Review Article
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Nuclear fusion: the management prospects

Abstract

The article discusses the prospects of controlled nuclear fusion. The operating installations of cold nuclear fusion and the tunnel effect are presented, which leads to the abandonment of the Rutherford planetary model of the atom and the recognition of Lev Sapogin's Unitary Quantum Theory.

Keywords: Controlled nuclear fusion, plasma, laser, tokamak, cold nuclear fusion, tunnel effect

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Introduction

The problem of controlled nuclear fusion is one of the most pressing problems of modern physics. The main obstacle to solving this problem is associated with the need to use dense high-temperature plasma and its retention for a sufficiently long time (Lawson's criterion). To date, controlled nuclear fusion has a important progress, but not the ultimate realization. One of the conditions is that the distance between two target nuclei must be lesser than the radius of the strong interaction. This means that the nuclear kinetic energy must be large enough to overcome the electrostatic potential barrier between two nuclei. The ignition temperature is not easily achieved by traditional methods. Chen, et al.[1] presented a way to realize nuclear fusion at lower temperature by γ-laser or strong enough γ-ray and ordinary laser to irradiate target atoms. The ignition temperature of nuclear fusion of the excited nuclei is lower, and the scattering cross-section of the excited nuclei is larger. In this case, the Lawson criterion can easily be realized. The traditional method of providing such conditions is based on the inertial or long-term confinement of thermonuclear plasma heated to a temperature of about 10keV. This thermonuclear method has been investigated for 60 years in different laboratories of the world, and the prospect of achieving a positive result is still quite uncertain, despite the very large financial and intellectual efforts. An example is the International Thermonuclear Experimental Reactor – ITER in France based on the tokamak. Great attention is given to the prospects for the tokamak as of thermonuclear source (14MeV) of the neutrons in the pulsed mode of operation. The steady-state regime associated with prolonged plasma confinement in a tokamak is considered to be in the long term. In June 2016 it was reported to delay completion of the work from 2020 to 2025. Today, we can talk about a complex problem faced by the creators of the ITER project, because for the calculation of electrodynamics in a tokamak currently used classical equations of Maxwell. Real electrodynamics inside the tokamak is very different from the calculation.[2] Hot plasma particles move along magnetic field lines of arbitrary topology to the walls of the tokamak and destroy it. For tokamaks, the risk are caused by the lack of a full theory of electrodynamics, which could adequately describe the actual behavior of electric and magnetic fields and currents, and is further exacerbated by the fact that all fusion programs are based on heating and compressing the reacting material and at the same time has an adjective "controllable", although there is no control at all. Just the initial amount of the reacting substance is prudently taken very small. In quantum physics, there are no ways to influence this process. The fusion reaction of light nuclei of deuterium and tritium occurs at a temperature of hundreds of millions of degrees and is the most promising thermonuclear reaction:

$$ {}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + 17.6\ MeV \qquad (1)$$

In future models of the reactors in contrast to all existing projects will react in any moment of time only the smallest part of deuterons, which automatically selected relative to initial phases. It could be possible to obtain in result the small energy generating during long period of time until the reserve of light reacting nuclei will not be exhausted. That cold nuclear fusion does have the right to be called "controlled". In principle, this is possible when an external controlling electromagnetic field or a field of another nature is applied to a reacting system that contains ordered deuterium atoms and free deuterons. The same properties can have special geometries of atomic lattices. Diffraction scattering of the deuteron flux on such gratings and their subsequent dispersion will lead to the automatic selection of deuterons by energies and phases.

Real electrodynamics inside the tokamak

Tokamak is a toroidal chamber with magnetic coils, designed for magnetic plasma confinement in order to achieve the conditions necessary for the occurrence of controlled thermonuclear fusion. To create the magnetic trap uses a combination of magnetic fields: strong toroidal field **B**t and a weaker (100 times) poloidal field **B**p, as well as the **B**i field current I, flowing through the plasma column. It is believed that the plasma is stable in a tokamak if the criterion Shafranov - Kruskal:

$$ \mathbf{B}t / \mathbf{B}i > R/\alpha \qquad (2)$$

where R - radius of the circumference of the plasma ring, α - the radius of the cross section of the plasma column.

However, due to the effect strong toroidal magnetic field **H**t, arises of generation poloidal magnetic field **H**p and hold the plasma in a tokamak a long time is not possible. The more intense toroidal magnetic field generated by the windings of the toroid, and it reaches 3-5Tl in the tokamak, the more intense extra poloidal magnetic field will be created by it. Chief Scientific Officer of the Siberian Branch of the Russian Academy of Sciences, professor VV Aksenov[3,4] experimentally and mathematically substantiated the effect of self-excitation and the uncontrolled growth of magnetic fields. This leads to uncontrolled instabilities of plasma column.[3,4] Self excitation process will grow almost instantly due to the mutual generation of the above-mentioned magnetic fields. According to the electrodynamics developed by Professor VV Aksenov, the magnetic field inside the tokamak obeys the following equations:

$$\mathbf{H}m = \nabla\times(Q\mathbf{r}), \quad \mathbf{H}p = \nabla\times\nabla\times(Q\mathbf{r}),$$

$$\nabla\times\mathbf{H}m = \mathbf{H}p, \quad \nabla\times\mathbf{H}p = \chi\mathbf{H}m \qquad (3)$$

