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# COLD NUCLEAR FUSION, TUNNEL EFFECT AND NUCLEAR TRANSMUTATION

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## ABSTRACT

*The article presents a new type of nuclear transformations not recognized by modern nuclear science, but discovered experimentally and the operating installations of controlled cold nuclear fusion are presented. The possibility of cold nuclear fusion in the interstellar medium, which results in the appearance of thermal background radiation of the Universe in the microwave range from 10 GHz to 33 GHz, is considered.*

***KEYWORDS:*** *Proton, Electron, Tunnel Effect, Cold Nuclear Fusion*

## INTRODUCTION

In the report, I will present a new type of nuclear transformations not recognized by modern nuclear science, but discovered experimentally [1]. At the same time, the fusion of nuclei during cold nuclear transmutations occurs at energies of several electron volts and cannot be compared with the energies of nuclear reactions from units up to hundreds of millions of electron volts. Nuclear scientists are accustomed to this range of energies in nuclear reactions. It is this circumstance that allows them to reject a priori any nuclear processes in biology, since at such fragment energies, destruction of tens and hundreds of thousands of complex biological molecules will occur. But this is true only for fission reactions, and there are no such obstacles for the synthesis of new nuclei. When the French scientist Louis Kervran published a book on nuclear transmutations in biology, the famous physicist C. Sagan advised the author to read an elementary textbook on nuclear physics, and when the first creator of the "warm" nuclear fusion technology, engineer Ivan Stepanovich Filimonenko in 1957 created a "pure" thermionic installation (TEGEU) for the synthesis of helium from deuterium at a temperature of 1150 ° C, the Russian Academy of Sciences pretended that nothing had happened and, with the persistence of maniacs, continued to invest heavily in Tokamak thermonuclear facilities, until in 2021 they quietly covered this project. For that, in 1989, Martin Fleishman and Stanley Pons (who, while still a citizen of the Ukrainian SSR, was an expert on the latest Soviet thermionic nuclear installations and, on duty, should have known about the work of Filimonenko) announced that they managed to force deuterium to turn into helium at room temperature. temperature in the device for the electrolysis of heavy water [2]. Like Filimonenko, Fleishman and Pons used electrodes made of palladium. Palladium is distinguished by the amazing ability to "absorb" a large amount of hydrogen and deuterium. The number of deuterium atoms in a palladium plate can be compared with the number of atoms of palladium itself. In their experiment, physicists used electrodes previously “saturated” with deuterium. When an electric current passed through heavy water, positively charged deuterium ions were formed, which, under the action of electrostatic attraction forces, rushed to the negatively charged electrode and penetrated into it. At the same time, as the experimenters were sure, they approached the deuterium atoms already in the electrodes at a distance sufficient for the nuclear fusion reaction to proceed. The proof of the reaction would be the release of energy - in this case it would be expressed in an increase in the temperature of the water - and the registration of the neutron flux. Fleishman and Pons stated that both phenomena were observed in their setup. According to the Defense Intelligence Agency (DIA), if LENR works, it will be a disruptive technology capable of revolutionizing the production and storage of energy. An example is Andrea Rossi's E-Cat reactor. In the E-Cat reactor, in a system that is a ceramic tube filled with nickel powder, placed under pressure with hydrogen, in the presence of an electric current, heating occurs, with the release of energy several times greater than consumed. The fuel consists mainly of nickel nanopowder several microns in size (550 mg), lithium and aluminum in the form of LiAlH4 with an isotopic composition approximately corresponding to the natural one with a deviation within the instrument error.

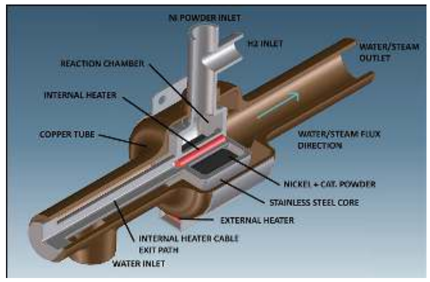


**Figure 1: Andrea Rossi E-Cat Reactor.**

On November 6, 2014, A. Rossi published an application for an American patent “Installations and methods for generating heat” [3]. In October 2014, a report [4] of a 32-day test of the E-cat facility by Andrea Rossi was published, in which the unique heat-generating properties of the reactor based on low-energy nuclear reactions (LENR) were fully confirmed. In 32 days, 1 gram of fuel (a mixture of nickel, lithium, aluminum and hydrogen) generated a net of 1.5 MWh of thermal energy, which is an energy density of 2.1 MW/kg, unprecedented even in nuclear energy Thus, the energy release of TVEL at the Rossi plant turned out to be about 50 times higher than that of modern nuclear reactors in TVEL. The fresh and spent E-cat fuel test results shown in Table 1 are measured by two methods: For method 1, a scanning electron microscope, Scanning electron microscopy (SEM), X-ray spectrometer, energy dispersive X-ray spectroscopy (EDS) and mass spectrometer, time-of-flight secondary ion mass spectrometry (ToF-SIMS) were used; For method 2, chemical analyzes were carried out on Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and atomic emission spectroscopy (ICP-AES) spectrometers.

