity it may be dangerous (see next page). It is estimated that during the demonstration of only one module of the generator E-Cat (October 6, 2011) at only 3 kW of power for about 3 h, $\mathrm{Ni}^{65}\gamma$-activity on the order of the Curie (Cu = $3\times\ 10^{10}$ Bq - decays per second) was produced. However, there are certain ways to suppress this, and perhaps Rossi et al. found a way intuitively.

The isotopes of hydrogen are also possible from the following reactions:

$$\mathrm{H}\ ^1(\mathrm{E}^-, \mathrm{E}^0)\ \mathrm{n}\ (\beta^-) + 2.05\ \mathrm{MeV}, \tag{24}$$

$$\mathrm{H}^1(\mathrm{E}^-, \mathrm{E_N})\gamma + 8.10\ \mathrm{MeV}, \tag{25}$$

$$\mathrm{H}^2(\mathrm{E_N}, \mathrm{E}^0)\ \mathrm{H}^3\ (\beta^-) + 0.21\ \mathrm{MeV}, \tag{26}$$

$$\mathrm{H}^2(\mathrm{E}^0, \mathrm{E_N})\ \mathrm{H}^1 + 3.83\ \mathrm{MeV}, \tag{27}$$

$$\mathrm{H}^2(\mathrm{E}^-, \mathrm{E_N})\ \mathrm{n}\ (\beta^-) + 5.88\ \mathrm{MeV}, \tag{28}$$

$$\mathrm{H}^3(\mathrm{E_N}, \mathrm{E}^-)\mathrm{He}^4 + 11.70\ \mathrm{MeV}. \tag{29}$$

Thus, the second stage, too, produces nine new subsidiaries of radioactive and stable isotopes, taking into account the radioactive β decay (β^--decays and ε-capture e): Fe^{57}, Fe^{59}, Co^{60}, Co^{62}, Ni^{66}, Cu^{64}, Cu^{66}, and Zn^{66}.

At the third and subsequent stages, the accumulation of daughter isotopes in each subsequent phase will be reduced,and their concentration will decrease. Although these stages will continue more than 28 times and will work enough with this collection to produce of more than 95 new isotopes.

So for these first two stages, the most effective for production of new isotopes must have worked enough to produce four new chemical elements (Fe, Co, Cu, and Zn), which were observed by A. Rossi and C. Focardi in their demonstration experiments. Among the 18 newly established isotopes, there will be six radioactive isotopes, of which the most dangerous is the isotope Ni^{65} hard γ-rays with energy γ-quanta of 1.48 (25% – probability of emission of γ-ray) and 1.115 (16%).

Energy absorption of γ-rays in lead is a factor of 2.7 in its thickness of about 4 cm. It is estimated that during the demonstration work of only one module of the E-Cat generator (October 6, 2011) in only 3 kW of power for about 3 h should be established $\mathrm{Ni}^{65}\gamma$-activity of the order of the Curie (Cu = 3×10^{10} Bq - decays per second). However, there are methods to get rid of the γ-rays. Perhaps Rossi and Focardi used one of these methods, intuitively.

The above was stated in principle possible to provide Erzion Models catalysis of nuclear reactions to release of nuclear energy.

The order of magnitude of power in the Rossi experiment is in agreement with its estimation in the framework of the Erzion model.

According to references [6–10] in the E-cat about 100 g of Ni and 1.5 g of hydrogen are used, which is about 10^{24} of these atoms. In this case, the light nuclei of hydrogen are in a bound state of Enions (with concentration $C \sim 10^{-15}$ per nucleon) in the amount of 10^9, which are very loosely connected with the nuclei ($E_\mathrm{b} \sim 1.5$ eV), and when heated can let go and start a chain of exothermic catalytic Erzion nuclear reactions [17,18] at giant speeds (gigahertz). The frequency of Erzion chain of nuclear reactions in the E-Cat cell is $f \sim 10^{18}$ Hz, and the power of the energy released only 10% of Enions is about ~10 kW.

However, it should be borne in mind that the nuclear chain reaction will be closed only by a single reaction (27), in which neutral Erzion turns into Enion, but the responses to the transformation of Enions to Erzions – all the rest. Therefore, the deuterium is essential in the working body of the fuel system and in natural hydrogen to only 1.5×10^{-4}%. The total amount of nuclear energy produced for the entire cycle of the E-cat with 1.5 g of hydrogen will be limited to the value of ~30 MJ, and a full time job at a power setting of ~10 kW will be only one hour.

