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Magnetic Fields And High-Temperature Superconductivity In Excited Liquids. Unknown Particles

Gennady V. Mishinsky

Joint Institute for Nuclear Research, http://www.jinr.ru/

Dubna 141980, Moscow Region, Russian Federation

E-mail: mysh@jinr.ru

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Abstract: **The article presents a number of experiments in liquid media on the transformation (transmutation) of atomic nuclei of some chemical elements into atomic nuclei of other chemical elements. In the theory of low-energy nuclear reactions, the transmutation of atomic nuclei occurs in strong magnetic fields, more than 30 T. Magnetic fields appear in ionized liquid media as a result of the unidirectional motion of an ensemble of electrons. The exchange interaction between electrons with parallel spins forms a self-consistent field in the medium, in which electrons pair into orthobosons with S = 1ħ. Orthobosons are attracted to each other and form orthoboson "solenoids" - "capsules" with strong magnetic fields inside. "Capsules" can fly out of liquid media, and then they are registered as unknown particles with strange properties. In some cases, when an electric current passes through the liquid, the electric current can be realized in the form of orthobosonic "solenoids" connected in continuous "filaments" from one electrode to another. Such "filaments" exhibit characteristics of superconductivity.**

Keywords: **low-energy nuclear reactions, exchange interaction, quantum fluids, low-temperature plasma, electron pairing, strong magnetic fields, high-temperature superconductivity, unknown particles**

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Contents

1. INTRODUCTION

"Impossible" radiationless and low-energy nuclear reactions were discovered at the end of the last century, in 1989-1992: cold nuclear fusion reactions and low-energy transmutation reactions [1-3].

It turned out that nuclear reactions with the transformation of some chemical elements into other chemical elements can occur in weakly excited condensed matter with a low, only ~ 1 eV/atom, excitation energy in the reaction region. This phenomenon has received the name: low-energy transmutation of chemical elements (hereinafter- transmutation). The methods of experiments on the transmutation are extremely diverse and fundamentally different from the methods of nuclear physics. Transmutation reactions were discovered and subsequently reproduced in a glowing gas discharge [4-6]; in

industrial electronic zone melting of zirconium ingots in a vacuum furnace [7]; during explosions of metal targets irradiated by a powerful pulse of electrons [8,9]; during explosions in liquid dielectric media of metal foils, through which a powerful pulse of electric current was passed [10,11]; when exposed to a pulsed current on a melt of lead with copper [12]; during the passage of electric current in water-mineral media [3]; during ultrasonic treatment of aqueous saline solutions [13]; when irradiating condensed gases with braking gamma quanta [14-16]; in growing biological structures [17-19] and in many others [1-3]. The results of transmutation experiments, despite their variety, are qualitatively similar to each other.

Transmutation reactions are carried out for all chemical elements, starting with hydrogen, and they usually occur with the participation of a large number of atomic nuclei. Transmutation reactions include both fusion and decay of nuclei. Experiments show that practically all chemical elements can be synthesized in transmutation reactions: from hydrogen and, so far, to actinium [15]. In this case, the reaction products, which are isotopes of chemical elements are obtained as stable isotopes, i.e. non-radioactive isotopes.

The synthesis of chemical elements with a nuclear charge Z greater than that of iron nuclei ($Z = 26$) led to the conclusion that multinuclear reactions take place in transmutation reactions. Multinuclear transmutation reactions must be introduced to explain the production of heavy chemical elements in a medium consisting of light elements in many experiments. Such heavy elements cannot be obtained in paired reactions that occur between light elements of the medium.

Transmutation reactions occur only as a result of external influence on the condensed matter. In most experiments, transmutation reactions occur due to action of electrons on the medium by means of powerful pulses of electrons or powerful currents. So, for example, the book [3] "discusses the transformation of some chemical elements into others under electromagnetic influences. Five methods of exposure are shown that give qualitatively similar results. The transformation processes are accompanied by energy release. The general nature of the impact by various ways is associated with large pulse currents and pulse fields. Basically, there are two types of media that are exposed: metal melts and aqueous media".