**Table 1**

| № метода измерений | Образец | $^{6}$Li | $^{7}$Li | $^{58}$Ni | $^{60}$Ni | $^{61}$Ni | $^{62}$ Ni |
|---|---|---|---|---|---|---|---|
| | Изотопный состав природный | 7,5-7,6 | 92,4 -92,5 | 68,1 | 26,2 | 1,1-1,8 | 3,6 |
| 1 | 2,13 мг образца свежего топлива | 8,6 | 91,4 | 67 | 26,3 | 1,9 | 3,9 |
| 2 | | 5,9 | 94,1 | 65,9 | 27,6 | 1,3 | 4,2 |
| 1 | 2,13 мг образца отработанного топлива | 92,1 | 7,9 | 0,8 | 0,5 | 0,0 | 98,7 |
| 2 | | 57,5 | 42,5 | 0,3 | 0,3 | 0,0 | 99,3 |

After 32 days of burnout, almost only even isotopes 62Ni and 6Li were noted in the sample (see Table 1). It is impossible to assume something non-nuclear here, but, as the authors note, it is also impossible to describe all possible reactions, since we immediately stumble upon a lot of contradictions: the Coulomb barrier, the absence of neutron and α radiation. But it is no longer possible to deny the fact of the transition of some isotopes to others through a channel so far unknown to science, and it is urgent to investigate this phenomenon with the involvement of the best specialists. The authors of the test also admit that they cannot present a model of the processes in the reactor consistent with modern physics. The physical process that provides the release of additional energy is described in my report. In the E-Cat reactor, protons, when passing an electric current, acquire excess energy in the process of repeated collisions with the walls of caverns, tens of angstroms in size in nickel grains. The analysis showed that the original statement about the transformation of nickel into copper is not true. The effect of excess heat release, similar to the E-Cat installation, was observed in amazing experiments by A. Samgin and A. Baraboshkin back in 1994 [5]. They used a special proton-conducting ceramic that, when passed through an electric current, was able to generate thermal energy thousands of times greater than the energy expended. However, no radiation or nuclear fragments were found. In order to rule out a nuclear fusion reaction of the D+D type, A. Samgin replaced heavy hydrogen (deuterium) with ordinary hydrogen in the manufacture of ceramics. If the effect of such a huge release of energy were associated with D+D reactions, then all the anomalous thermal effects would disappear, but they remained. It was concluded that nuclear processes are not responsible for this amount of energy released. The experiments of our scientists were reported to the 4th International Conference on Cold Fusion in Palo Alto, USA in 1994 [5]. When an electric current is passed in narrow cavities that appear in conductive ceramics during its firing, protons acquire excess energy during their collisions. Professor Lev Sapogin explains the excess energy in Andrea Rossi's E-Cat reactor and Samgin's experiments from the standpoint of Unitary Quantum Theory, considering the movement of protons in caverns similar to the oscillation of electrons in potential wells [6]. Violation of the laws of conservation of energy, observed in the experiments considered, requires a revision of quantum electrodynamics. Absolutely the same picture occurs with nitrogen in the production of ammonia (Figure 2).

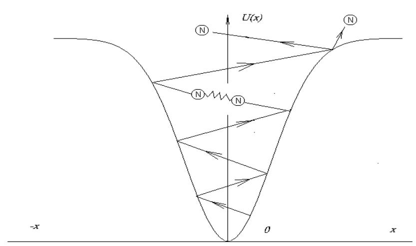


**Figure 2: Oscillations of a Nitrogen Molecule in a Limited Potential Well.**

Molecular nitrogen under ordinary conditions is almost an inert gas and it will react with hydrogen only in the atomic state. But to make molecular nitrogen atomic, a lot of energy is needed. It happens like this: a nitrogen molecule under pressure enters the catalyst cavity, which is heated to 500 ° C magnetite granules with additions of aluminum, potassium, calcium and silicon oxides. As a result, two free nitrogen atoms fly out of the cavity, which immediately combine with protons. By the way, this is the universal and the only mechanism of all heterogeneous catalytic reactions. The synthesis of ammonia from nitrogen and hydrogen is described by a reversible equilibrium reaction proceeding with a decrease in volume and release of heat:

$$N_2+3H_2 \rightarrow 2NH_3+Q \qquad (1)$$

There are amazing data on the decomposition of hydrogen sulfide $H_2S=H_2\uparrow+S\uparrow$ on metal catalysts with heat release. The reaction does not require energy. But this is a direct violation of the Law of Conservation of Energy from the point of view of chemical thermodynamics! A catalyst, by modern definition, does not contribute additional energy to the process it catalyzes. However, practice shows that the catalyst brings additional energy! [7]. The only reasonable explanation for this is the recognition of the influence of the environment (physical vacuum) on irreversible processes in non-equilibrium systems. Nobel Prize winner Ilya Prigogine was right when he stated that "in a steady state, active influence from the outside on the system is insignificant, but can be of great importance when the system goes into a non-equilibrium state” [8]. Thus, in narrow caverns, non-equilibrium particles draw energy from the physical vacuum environment. Vacuum is a world field of superpositions of oscillators with a continuum of frequencies [9]. The evolution of dynamic systems (field-particle), up to the self-organization of matter, is due to the existence of resonances between the degrees of freedom. I.Prigozhin and I.Stengers came to this conclusion in their monograph "Time, Chaos, Quantum" [8]. They revived N. Tesla's idea of the theory of global resonance, but if N. Tesla's resonance theory of the creation of matter in the ether was based on the intuition of a brilliant experimenter, then I. Prigogine's theory acquired rigorous mathematical forms. Poincaré's proof of the non-integrability of dynamical systems and the theory of resonant trajectories of Kolmogorov - Arnold - Moser allowed Prigogine to conclude that the mechanism of resonant interaction of particles in large Poincaré systems (BSPs) is mandatory. Ilya Prigogine wrote: “If the systems were integrable, then there would simply be no place for coherence and self-realization, since all dynamic movements would be essentially isomorphic movements of free (non-interacting) particles. Fortunately, in Nature, BSPs prevail over other systems” [8]. To this I can add that Professor Yu.I. Volodko from NPO them. Lavochkin discovered the effect of an increase in the gas velocity after exiting a narrow gap [10]. In this case, the velocity of gas molecules at the outlet of the nozzle exceeds the velocity of molecules at the inlet at the beginning of the nozzle by 2–4 times. This remains inexplicable for modern gas dynamics and leads to a significant increase in excess pressure. Dr. Yu.I. Volodko believes that the resulting additional energy is taken from the environment, in violation of the conservation laws adopted for closed systems [10]. An analogy with excess energy during the movement of hydrogen in caverns formed by nickel grains in the Rossi reactor or in catalysts during the production of ammonia or chemical reactions of hydrogen sulfide decomposition on the face. The mechanism for obtaining additional energy is the same - it is a resonance that allows you to draw the missing energy in the medium for the tunnel effect to occur during cold nuclear fusion.

Nature offers mankind various options for nuclear fusion: on the one hand, it is uncontrolled thermonuclear fusion realized in the depths of the sun and accompanied by coronary emissions that have a detrimental effect on all life on the planets, on the other hand, the thermal radiation of the universe realized in the form of cold nuclear fusion in the interstellar medium. The detected thermal background radiation of the Universe, discovered in 1965 A. Penzias and Robert Wilson, in the microwave range from 10 GHz to 33 GHz received in astrophysics an insufficiently convincingly justified name “relict”. This may be a process of cold nuclear fusion occurring in the space environment, with the release of energy sufficient to raise the temperature of the Universe to 2.7 K. Academician V.E. Fortov in his book "Lectures on the Physics of Extreme States of Matter" considered, in addition to astrophysical objects, the galactic and intergalactic space environment (dark matter and dark energy), which accounts for (95%) of the average density of the matter of the Universe [11] . According to the results of astronomical observations of the Planck telescope, the Universe consists of:

- dark energy (68.3%)
- dark matter (26.8%)
- ordinary (baryon matter) (4.9%)
- Of approximately 5% of the baryonic matter, 4/5 of the mass is in the interstellar medium and only 0.5% of the average density of the Universe is concentrated in stars [12].