In our first series of experiments, we used a metal hydride as a hydrogen absorbent metal intermetallic $\mathrm{LaNi}_{4,75}\mathrm{Al}_{0.25}$,very rich 20 years ago to the state of deuterium $\mathrm{LaNi}_{4,75}\mathrm{Al}_{0.25}\mathrm{D}_{5.5}$ [23]. Therefore, we consider all Erzion-nuclear catalytic exchange reactions at the first stage on stable isotopes of La and Al, and Be used in the recent series of experiments:

$$\mathrm{Be}^9(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Be}^{10} + 0.76\ \mathrm{MeV}, \tag{30}$$

$$\mathrm{Be}^9(\mathrm{E}^0, \mathrm{E_N})\mathrm{Be}^{8} + 4.38\ \mathrm{MeV}, \tag{31}$$

$$\mathrm{Be}^{10}(\mathrm{E_N}, \mathrm{E}^-)\mathrm{B}^{11} + 3.13\ \mathrm{MeV}, \tag{32}$$

$$\mathrm{Al}^{27}(\mathrm{E_N}, \mathrm{E}^0)\mathrm{Al}^{28} + 1.68\ \mathrm{MeV}, \tag{33}$$

$$\mathrm{Al}^{27}(\mathrm{E}_N, \mathrm{E}^-)\mathrm{Si}^{28} + 3.49\ \mathrm{MeV}, \tag{34}$$

$$\mathrm{La}^{138}(\mathrm{E_N}, \mathrm{E}^0)\ \mathrm{La}^{139} + 2.73\ \mathrm{MeV}, \tag{35}$$

$$\mathrm{La}^{138}(\mathrm{E}^-, \mathrm{E_N})\mathrm{Ba}^{137} + 2.02\ \mathrm{MeV}, \tag{36}$$

$$\mathrm{La}^{138}(\mathrm{E}^-, \mathrm{E}^0)\mathrm{Ba}^{138} + 4.58\ \mathrm{MeV}, \tag{37}$$

$$\mathrm{La}^{139}(\mathrm{E_N}, \mathrm{E}^-)\mathrm{Ce}^{140} + 0.04\ \mathrm{MeV}, \tag{38}$$

$$\mathrm{La}^{139}(\mathrm{E}^-, \mathrm{E_N})\mathrm{Ba}^{138} + 1.85\ \mathrm{MeV}, \tag{39}$$

$$\mathrm{La}^{139}(\mathrm{E}^-, \mathrm{E}^0)\mathrm{Ba}^{139}(\beta^-) + 0.52\ \mathrm{MeV}. \tag{40}$$

Twenty years after a sample was placed in storage, an analysis by a scanning electron microscope showed that it included about 5% copper and cerium. It is possible that the action of natural radioactivity and cosmic rays launched Erzion catalytic mechanisms of nuclear transmutation, which due to nuclear reactions(6), (7) and (38) provided the operating time of copper and cerium. By the way, this is just as it was at the Rossi and Focardi with operating 10% of copper from pure nickel, but for a shorter period due to the necessary process intensification temperature.

4. The Generation of Neutrons and X-ray

As is evident from the above, 40 Erzion nuclear exchange reactions with all stable isotopes of the major chemical elements involved in our experiments (except beryllium), neutron generation occurs only in the nuclei of atoms of light (proton) and heavy (deuteron) in the reactions of hydrogen, respectively (see reactions (24) and (28)).

In both these cases the reaction is provided by the negatively charged Erzion, which is generated by subsidiary nuclei formed by the isotopes of primary nickel and hydrogen in the reactions (10), (14), (18), (23) and (29) or on the primary isotope of La and Al in the intermetallic $\mathrm{LaNi_{4,75}Al_{0.25}}$in the reactions (34) and (38).

In the beryllium, neutrons are produced by an instantaneous collapse of the daughter isotope Be^8 two α-particles, neutrons, giving to the source nuclei in the reaction Be^9:

$$\mathrm{Be}^9(\alpha, \mathrm{n})\mathrm{C}^{12} + 5.6\ \mathrm{MeV}. \tag{41}$$

Although it is less likely to be formed in the reactions of hydrogen (24) and (28) through the preliminary formation of E^-on the child Be^{10}isotope in the reaction (32).

Because all neutrons generated in Erzion catalytic exothermic nuclear reactions chain from one initial Enion [17], they are born in bursts.

We observed mainly in the intermetallic $\mathrm{LaNi_{4,75}Al_{0.25}}$soft X-ray emission, which is due to the characteristic X-radiation of nuclear La ($E_\gamma \sim 40$ keV) in their transmutation in the reactions (35)–(40) or as nuclear Ni ($E_\gamma \sim 8$ keV) in reactions (1)–(23) with the emission of more soft X-rays.

5. Conclusion

As seen from the above, the Erzion Catalysis Model simply and naturally explains the Rossi and Focardi experiments on the fundamental level of a strictly scientific result. The model may also have a major prognostic potential for substantial optimization of future power plants [24–27].

In the near future we can expect rapid development of Cold Nuclear Transmutation, both in the theoretical and experimental plane. Large investments of financial capital will ensure a rapid breakthrough in the related fields of science and technology. Civilization is rapidly moving into a new Energy Era.

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