In this case, the effect of self-generation by a strong toroidal magnetic field $\mathbf{H}_{T}$ of the poloidal magnetic field $\mathbf{H}$p and vice versa is possible only in a conducting medium when the parameter $\chi \neq 0$.[4] Here Q is a scalar function of three or four variables, if we take into account the time dependence, and r is the radius vector. Vortices of a toroidal magnetic field create a force poloidal magnetic field and vice versa. This is one of the variants of the so-called dynamo excitation of a magnetic field. When the temperature rises inside the tokamak diffusion rate will also increase due to the growth of the resistance (conductivity drop) the plasma column and growth of the poloidal field inside the tokamak. VV Aksenov[4] conducted an estimation of self-excitation in the large model T-15 (Figure 1) according to his equations (3) of electrodynamics. The results are as follows.[4] If we assume $\nabla\times \approx 1/L$, where L is the linear dimension of the plasma pinch inside the tokamak, then:

$$(1/L)\times\mathbf{H}p \approx (\Upsilon/\eta)\times\mathbf{H}_T, \; (1/L)\times\mathbf{H}m \approx \mathbf{H}p \qquad (4)$$

where Υ is the diffusion rate of the field in the torus plasma, η is the magnetic viscosity.

Let the small radius of the plasma filament R = 2m, then $L = 2\pi\ R = 4\pi\ m$, and the intensity of the toroidal magnetic field $|\mathbf{H}m| = 5Tl$. The intensity of the additional poloidal magnetic field excited by the toroidal magnetic field will be of the order of

$$|Hp'| = 5/4\pi Tl \sim 0{,}4Tl$$

In this case, the estimate of the diffusion rate with respect to the original magnetic fields is as follows

$$\Upsilon = (\eta/L)(\ |\mathbf{H}p|/|\mathbf{H}m|) \qquad (5)$$

The additional toroidal magnetic field will increase by an amount

$$\Upsilon = (\eta/L)(\ |\mathbf{H}p|/|\mathbf{H}\mathrm{m}|) \qquad (6)$$

In conclusion, Professor VVAksenov notes that "the above approach to the description of electrodynamics in a tokamak needs a more thorough analysis involving the Boltzmann equation describing the behavior of plasma particles with increasing temperature in a complex magnetic field different from the toroidal one that arises in a tokamak due to self-generation. At the present time, electrodynamics in a tokamak is described by the well-known classical Maxwell equations.[4] In article,[3] the mutual generation of force and non-force magnetic fields is formulated by V Aksenov[5] in strictly mathematical formulas, and the appearance of these fields is determined by the theorem on total electric currents in spherical regions. These points to the inaccuracy of research only magnetic fields and the need to study electric currents when calculating the electrodynamics of tokamaks.

Today in EAST tokamak Chinese Institute of Plasma Physics succeeded in a record time of plasma confinement during the 30s, and in the ITER project is necessary to achieve the following: at steady state Pfus = 0,4-0,5GWt and Q> 5 and to bring the length of the plasma confinement before 3000s. In the natural fusion reactor, such as the Sun, regularly observed coronary solar plasma emissions, which indicates the instability of a solar reactor. Such plasma emissions from a fusion reactor could lead to an environmental disaster (Figure 2).

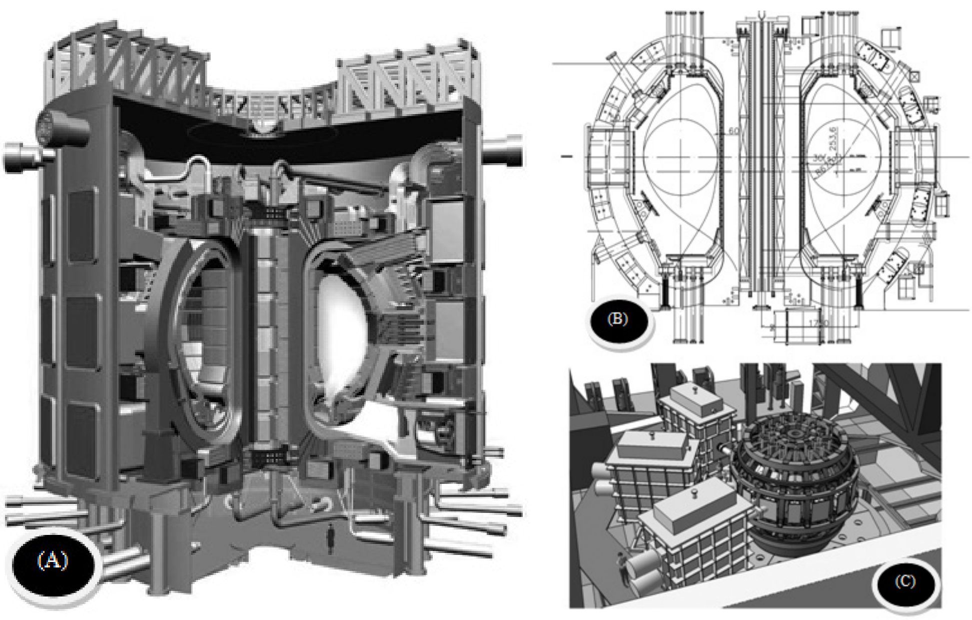

Figure 1 (A)Poloidal section of ITER reactor; To estimate the size of ITER in the lower part of the figure shows the silhouette of a man. (B) The cross section of placing the TM-15 tokamak (C) TM-15 tokamak in the experimental room.