The above considerations and numerous experiments show that transmutation reactions take place in liquids, in solutions, in melts and in gases under high pressure, i.e. on free atoms, the density of which is close to the density of a solid state, and during the passage of directed flows of electrons through these media.

The theory that explains transmutation reactions is connected, firstly, with the discovery of the fundamental resonant interference exchange interaction. RIEX-interaction occurs between nuclei that have common resonance states [20,21]. Such nuclei form nuclear molecules, including multinuclear molecules. Strong-weak, electromagnetic and inertial-gravitational interactions are realized simultaneously in RIEX-interactions between nuclei. And, secondly, the theory of transmutation is associated with the creation of the theory of pairing of atomic electrons into orthobosons with a total spin equal to one $S = 1\hbar$. This pairing of electrons occurs in strong magnetic fields > 30 T. Orthobosons form electron Bose-Einstein condensate in the atom. Such atoms are called Transatoms. Transatoms have external and internal ultra-strong magnetic fields. Internal magnetic fields that interact with the orbital and spin magnetic moments of nucleons in nuclei, transform them into Transnuclei. External magnetic fields allow transatoms to be attracted to each other. When transatoms approach each other, their electronic Bose-Einstein condensates are combined into one, common Bose-Einstein condensate and, thus, form binuclear, and then, multinuclear molecules.

Atomic electrons, in a strong magnetic field, inevitably pair into orthobosons. Atoms transform into Transatoms. Transatoms automatically enter into low-energy transmutation reactions.

The question arises, how strong magnetic fields are created in a condensed matter? This paper makes an assumption about the mechanism that creates such magnetic fields.

2. TRANSMUTATION OF CHEMICAL ELEMENTS

First, we present several experiments on low-energy transmutation of chemical elements in order the readers can get acquainted with it.

2.1. Transmutation of elements in electric discharge

Work on the transmutation of elements in an electric discharge in liquid media was carried out by A.V. Vachaev and N.I. Ivanov [3]. The installation consisted of two tubular electrodes with an inner diameter of 6 to 50 mm located opposite each other at a distance of 1–1.5 mm of their diameter. Between the electrodes, inside which the liquid moved, a specific electric discharge was created, and plasma appeared. The electrodes were inside a coil that creates a magnetic field. The plasma was ignited by a pulsed discharge of additional electrodes located across the liquid jet between the tubular electrodes. The plasma between the tubular electrodes was an electrically conductive film that formed a multidimensional figure of the type of revolution hyperboloid with a pinch 0.1–0.2 mm in diameter. The discharge proceeded almost noiselessly with a minimum release of heat and gas phase. The magnitude of the current that passed through the tubular electrodes varied within 0.1-100 A, but the current was 20-40 A in most cases.

As a result of the work of the installation, a stable process of transformation of the initial material of the medium into new elements and their compounds, in the gaseous, liquid (dissolved in the medium) and solid state, arose in it. All works were carried out in a mode with a maximum solid phase yield, up to 300 g/L on the average. The installation was able to work for many days. In the experiments, various liquid media were supplied to the inlet of the installation: water (distilled, drinking, river water), water-mineral mixtures, effluents from various production facilities, water-carbon, organic mixtures. **Fig. 1** shows, by way of example, the yields of "extraneous" elements for the cases of distilled water treatment (Fig. 1a) and domestic wastewater treatment (Fig. 1b).