As the latest research has established, the behavior of dark matter is similar to the behavior of atoms in a Bose-Einstein condensate (quantum fifth state of matter), obtained at a matter temperature close to absolute zero - 273.5 Celsius or 0 Kelvin. In June 2020, the Bose-Einstein condensate was successfully recreated in Earth orbit, on the International Space Station (ISS) [13]. Only there it was possible to create all the conditions for the appearance of the quantum fifth state of matter within a few seconds, but this was enough for scientists to get an idea of how exactly dark matter moves and why we cannot see and feel it (Figure 3). The quantum vacuum (dark matter) is, by definition, in a lower energy state than baryonic matter. In a Bose-Einstein condensate, a significant fraction of the atoms are also in the lowest energy quantum state (or ground state), while the atoms behave as a single quantum object with a common wave function. To obtain a Bose-Einstein condensate on the ISS, rubidium atoms were cooled to a temperature equal to one ten-millionth part of a Kelvin above absolute zero in a state of weightlessness. The condensate is extremely sensitive to the influence of gravity, which can knock atoms out of the trap and prevent effective cooling, so only the ISS managed to keep the condensate for 5-10 seconds, and repeat the process 6 times a day.

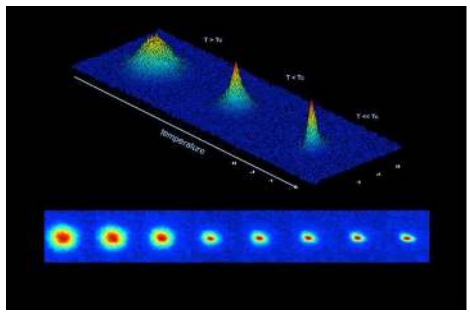

**Figure 3: Bose-Einstein Condensate (BECS*).***

Now physicists are saying that instead of studying empty space, they can create a Bose-Einstein condensate and study the quantum vacuum. In it, sound particles and photons are heard in the background vacuum. The sound is not generated by the broadcaster, but is heard through acceleration. The Unruh effect creates a thermal response of the accelerated detector as it moves in vacuum [14].Under normal conditions, a vacuum quantum behaves like a quasi-particle in a condensed state. In a state of excitation, a vacuum quantum loses its original state and passes into a new state - into the state of a neutron $n^0$ (1840; 1; 0), which then passes into three particles, a proton $p^0$ (1836; 1; 1), an electron $e^-$ (1; 1; -1) and antineutrino $\gamma^-$(1; -1; 0) [15]. In the process of neutron birth, several types of elementary particles are distinguished. They form the corresponding radiation, by the combination of which it is possible to detect the processes of the production of neutron, proton, deuterium and tritium:

- Γ-quanta $\gamma^-$(0;1;0) and $\gamma^+$(0;1;0) form γ-radiation;
- Neutrinos $^b\gamma^-$(-1;-1;0) and $\gamma^+$(1;1;0) – neutrino radiation;
- Electrons and positrons $^We^-$ (-1;-1;-1) and $e^+$(1;1;1) – generates β-radiation;
- Generated single neutrons $n^0$ (1840;1;0) give neutron radiation;
- Neutrons grouped in pairs form α-radiation [15].

It is in such an interstellar medium that cold nuclear fusion occurs, which makes it possible to create thermal background radiation from the Universe in the microwave range from 10 GHz to 33 GHz. When the vacuum is irradiated with third-party γ-quanta, the vacuum must be transformed into matter, while the five types of radiation indicated above will be present, and high energy and temperature will also be released. With the continuation of this experiment in a significant volume, it is possible to achieve the occurrence of a thermonuclear reaction of the proton-proton cycle (similar to the current one in stars) [15].

Today, with the creation of the largest James Webb space telescope, astrophysicists have the opportunity to look into the depths of the Universe, 13 billion years old in the infrared, and there they did not see the expected picture of the Big Bang. Astrophysicists are in a panic. In July 2022, a large group of astrophysicists published an article called "Panic!" [16]. According to the latest astrophysical data, the number of small galaxies and their location in the depths of the Universe, aged 13 billion years, does not correspond to the expected picture of the Big Bang. Astrophysicists tend to think that the universe has always existed and the Big Bang, along with the singularity, is Einstein's unscientific fantasy. Based on the latest conclusions of astrophysicists, the nature of the background radiation discovered in 1965 by A. Penzias and R. Wilson cannot be relic, which means that the hypothesis of cold nuclear fusion in the space environment acquires a scientific status.