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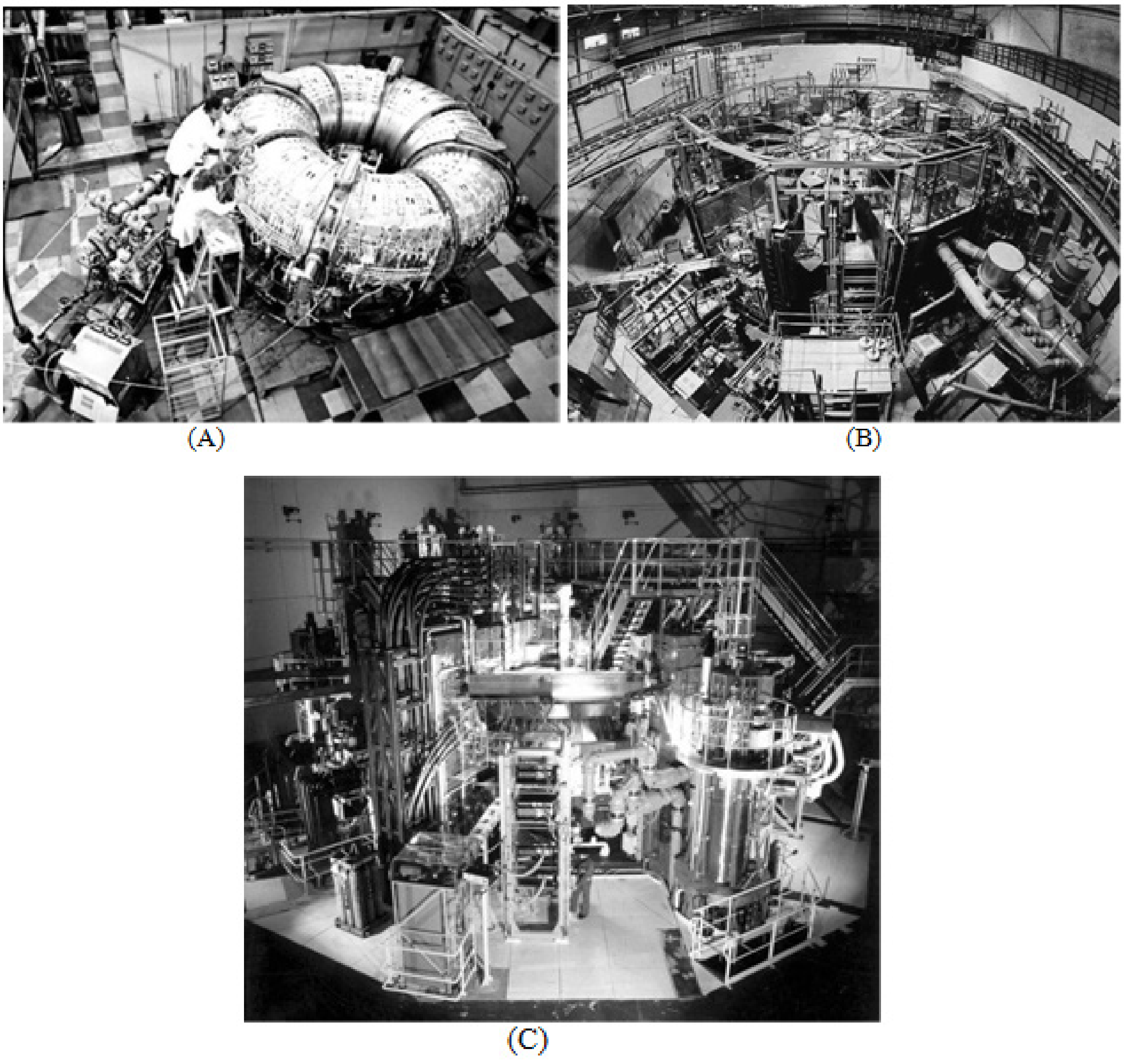

Figure 2 Tokamaks with superconducting coils: (A) the assembly of the superconducting coils of the tokamak T-7, (B) T-15, (C) ITER.

Experiments with controlled cold nuclear fusion

Stable controlled generation of alpha particles in the process of nuclear fusion reactions involving deuterium nuclei at room temperature in a heat wave field

By AA Kornilova et al.[5] samples of polycrystalline deuterated titanium with a grain size of not more than 50 microns were selected as the object of action of a heat wave. These samples had the shape of a cylinder about 1cm long and about 7mm in diameter. Stimulating high-frequency heat waves fell on this sample in the direction of the cylinder axis, i.e. perpendicular to the end surface.