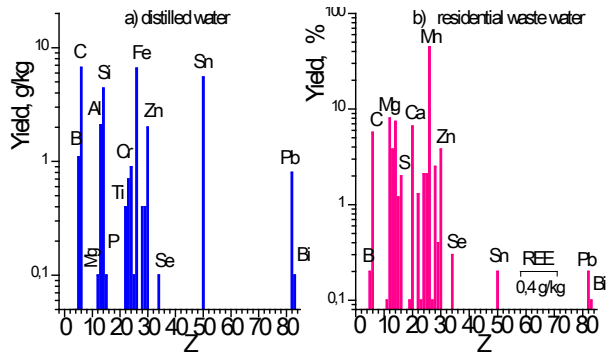

Fig. 1. *Elements yield at processing in electric discharge a) of distilled water, b) of residential waste water. REE – rare earth elements.*

2.2. Experiments on melting zirconium with an electron beam

The paper by M.I. Solin [7] describes the results of experiments on zone melting of zirconium ingots by an electron beam. The experiments were carried out in industrial vacuum furnaces with heating of the ingot by means of an electron beam. The accelerating voltage in the electron gun was maintained at a level of 30 keV. The density of the power supplied to the surface of liquid zirconium was 0.38 - 0.4 kW/cm^2.

After melting, microstructures or, as the author calls them, nugget products, were discovered in the zirconium ingot. The elemental composition of those nugget products significantly differed from the initial material. The minimum size of microstructures was 0.1–1 μm. **Fig. 2***a* shows a typical mass spectrum of zirconium blanks, and Fig. 2*b* shows mass spectrum of the nugget product formed in the ingot. As can be seen, Li, Be, B, Ba and rare earth metals - elements that

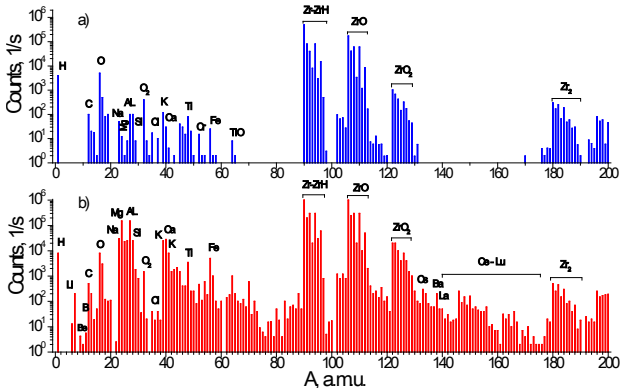

Fig. 2. *a) mass-spectrum of zirconium ingot prior to electron melting, b) mass-spectrum of nugget product.*

were absent in the original ingot - were formed in the nugget product. In addition, the content of elements such as Na, Mg, Al, Si, K, Ca, Ti, Cr, Mn, Fe was increased by 2-3 orders of magnitude in the nugget. The content of these elements in individual nuggets ranged from 2 to 45 weight percent. By means of *X*-ray microanalysis and Auger spectroscopy, a high content of carbon, nitrogen and oxygen was found in nuggets.

In the experiments, a significant increase in the melting rate of zirconium by a factor of 6-8 was noted with a constant input energy of the electron beam, and for some modes of heating the ingot, the rate of its melting would increase by a factor of 50. Thus, the melting process was accompanied by significant energy release. The author points out that the mass of the metal is a critical parameter for the onset of anomalous processes.

2.3. Ultrasound element transmutation

The works of A.F. Kladov [13] noted the transmutation of atomic nuclei of chemical compounds in the process of ultrasonic treatment of their aqueous solutions. The experimental installation was a hydrodynamic rotor-type generator of ultrasonic vibrations. The main parameters of the installation are as follows: sound intensity $>10^6$ W/m^2, frequency (fundamental tone) – $5.9 \cdot 10^3$ Hz, operating pressure in the activator – 10^6 Pa, working volume – 6.3 liters, active zone volume – 0.25 liters.