The data from cold fusion experiments are extremely numerous and varied, but I will focus on the most important and fixed results. Thus, when studying the classical electrolysis of a deuterium-saturated palladium cathode in heavy water, an extremely large heat release is observed: up to 3 $kW/cm^3$ or up to 200 MJ in a small sample. Thermonuclear fusion products were also discovered: tritium ($10^7$-$10^9$ t/sec), neutrons with an energy of 2.5 MeV (10-100 n/sec), helium. In addition, the radiation of the charging particle (p, d, t, $\gamma$) can be observed. Similar processes can be studied during a gas discharge on a palladium cathode, during a phase transition in various crystals saturated with deuterium, when a deuterium mixture is irradiated with a powerful sonic or ultrasonic flow, in cavitating microbubbles in heavy water, in a tube with palladium powder saturated with deuterium at a pressure of 10 -15 standard atmospheres [17]. In nature, nuclear transformations are widespread (this is especially noticeable for plants and biological objects), but they are weakly associated with the release of energy. Examples of such reactions are:

$$Mn^{55} + p \rightarrow Fe^{56} \quad (2)$$

$$Al^{27} + p \rightarrow Si^{28} \quad (3)$$

$$P^{31} + p \rightarrow S^{32} \quad (4)$$

$$K^{39} + p \rightarrow Ca^{40} \quad (5)$$

In classical biology, the K-Na equilibrium has long been known, when the ratio between the number of K and Na ions is maintained with great accuracy. Professor T.Pappas performed research on one of the well-observed reactions in biological cells [18]:

$$Na\ {}_{23}{}^{11} + O_{16}{}^{8} = K\ {}_{39}{}^{19} \quad (6)$$

Professor M. Su Benford called this nuclear reaction the "equation of life". Reactions (2 - 6) are reactions of weak nuclear interaction involving neutrinos. Common to all these nuclear reactions and isotope transmutations in biological systems is the absence of products that explain thermal effects [19]. In reactions of this type, a very slow proton (its kinetic energy is practically zero) penetrates into the nucleus in the process of a tunnel effect and remains there. There is no release of nuclear energy because the nucleus remains stable both before and after the reaction. Reactions of this type were generally considered impossible at low energies and therefore were not studied in classical nuclear physics. Today there is a lot of experimental data confirming the massive nature of nuclear transmutation. Moreover, there are many nuclear waste disposal projects that use this method. In new physical theories, the nature of the tunneling effect is explained from different positions. In the Unitary Quantum Theory (UCT) of Professor L. Sapogin, when tunneling, a particle must approach a potential barrier in a phase when the amplitude of the wave packet is small, and the particle overcomes the barrier in the absence of a charge [20]. The author of another theory of the tunnel effect, Professor V.I. Vysotsky argues that the tunnel transition is due to the synchronization of coherent quantum-correlated states of light nuclei (for example, a proton or deuteron), and in this state, very large short-term fluctuations of the particle energy associated with resonance are generated. Thus, when gaseous deuterium is exposed to a pulsed magnetic field with an amplitude of 10 kOe and a leading edge duration of 2 • 10 μs, the probability of a tunnel effect during dd interactions and a temperature of 300-500 K increases from $D_r$ from $\approx 10^{-80}$ to $D_r \approx 0.1$. This process of dd-interaction can be realized in a gas with particle density $n \leq 10^{17} cm^{-3}$ [17]. A real breakthrough in the field of controlled cold fusion was the work of A.A. Kornilova and V.I. Vysotsky. They managed in the laboratory to start, regulate and stop the nuclear fusion reaction in deuterated polycrystalline titanium [21]. At a sufficiently high degree of saturation of the metal hydride with hydrogen or deuterium, internal stresses arise in the latter, which can lead to lattice cracking and the formation of microcracks. At each act of formation of such a microcrack, the formation of coherent correlated states of deuterons also occurs in the volume of the formed crack. Since there can be many such deuterons in the microcrack zone, the effect of "opening" such a microcrack can cause powerful pulses of particles and radiation accompanying nuclear reactions. However, such a process of microcracks is spontaneous, and the moments of opening of various microcracks are usually independent. At the same time, a very short shock wave generated by a thermal wave leads to synchronization (as well as stimulation) of the process of opening such microcracks and sharply increases the efficiency of nuclear reactions. Similarly, the action of such waves can stimulate various phase transitions with a change in the local topology of the lattice, which can lead to the concomitant formation of coherent correlated states accompanied by the generation of giant particle energy fluctuations. One of the manifestations of such synchronized fluctuations is the generation of high-power X-ray pulses, which was discovered and studied in numerous experiments [22].

## CONCLUSIONS

The article contains a far from a complete list of effects confirming the presence Cold nuclear fusion, tunnel effect and nuclear transmutation, but performance time is limited.

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