From the experiments,[4] this can be as an initial source of variable local heating with a frequency of temperature change close to one of the optimal frequencies $\omega n = \pi(2n + 1/2)\tau$, $n = 0,1,2\ldots$ (such modulated heating can be realized, for example, by a modulated laser beam), and maybe source of short heating pulses, the duration of which $\Delta t \leq \tau$ does not exceed the time of thermodynamic relaxation. In the latter case, the spectrum of this pulse will contain the necessary spectral components. From the essence of the process of propagation and absorption of such a wave, it follows that the initial thermal (temperature) wave will be, in fact, a wave packet with a central frequency that coincides with ωn, and narrow band the frequency $\Delta\omega$, adjacent to this frequency. The width of this band is determined from the condition that heat waves with frequencies corresponding to the boundary of this interval also reach the place of registration with permissible absorption in a given medium (as a rule, attenuated not more than 2 times). When this packet hits the boundary with another medium (for example, the air – metal boundary), a very sharp short-term heating of this boundary occurs, which leads to excitation of a shock acoustic wave (in fact, a very short packet) inside the second medium (in the metal lattice), which distributed in it without noticeable weakening. When this shock wave reaches, for example, a potential well, where a hydrogen or deuterium atom is located, localized between two heavier atoms, the pulse modulation of the parameters of this well takes place - its very rapid compression and subsequent expansion. In cavitation experiments, effects associated with the generation of coherent X-rays, which can significantly influence the formation of undamped heat waves, were also discovered.[6] Another aspect relates to the features of the course of nuclear reactions in modulated potential wells. Such a deformation leads to the formation of coherent quantum correlated states of light nuclei (for example, a proton or deuteron) in this well. It was shown that in such a state there is a generation of very short amplitude fluctuations of the particle energy associated with the synchronization of vibrational states (resonance).[7,8] The amplitude of these fluctuations with a typical thermal energy of the crystal lattice at the level of 0.025eV can reach (and exceed) $\delta E = 30 \ldots 50 KeV$ which is sufficient for the implementation of effective nuclear fusion both between different deuterons and between this particular proton or deuteron and the nucleus of the lattice. This general scheme can be optimized if the lattice containing these particles is in a tense (quasistationary) state. In particular, at a sufficiently high degree of saturation of the metal hydride with hydrogen or deuterium, internal stresses appear in the latter, which can lead to cracking of the lattice and the formation of microcracks. In each act of formation of such a microcrack, the formation of coherent correlated states of deuterons in the volume of the formed crack also occurs. Since there can be a lot of such deuterons in the microcrack zone, the effect of the "opening" of such a microcrack can produce powerful impulses of particles and radiation accompanying nuclear reactions. However, such a micro cracking process is spontaneous, and the moments of opening of different microcracks are usually independent. At the same time, a very short shock wave generated by a heat wave leads to synchronization (and also stimulation) of the process of opening such microcracks and dramatically increases the efficiency of nuclear reactions. Similarly, the action of such waves can stimulate various phase transitions with a change in the local lattice topology, which can lead to the concomitant formation of coherent correlated states, accompanied by the generation of giant fluctuations of particle energies. One of the manifestations of such synchronized fluctuations is the generation of high-power X-ray pulses, which was discovered and investigated in numerous experiments.[6] The question of the type of nuclear reaction observed in these experiments,[5] as well as the type of particles detected by track detectors, is very important. It is well known that with high deuteron energy a high probability has two reactions:[5]

d + d = p + t + 4,03 MeV, (1 channel)

d + d = n + ^{3}He + 3,27 MэВ. (2 channel) (7)

Third possible reaction

d + d = ^{4}He + 23,8 MэВ (3 channel)

with a high energy of interacting particles has a very small probability.

The situation changes fundamentally at low deuteron energy. In this case, the process of interaction is determined not by the real energy of the particle (it is very small for the occurrence of such reactions between charged particles), but by the virtual energy formed as a result of the formation of coherent correlated states. In the most concentrated form, these states are characterized by modified uncertainty relations, called the Schrödinger-Robertson relations for momentum and coordinate. The fundamental difference between these relations from the well-known uncertainty relation of Heisenberg is the possibility of introducing an effective Planck constant, the value of which can be many orders of magnitude greater than the "standard" Planck constant ħ. In these relations, the value of r is the correlation coefficient, and the G-coefficient of correlation efficiency. It was shown that in the process of deformation of microcracks the value of G can reach very large values of G ≥ 10^3 ... 10^5.[5] In particular, when the deuteron is localized in the interatomic space typical for condensed media with a period a = 1,5Å (wherein $\delta q \leq 0{,}75\text{Å}$) the fluctuation of energy in the coherent correlated state with G = 10^4, exceeds the value δE (min) = 50KeV, which, even on this lower threshold, substantially exceeds the temperature planned for the tokamaks. It should be noted that the real amplitude of this fluctuation can significantly exceed δE (min). In such a correlated state, the reaction probability due to the specifics of using virtual energy may exceed the probability of "standard" reactions.[8] The very high degree of track identity suggests that in this experiment alpha particles of the ^{3}He and ^{4}He type were also recorded.

AA Kornilova[5] declare that these studies will continue, however, even at this stage it is obvious that the method of such remote stimulation of nuclear fusion opens up new opportunities and prospects for the implementation of controlled nuclear fusion. In this paper, we consider a method associated with the stimulation of such reactions with a controlled low-intensity effect on a polycrystalline solid-state target (deuterated titanium) containing deuterium. Such a stimulating factor is a high-frequency continuous heat wave generated and propagating in the air prior to contact with the target during cavitation of a water jet in a closed chamber.

Anomalous energy release by oscillating particles in the electromagnetic field from the standpoint of Leo Sapogin's Unitary Quantum Theory (UQT)

In 1922, Clarence Ayrion and Gerald Wendt of the chemical laboratory at the University of Chicago set up an experiment on the electrical explosion of a tungsten wire in a vacuum. During the experiment, they expected to achieve the decomposition of tungsten into lighter elements. The experiment, repeated 21 times, showed that as a result of an electric explosion of a tungsten wire, particles of helium-4 are formed in the flask. Rutherford became interested in this experiment, which doubted the results and decided to disprove them by irradiating a tungsten target with an electron beam. The experiment set by Rutherford was fundamentally different from that of Ayrion and Wendt (electron beam irradiation and electric explosion are two very different processes), so Rutherford grossly violated the scientific methodology, refuting the results of one experiment completely different. In his experiment, Rutherford did not detect nuclear reactions and sharply criticized the work of Ayrion and Wendt. This turned out to be enough for the study of nuclear reactions in the electrical discharge to be stopped for many years. Only after 80 years (!) The experience of Ayrion and Wendt was repeated by the research group of Professor L Urutskoyev.[9] At the experimental facility, called Helios, the Urutskoev[9] group reproduced the experiment on electric explosion of tungsten and fully confirmed the results using modern instruments. A relatively large isotope change (at the level of 5–7%) was detected during the explosion of wires and foils immersed in a liquid, through which submillisecond high current pulses with a total energy of 20–30kJ were passed. In addition to an excessive amount of helium-4, mass spectrometry analysis showed a deficit of the tungsten-180 isotope in comparison with the initial number of isotopes, which indicates a nuclear process.[9]