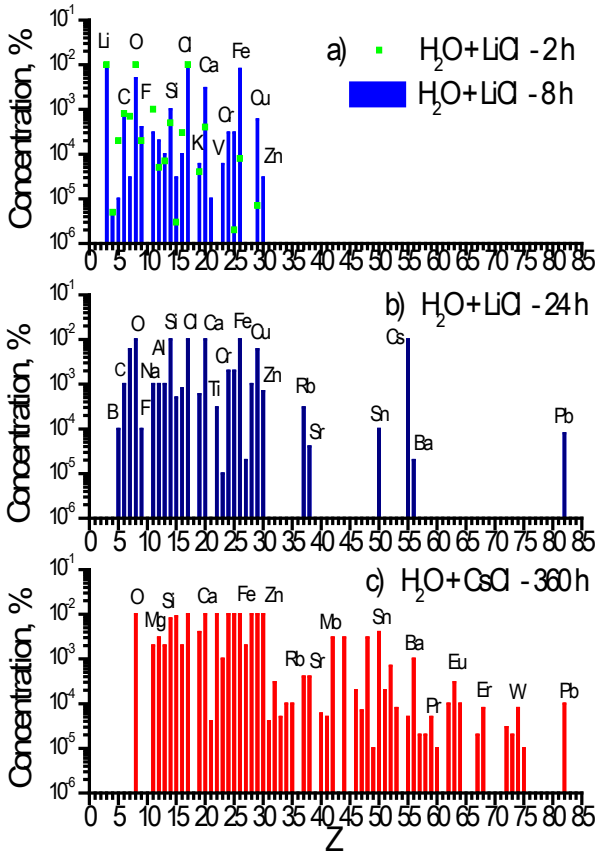

Fig. 3. *a), b) Element composition of LiCl-solution after 2-hour, 8- hour and 24-hour ultrasound activation, c) element composition of CsCl -solution after 360-hour ultrasound activation.*

The author worked with stable and radioactive isotopes. **Fig. 3** shows the spectra of the elements obtained at different times of treatment of solutions of LiCl and CsCl salts. The LiCl solution was treated for 2, 8, 24 hours, and the CsCl solution – for 360 hours. The histograms show that over time, the amount of "extraneous" elements in the solution increases - from boron to lead (Fig. 3*a-c*). Unfortunately, the author did not give, in his paper, the elemental composition of a solution of LiCl and CsCl salts before ultrasonic activation. However, an indirect assessment of the intensity of the appearance of foreign elements can be made by comparing the spectra of LiCl after 2 and 24 hours of treatment.

The paper also describes experiments with radioactive isotopes: ^{60}Co, ^{137}Cs, ^{40}K, ^{126}Sn, ^{188}Pt, ^{197}Hg. It turned out that during the operation of the installation, the number of radioactive

nuclei changes, i.e. there is a transformation of radioactive isotopes into stable isotopes. Also, A. Kladov discovered a significant, twofold, decrease in the activity of the plutonium-beryllium neutron source after the activator was in operation. The source was located at a distance of 2.4 m from the activator. The correctness of the measurements has been confirmed by repeated checks.

During the operation of the installation, the volume of the solution decreased with the guaranteed tightness of the activator. The average rate of solution decrease was 28 ml/hour. This fact means that water molecules are involved in transmutation reactions.

A. Kladov believes that the main operating factor in the presented technological process is cavitation.

2.4. Exposure of gases to braking gamma radiation

In the experiments of A.Yu. Didyk, R. Wisnievsky and others [14-16], high-pressure gases hydrogen, deuterium, helium and xenon were irradiated with braking gamma quanta with a maximum energy of 10 MeV for tens of hours. After irradiation, solid-state micro-objects in the form of crystalline and amorphous microparticles, filaments, nodules and inclusions were found on the inner surfaces of the reaction chambers. The sizes of microobjects were from 0.5 μm to 1 mm. Studies of the elemental composition of the revealed structures, carried out using X-ray microprobe analysis, showed the presence of chemical elements in them that were absent in the reaction chambers before irradiation. Chemical elements were recorded in the range from carbon to actinium (Z = 89).