It turns out that Rutherford was wrong, rejecting the possibility of nuclear reactions during an electrical discharge. Just low-energy synthesis does not fit into the planetary picture of the world in which electrons are placed in elliptical orbits around the atomic nucleus. In reality, electrons in atoms in orbits do not fly. Rutherford proposed a planetary model that has nothing to do with reality, so there are a lot of experiments in physics that have no explanation. The electron inside the atom is not a particle flying in orbit, but most likely a standing electromagnetic wave that does not have orbits and coordinates, but a form of oscillation of a particle in an oscillator with a certain frequency and amplitude, which explains the observed phenomena much better.

L Sapogina's[10] Unitary Quantum Theory (UQT) describes elementary particles as wave packets of partial waves with linear dispersion. You can choose the dispersion so that the wave packet at its movement periodically spreads and gathers, and the envelope of this process coincides with the wave function. The most important results of new Unitary Quantum Theory approach is the emergence of a general field basis for the whole of physical science, since the operational description of physical phenomena inherent in standard relativistic quantum theory is so wholly unsatisfying. The particle was formally considered as a point in order to explain the wave function/probability amplitude. However, neither the point hypothesis, nor the Bohr's antiquated complementarity principle proved useful in understanding the structure of elementary particles and elaborating the quantum field theory within the accepted paradigm. The standard model (SM) even lacks a mass spectrum calculation algorithm for elementary particles. SM contains from 20 to 60 arbitrary adjustable parameters (there are different versions of SM) for calculating the mass of particles. LG Sapogin's Unitary Quantum Theory (UQT) allows for calculating the mass spectrum of all hitherto known or hypothetical elementary particles up to the Higgs Boson.[11] There are strong hard rules in the modern theoretical physics. Any new theory has to include classical. In UQT this is strictly satisfied because the Hamilton-Jacobi relativistic equation and Dirac equation follow from the UQT, i.e. all modern basics of the fundamental quantum science. Particle mass is replaced in the UQT equation system with the integral over the whole volume of the bilinear field combinations, yielding a system of 32 integral-differential equation. In this approximation of the UQT, the wave packet is realized as a spatial divided electric charge that oscillates, its equation depends on time, coordinate and velocity and it could work in the rough model of the particle as oscillated charge, so we can exploit the Newton equations. It is becoming easy to see the tunneling effect: while the moving particle is approaching to the potential barrier, in the phase when the charge is extremely small, it is easy for it to go through the barrier, and when the quantity of the charge is large, the repulsion force is increasing, and the particle will be reflected. By the way, by means of the UQT it is possible to get this equation from the Schrödinger's one with very low energies.[10] But there are though some interesting differences. The equations of motion of the oscillated charge were not treated in physics before and they have an important difference from the classical laws of motion - the invariance of the motion in the relation to invariance translations. It means the absence of the great classical momentum and energy conservation laws. They appear in the UQT and then in the classical mechanics only with an averaging for all particles. Paradoxically, in classical electrodynamics particle can move with a constant acceleration, generating energy from nowhere. It is known that in the case of charged particle movement in plane condenser with the constant tension to be applied classical uniformly accelerated motion $x = \alpha t^2$ appears. In the Unitary Quantum Theory professor L Sapogin[10] proposed the same solution for the equation with the oscillating charge. Let show that Schroedinger equation has physically similar solution also. Viz., let potential in Schroedinger equation be equal $U(x) = rx$. Then complete Schroedinger equation is as follows:

$$\frac{\hbar^2}{2m}\frac{d^2\Psi(x,t)}{dx^2} - rx\Psi(x,t) + i\hbar\frac{d\Psi(x,t)}{dt} = 0 \tag{8}$$

We will seek the solution in rather unusual form

$$\Psi(x,t) = b\exp\left(i\frac{m\alpha^2 t^3}{2\hbar} - i\frac{m\alpha t x}{\hbar}\right) \tag{9}$$

The strange form of the wave function (9) is determined by the fact that that the speed in the expressions for energy $\hbar ù = mv^2/2$ and momentum $\hbar k = mv$ in the formula (9) were replaced by $v = \alpha t$. Substituting (9) in (8) we get (after reducing):

$$-2m\alpha^2 t^2 = (m\alpha - r)x = 0 \tag{10}$$

Equality (10) is satisfied if we assume that the coordinate $x = At^2$, where the acceleration A is

$$A = 2\frac{m\alpha^2}{m\alpha - r} \tag{11}$$

If in (11) impose the requirement $r \to 0$ (potential vanishes), then absolutely strange particular solution appears where the particle is able to move with constant acceleration 2α and to generate energy no of an unknowns where origin. That effect remains valid even if impose the requirement $r \to 0$ (potential vanishes) directly in equation (8).[10]

Andrea Rossi's reactor E-Cat

Today the science world is agitated by E-Cat of Andrea Rossi. The reactor is a ceramic pipe, in which nickel powder is placed under pressure with hydrogen. When there is an electrical current system heats up and emits in 3-50 times more heat than it consumes. We are talking about a MegaWatt. Official scientific commissions have come to the conclusion that nuclear reactions cannot produce so much heat, although the isotopic composition of the nickel and changes, and self heat generation is quite mysterious, but it does not preclude the use of such facilities. Lev Sapogin et al.[12] offers an explanation of the thermal effect from the standpoint of its Unitary Quantum Theory (UQT). The UQT equation with the oscillating charge is essentially Newton's equation for the motion of a charge in an external potential, but the amount of the charge depends on the time, speed and location.[10] In solving the problem of the harmonic oscillator, in addition to conventional fixed-making there are two new solutions (Figure 1), which were named L Sapoginym "Crematorium" and "Maternity Home". In the first decision of the particle oscillates in a potential well with an exponential decrease of energy, and second decision, its energy increases (Figure 3).

Grains of Nickel (it could be grains or finest crystals) in E-cat have caverns with size of tens Angstroms (they work as potential wells); proton of adequate phase can penetrate inside a cavern. Heat is generated in these caverns under terms of ―Maternity Home‖ as the result of protons numerous knocks on cavern's walls Fig. 3. At present history with E-cat of Andrea Rossi looks the deafening slap in the face to whole modern science.[12] In 2014, Rossi provided his facility for independent 30-day tests, during which two different laboratories conducted an isotopic analysis of the initial substance (fuel) and the spent substance after the tests. The analysis showed that the initial statement about the transmutation of nickel into copper is not true. In practice, the installation of Rossi is the transmutation of nickel-58,60,61 to nickel-62, as well as lithium-6 to lithium-7. Independent tests showed that the heat dissipation in the Rossi unit during the 30-day test was 5.8GJ per 1gram of fuel. The power of energy release is about 2MW/kg, for comparison, the power output of the VVER-1000 is 111kW/l of the core or 0.035MW/kg of fuel. Thus, the energy release of TVEL in the Rossi facility is approximately 50 times more than that of modern nuclear reactors in TVEL, which is quite consistent with nuclear fusion reactions. The first generator, generating industrial steam with a temperature of 600°C, Rossi thinks to submit at the beginning of 2019 "to prove his rightness and confirm the expectations of partners and sponsors, as well as all supporters and enthusiasts of LENR" (conventional efficiency of such generators is expected to be at least 600%) . At the same time, he is developing a single-module reactor of the SK type ("Sven Kullinger") with a power of 1kW.

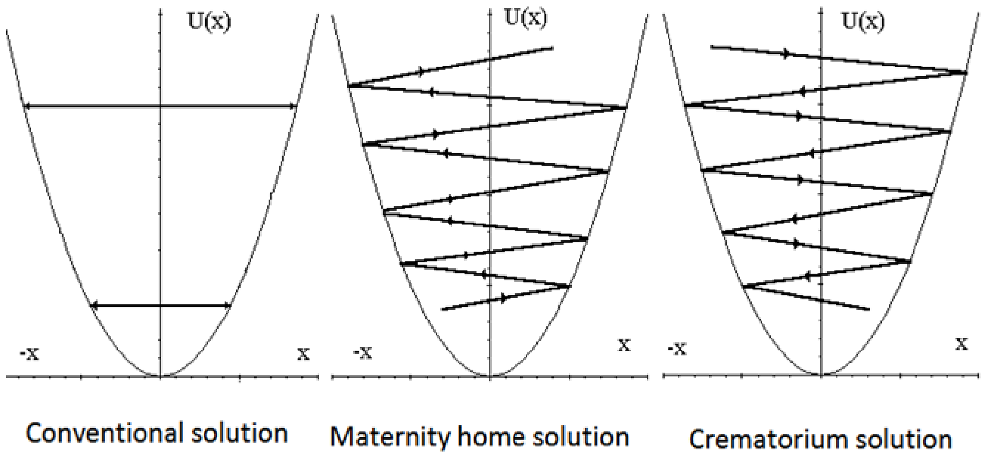

Figure 3 The solution of the harmonic oscillator problem.

The astonishing experimental results of A Samgin et al.[13] should be added (Russia) and of T Mizuno et al.[14] (Japan). They have used, apparently independently one from each other, some special proton-conductive ceramics that is able to generate the thermal energy thousands time more than energy electrical current runs through it. In some experiments of T Mizuno[14] that value exceeded 70000. However, no radiation or nuclear fragments were found, and nuclear processes are not responsible for such energy release. Such proton-conducting (if to speak quite accurately, deutero-conducting) ceramics were created by powder metallurgy by sintering at high temperature. In other words, all chemical processes in it have long passed. The origin of such a quantity of excess energy in the framework of ordinary science is absolutely incomprehensible, since this cannot be explained by either nuclear or chemical reactions or phase transitions. The authors of this experiment assumed that nuclear fusion reactions of the D+D type were underway. After releasing such a large amount of energy, the tablet disintegrates into powder.

To be fair, it should be noted that the first creator of the technology of "warm" nuclear fusion, which is so persistently preferred not to recall in the Russian Academy of Sciences, was engineer Ivan Stepanovich Filimonenko. In 1957, he created a "clean" thermionic installation (TEGEU) for the synthesis of helium from deuterium at a temperature of 1150°C.