The most impressive result in the experiment on the irradiation of helium at a pressure of 1.1 kbar for 28 hours was the detection of thin, cylindrical, black foils of considerable size in the inner part of the chamber (**Fig. 4**) [14]. The internal dimensions of the chamber were 15 mm long, 8 mm in diameter, and 0.75 cm^2

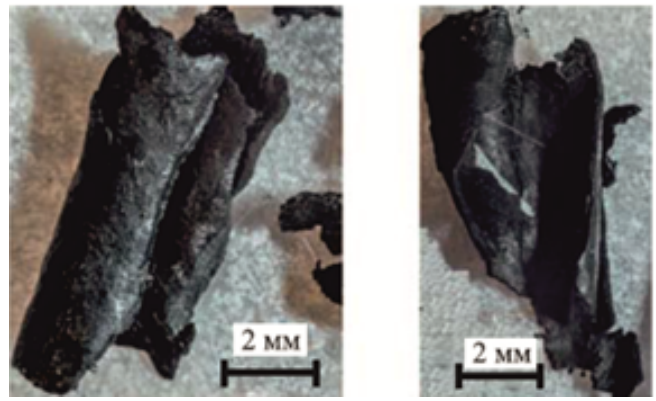

Fig. 4. *Pictures of black foils.*

in volume. The foils consisted predominantly of carbon and left oily marks on the paper. The latter indicates the presence of liquid oils on the foils in the form of hydrocarbons and synthesis of hydrogen. **Fig. 5** shows the total elemental composition of foils and other solid-state microparticles formed as a result of irradiation, averaged over 11 measurements [15].

In three experiments on braking gamma quanta irradiation of xenon $_{54}$Xe at pressures of 250, 270, and 550 bar and with a duration of 60–70 hours, reaction chambers with an inner diameter of 1 cm, a length of 5.8 cm, and a volume of 4.5 см^3 were used [15]. As a result of irradiation in all three experiments, after their completion, newly formed objects were found in the chambers: microparticles with a size of 0.5 μm to 1 mm, and anomalous solid-state structures on the walls of the reaction chambers. The resulting objects mainly contained "extraneous" elements

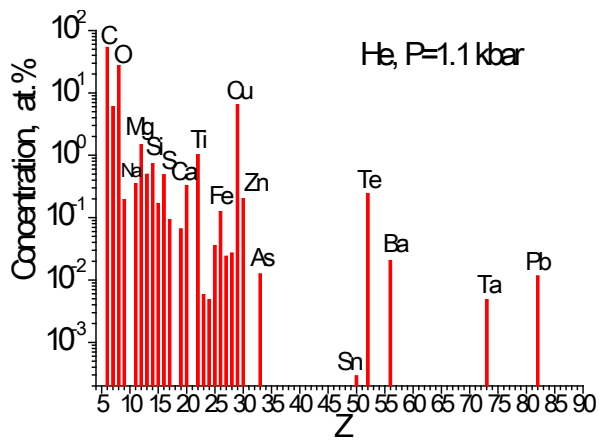

Fig. 5. *The concentrations of elements for experiment with He, P = 1.1 kbar.*

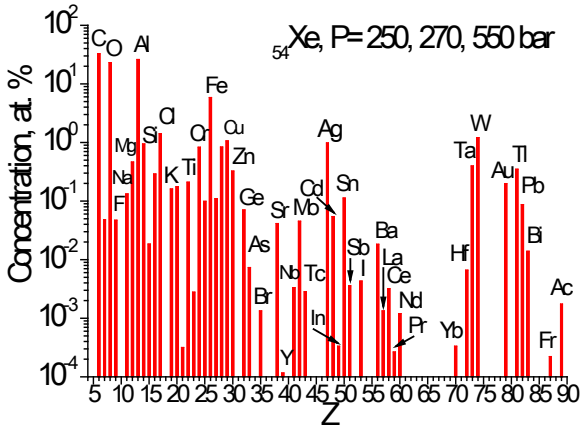

Fig. 6. *The concentrations of chemical elements for three experiments with Xe.*

ranging from carbon to bismuth. Elements were registered in the experiments that do not have stable isotopes: technetium, francium, actinium. **Fig. 6** shows the concentrations of chemical elements averaged over three experiments P = 250, 270, 550 bar. 289 measurements were used in this distribution. Based on the totality of the data of these experiments, it can be argued that "practically all elements" of the Periodic Table are synthesized in xenon as a result of prolonged exposure of condensed xenon to braking gamma quanta.