The experiments carried out by Fleishman and Pons. patterson fuel element

In 1989, the electrochemists M Fleischman et al.[15] carried out the electrolysis of heavy water with a palladium wire helix. A large amount of heat has been detected. Realizing that chemical reactions on palladium cannot be responsible for such thermal effects, they reported that the D+D nuclear reactions took place in their experiments. The products of nuclear reactions, which they found in microscopic quantities they could not be responsible for the release of heat. Fleischman and Pons declared the fraudsters. In fact, the history of perception of cold fusion at the Massachusetts Institute of Technology is the history of the crying scientific fraud of those researchers who in 1989 tried to eliminate cold fusion as quickly as possible and have since received hundreds of millions of dollars from DOE for their research on hot fusion.

This was frankly told to the world by Eugene Mallov in his special report, who worked at the time at the Massachusetts Institute of Technology (MIT) News Service. In 1991, in protest, he left him after he learned of the machinations resorted to by the head of the MIT controlled nuclear fusion program to prevent studies on cold fusion in the United States and other countries. However, despite the persecution, cold nuclear fusion and LENR have again become the subject of increased interest in recent years not only for scientists, but also for governments of a number of countries and major companies. This is what the US National Defense Law for the 2017 Fiscal Year says: "The Committee is aware of recent positive developments in the development of low-energy nuclear reactions (LENR), which produce ultra-clean, inexpensive renewable energy that will have strong implications for national security. According to the Defense Intelligence Agency (DIA), if LENR works, it will be a destructive technology that can revolutionize the production and storage of energy."

The CETI thermal element created by James Patterson,[16] USA, in which electrolysis of specially made nickel balls in ordinary water occurs, will strike any imagination. The American newspaper Fortean Times No. 85, 1995, wrote about this: "On December 4, 1995, it will go down in history. On this day, a group of independent experts from 5 American universities experienced the work of a new energy source with a steady thermal output of 1.3kW. The consumed electrical energy was 960 times less." All experts note that the heat released has a mysterious nature of origin and cannot be explained by chemical or nuclear reactions, as well as phase transitions. According to Patterson himself, everything that happens in an element is related to nuclear reactions.

Generation of excess energy during charger cluster acceleration

In 1969-1971, being a post-graduate student of the Russian State Pedagogical University, St. Petersburg, Department of Physical Electronics I dealt with the phenomenon of secondary electron emission. During the work I paid attention discovered the effect of unexplained energy growth of clusters of secondary electrons. The composition of my vacuum installation for the investigation of secondary electron emission included:

i. The spherical condenser was a glass flask 0.4 m in diameter with a metal layer applied to the flask wall connected to electrodes soldered to the walls of the flask. Inside the flask, a deep vacuum was created with the aid of vacuum pumps;

ii. A metal target placed in the center of the sphere;

iii. An electron gun capable of generating primary electrons by heating a spiral, focusing them into a narrow beam and directing it to a target, giving them a predetermined energy (relativistic velocity).

Secondary electrons were generated by impact and deceleration of primary electrons in the target and recorded on the inner walls of a spherical capacitor. Between the target and the metal layer on the walls of the spherical capacitor, a predetermined potential difference was established. The Studies of secondary electron emission were carried out under conditions of deep vacuum.

In the case of secondary emission, the electrons emitted from the target have are approximately evenly distributed initial phase, since secondary current caused by electrons having a kinetic energy larger than the height of the potential barrier (output work). The existence of a large number of electrons with the same phase facilitates the formation of clusters. It should be noted that the emergence of excess energy clusters and their discovery due to the fact that in contrast to the increase in the energy of a single electron, clusters of electrons experimental easier to register growth of energy and reliably separate them from the primary electrons. These clusters acquire during acceleration an energy that in tens of times the calculated value of the energy of charge for a given potential difference.

A similar effect of excess energy generation during the acceleration of charged clusters, which appears on pointed cathodes with large currents of autoelectronic emission. The first research in this sphere was started by Kenneth Shoulderg.[17] In Russia, these studies were conducted by Academician G.A. Month in 1966. These researchers discovered two extremely interesting facts:

i. Electron current is generated by sufficiently stable electron clusters consisting of 10^{11} electrons with a size of the order of 20 microns.

ii. These clusters acquire during acceleration an energy, which exceeds by 30 and more times the value possible when the charge passes the used potential difference.

iii. These phenomena (especially the second one) are absolutely incomprehensible from the point of view of the ordinary physics.

Charge clusters are the key to understanding the processes that open the way to new energy. It is in them that Low Energy Nuclear Reactions (LENR), low-energy nuclear reactions take place, accompanied by the release of energy and the transmutation of atomic nuclei of chemical elements. Flow during the life of the cluster and especially rapidly during its decay.

Cold nuclear fusion, tunnel effect and nuclear transmutation

Nuclear fusion occurs when a charged particle overcomes the repulsive Coulomb barrier and enters the region of nuclear attraction forces. To implement tunneling, the particle must approach the potential barrier in the phase when the amplitude of the wave packet is small, and the particle in the absence of charge overcomes the barrier, "not noticing" it. In another phase, when the amplitude of the wave packet is large, non-linear interaction begins, and the particle can be reflected from the barrier. From the point of view of unitary quantum theory (UQT), Professor L Sapogina,[10] the motion of electrons in tunnel junctions can occur even at very low temperatures. The cold nuclear fusion experimental data are extremely numerous and various, but I am going to dwell on the most important and fixed results. Thus at classical electrolysis study of the palladium cathode saturated with deuterium there is enormously great heat generation in heavy water: up to $3kW/cm^3$ or up to 200MJ in a small sample. There were also detected fusion products: tritium (10^7-10^9t/sec), neutrons with the energy equal to 2,5 MeV (10-100n/sec), helium. The absence in the products of the reaction alpha particles ^3He shows that heat does not the result from the reaction d+p. More over one can observe the emanation of charger particle (p,d,t,γ). We can study similar processes at gas discharge over palladium cathode, at change of phase in various crystals saturated with deuterium, at radiation treatment of deuterium mixture by strong sonic or ultrasonic flux, in cavitations micro-bubles in heavy water, in a tube with palladium powder saturated with deuterium under the pressure of 10-15 standard atmospheres and others. Common to all these processes is the lack of products of nuclear reactions to explain the resulting thermal effects.