The first two experiments in the presented experiments on transmutation are associated with electronic action on liquid media: electric current and electron beam. Transmutation in the third experiment is caused by the collapse of cavitation bubbles, in which electrons in the near-surface layer move towards the centers of the bubbles. The directional movement of electrons in experiments with high-pressure gases is created by unidirectional gamma quanta that ionize the gases.

The production of graphite foils in weighed amounts in the experiment with helium **2.4** is explained by the production of orthohelium atoms. Orthohelium is obtained as a result of ionization, by gamma radiation, of gas atoms with subsequent recombination of their ions [22]. The orthohelium atom, in which electron spins and, accordingly, their magnetic moments are parallel to each other, has magnetic fields: ~ 400 T at the center of the atom, in the region of the nucleus and ~70 T at its diameter ~$1.75 \cdot 10^{-10}$ m. Therefore, orthohelium atoms are attracted to each other, combine and create multinuclear molecules, in which transmutation reactions take place.

The production, in experiment **2.1**, of a huge amount of "extraneous" chemical elements up to 300 g/L during the treatment of liquid media in an electric discharge, is associated with the creation of a continuous specific electron current, through which a liquid flow inevitably flows. It is obvious that it is in the plasma film of a specific electric discharge that low-energy transmutation reactions take place. A strong magnetic field is formed inside the discharge film, and that field creates conditions for these reactions.

In experiments: with zone melting of zirconium, with ultrasonic cavitation and with gamma quanta irradiation of xenon, no gram amounts of "extraneous" chemical elements in transmutation products were registered. This is due to the fact that transmutation processes occur in local areas of condensed matter in these experiments. An important feature of these local areas is the presence of strong magnetic fields inside them.

3. ELECTRONS IN EXCITED LIQUIDS

By liquids, we will also mean metal melts and gases at a pressure of ~1 kbar in this paper.

Since in most experiments the transmutation reactions are carried out not in the entire volume of the excited matter, it is logical to assume that some local regions –"capsules" are formed in the matter, which contain a large number of atoms and in which transmutation reactions take place. In addition, the large variety of physical experiments on transmutation requires the existence of some one-type object, characteristic of all these experiments. Such an object of the same type is a "capsule". "Capsules", according to the author, are plasma formations with a strong electromagnetic field inside. Since the diameters

of atoms are in the range (0.1-0.4) nm, and the distances between them in liquids, in melts and in gases at a pressure of ~1 kbar are ~ (0.3-0.5) nm, then, to accommodate several atoms in such "capsules", simple geometric considerations should give their minimum linear dimensions ~1-2 nm.

Numerous experiments have shown that transmutation reactions are carried out from room temperature of a condensed matter [23] to temperatures of ~2000°C. One of the characteristic temperatures favorable for triggering transmutation reactions is the temperature range of 300-400°C. Nanoclusters with a diameter of 6-7 nm are formed near metal surfaces at such temperatures [24]. Such nanocluster size makes it possible to achieve 300% of the concentration of hydrogen or deuterium atoms per cluster atom [25]. This concentration allows us to start cold fusion reactions. I.S. Filimonenko created a hydrolysis installation designed to generate energy in the reaction of "warm" nuclear fusion of helium from deuterium, which works at a temperature of 1150°C [26]. A. Smits and A. Karssen obtained mercury by passing an electric current through thoroughly purified molten lead at a temperature of T = 800°C [27]. V.A.Krivitsky also carried out transmutation reactions, when passing a pulsed current of ~ 7.5 kA through the melt of metals: Pb, Cu and Na_2O, at a temperature of T = 1100°C [12]. A. Rossi [28] and A.G. Parkhomov reactors of [29] operate at temperatures of 1200-1400°C and even at a temperature of 1800°C. Cold fusion reactions were carried out in their reactors followed by the launch of low-energy transmutation reactions.

The average electron energy at room temperature 300 K is 0.025 eV, and it is 0.2 eV at 2300 K. Correspondingly, the de Broglie wavelength $\lambda = h/p$ (p is electron momentum) for the specified temperature range varies from 7.8 nm to 2.7 nm. Correlations can arise between electrons at such distances. Correlations between electrons can also be realized along their coherence length.

The de Broglie wavelength of electrons at a temperature of T ~3 K has a value of ~80 nm, while it is known from the theory of superconductivity that the "size" of a Cooper pair or coherence length is ξ ~2000 nm, $\xi \sim \hbar p_F / m_e k T$, where $p_F = \sqrt{2 m_e \varepsilon_F}$ – the Fermi momentum, ε_F is Fermi energy, k is the Boltzmann constant, m_e is the electron mass. At a temperature T~2300 K, the coherence length for electrons will be ξ~3 nm, which is commensurate with their de Broglie wavelength. The coherence length can be increased by changing the effective Fermi energy $\varepsilon_F^* = \frac{\hbar^2}{2m_e}\left(3\pi^2 \frac{N}{V}\right)^{2/3}$. To do this, it is necessary to increase the density of free electrons by increasing the density of electron current j = $e\rho v$, where V is the volume of the metal, N is the total number of free electrons in it, e is the electron charge, ρ is the density of free electrons, v is the speed of their directed motion.

Correlation between electrons (or other objects) arises from an additional interaction. This interaction does always exist between electrons, but it can be suppressed. Additional interaction begins to manifest itself only when certain conditions are created.

The electron-phonon interaction in metals at extremely low temperatures, at several degrees Kelvin begins to manifest itself, and it transforms metals into a state of superconductivity [30]. In a pairwise electronic interaction that occurs through phonon exchange, electrons are attracted to each other. In the case when their total momentum is equal to zero $\mathbf{P}_{1e} = -\mathbf{P}_{2e}$, correlated electrons pair and form a Cooper pair with oppositely directed spins $S = 0\hbar$.

Electrons are attracted to each other in an atom that is in a strong magnetic field. This attraction is provided by an additional exchange Coulomb interaction when the electron spins are parallel [31]. Exchange interaction appears between identical particles when their wave functions overlap. The more the wave functions

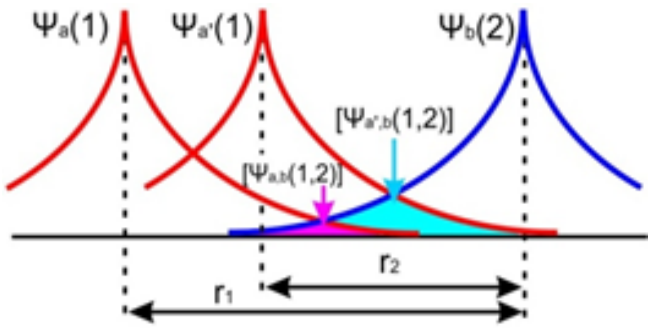

Fig. 7. *Overlap of wave functions of identical particles.*

of identical particles overlap, the greater is the exchange interaction (**Fig. 7**). Due to the exchange interaction, atomic electrons combine into orthobosons – into pairs with $S = 1\hbar$. The fulfillment of the Pauli principle and the equality to zero of the total momentum of electrons in the orthoboson are ensured by the appearance of oscillations of electrons around their orbitals. Electrons in the orthoboson oscillate in antiphase, $\mathbf{P}_{1e} = -\mathbf{P}_{2e}$ [32].