The deeply studied interaction d+d proceeds along three channels:[10]

$$D + D \rightarrow T(1,01) + p(3,03), \quad \text{(1 channel)}$$
$$D + D \rightarrow He(0,82) + n(2,45) \quad \text{(2 channel)} \quad (12)$$
$$D + D \rightarrow He + \gamma(5,5) \quad \text{(3 channel)}$$

All these reactions are exothermic. The third channel has a very small probability. It was established experimentally that reactions can occur at arbitrarily small energies. In the D_2 molecule, the equilibrium distance between the atoms of 0.74Å and in quantum theory these two deuterons could accidentally enter into a nuclear fusion reaction, but the magnitude of the interaction is very small. There is an estimate: in the water of all seas and oceans there are 10^{43} deuterons, and in 10^{14} years only one such reaction will occur. It can be seen from the above that the main reason preventing the implementation of the d+d reaction is the presence of an extremely high Coulomb barrier. So in the experiments of M. Fleischman and S. Pons, the energy of deuterons in a conventional electrolytic cell of Fleischman-Pons is about 0.025 eV, and the height of the Coulomb barrier for this case is 0.8MeV. In classical and quantum mechanics, overcoming such a barrier with a height of tens of millions of times greater than the kinetic energy of a particle is simply not possible. This circumstance allows official nuclear physics to assume that there is no cold nuclear fusion in nature. However, the presence of the tunnel effect and a large number of experiments accumulated in physics suggest the controlled cold nuclear fusion exists.

It was discovered long ago that nuclear transmutations are widely spread (it is especially evident for plants and biological objects), but they are faintly connected with energy liberation. The examples of such reactions are:

$$\begin{aligned} Mn^{55} + p &\rightarrow Fe^{56} \\ Al^{27} + p &\rightarrow Si^{28} \\ P^{31} + p &\rightarrow S^{32} \\ K^{39} + p &\rightarrow Ca^{40} \end{aligned} \quad (13)$$

In reactions of such a type very slow proton (its kinetic energy is equal practically to zero) is penetrating inside the nucleus by the abovementioned way and stays there. There is no nuclear energy liberation, because the nucleus remains stable both before and after reaction. In accordance with classical nuclear physics, the nucleus, as usual, after a charged proton with great kinetic energy gets inside it, becomes unstable and breaks to pieces, and its fragments obtain bigger kinetic energy. The reactions of above-mentioned type were considered impossible at all at small energies and therefore were not studied in the classical nuclear physics. Apparently, that is absolutely new type of nuclear transmutations unacknowledged by modern nuclear science, but experimentally discovered sufficiently long ago. Today there are a lot of experimental data confirming the mass character of nuclear transmutation.[10] Moreover there are many projects of nuclear waste neutralization that use this method. Another thing is that in the new physical theories the nature of the tunnel effect is explained from different positions. In the L Sapogina's Unitary Quantum Theory (UQT),[10] during tunneling, a particle should approach the potential barrier in the phase when the amplitude of the wave packet is small, and the particle in the absence of charge overcomes the barrier, "not noticing" it. The author of another theory of the tunnel effect, Professor VI Vysotsky[8], states that when a shock wave reaches a potential well, where a hydrogen or deuterium atom is located between two heavier atoms, there is a pulse modulation of the parameters of this well - it's very fast compression and subsequent expansion. Such a deformation leads to the formation of coherent quantum correlated states of light nuclei (for example, a proton or deuteron) in this well, and in such a state there is a generation of very large short-term fluctuations of the particle energy associated with the synchronization of vibrational states (resonance). In the experiments of Professor VI Vysotsky[8] when exposed to a deuterium gas with a pulsed magnetic field with an amplitude of $10\,k\ni$ and a leading edge duration of $2 \bullet 10^{-7}s$, the probability of a tunnel effect at dd interactions and a temperature of 300-500K increases from $D_r \approx 10^{-80}$ to $D_r \approx 0.1$. This dd-interaction process can be implemented in a gas with a particle density of $n \leq 10^{17}cm^{-3}$.

Conclusion

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 in the microwave range from 10GHz to 33GHz 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 2.7K. From the point of view of the unitary quantum theory (UQT) of L Sapogin et al.[10] the motion of electrons in tunnel junctions can occur even very low temperatures. This is confirmed by the experiments of American scientists who managed to establish tunnel effects near the absolute zero of temperature (in liquid helium).[18] On the basis of the UQT Sapogin equation, it is possible to determine optimal conditions for the implementation of cold controlled nuclear fusion processes at sufficiently low temperatures. The future of systems of truly controlled nuclear fusion will lie not on the primitive path of heating and compression, but on the path of collisions of nuclei with low energies, but with fine adjustment. The choice must be made by man.

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Conflict of interest

Authors declare there is no conflict of interest.

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