Most transmutation experiments occur, as already mentioned in the introduction, due to the electronic impact on condensed matter with a high electron density: with the help of powerful pulses of electrons or powerful currents. Condensed matter, weakly excited for transmutation reactions, are ionized liquid matter in which, to create strong magnetic fields,

- firstly, there are free electrons and ions not bound into atoms, in sufficient quantities, with a density of $\varrho \geq 10^{21}$ cm^{-3};
- secondly, all or most of the electrons move in liquid matter in the same direction. These electrons make up an ensemble of electrons of volume *W*.

It is known that the directed motion of electrons creates a magnetic field both due to the transfer of electric charges of electrons e− and due to the transfer of their magnetic moments μ_e. The magnetic moments of electrons, which move in one direction, are directed, due to the property of helicity, in one direction, in the direction of their momenta. The spins of electrons are directed against the momenta - they have a left-handed helicity. The electron magnetic moment is directed against the spin. The magnetic field $\mathbf{B}_\mu$ created by the magnetic moments is described by the Landau equation [33]:

$$\mathbf{B}_\mu = \mu_0 \sum_i \frac{3\mathbf{n}_i(\boldsymbol{\mu}_e \cdot \mathbf{n}_i) - \boldsymbol{\mu}_e}{r_i^3}, \quad (1)$$

where $\mu_0 = 1.26 \cdot 10^{-6}$ *H/m* is magnetic constant; $\mu_e = 9.29 \cdot 10^{-24}$ J/T= $5.79 \cdot 10^{-5}$ *eV/T*, *r* – is the distance from the electron to the point at which the field $\mathbf{B}_\mu$ is calculated; $\mathbf{n}_i$ is a unit vector in the direction r_i, i is the number of electrons with parallel spins. It follows from formula (1) that the magnetic moment of an electron $\boldsymbol{\mu}_e$ creates a magnetic field equal to 30 *T* at a distance of 0.092 nanometers along its direction axis (the diameter of a hydrogen atom is 0.106 nm).

Thus, a directionally moving ensemble of electrons generates a seed magnetic field $\mathbf{B}_{\mu 0}$ (1) in a condensed matter, which averaged direction coincides with the direction of electron motion. Therefore, the electrons, in addition to moving predominantly in one direction, additionally rotate around the lines of the magnetic field created by them. In this case, the rotation of all electrons in the ensemble is also unidirectional – clockwise, if you look in the direction of electron motion. In an ionized liquid, as different from a solid state, singly charged ions also move directionally towards the electrons. Therefore, electrons also revolve around ions. Moreover, due to the regular change in the distance between ions and electrons, as a result of the Coulomb interaction between them, the electrons begin to oscillate both along and across the direction of their motion. Due to the thermal motion of electrons and because of their constant collision both with each other with a frequency of $(2\text{-}7) \cdot 10^{14}$ *c*$^{-1}$ and with atoms-ions, the rotation and oscillations of an individual electron can be spoken of as of trends in motion in the general field created by the ensemble of electrons. However, the combined motion of all electrons in the ensemble forms both a local vortex motion

of matter in a liquid medium and oscillations of matter inside the vortex.

The electron spins are oriented in the seed magnetic field $\mathbf{B}_{\mu 0}$ either along the field or against it. Due to its nature, the magnetic field $\mathbf{B}_{\mu 0}$ created by the sum of magnetic moments of electrons, is spatially inhomogeneous and anisotropic. Therefore, electrons which move in a changing field $\partial \mathbf{B}_{\mu 0}/\partial t$ and which have a field-antiparallel orientation of the magnetic moments $\mathbf{B}_{\mu 0}\uparrow\downarrow\boldsymbol{\mu}_e$, will change the direction of the magnetic moments $\boldsymbol{\mu}_e$. Thus, the number of free electrons in a state with magnetic moments parallel to the field increases, up to the moment when most electrons would pass into this state. Consequently, the seed magnetic field increases up to saturation $\mathbf{B}_{\mu}$. Accordingly, the spins of these electrons will also become parallel. Spin plasma is formed.

4. PAIRING OF ELECTRONS IN LIQUIDS

4.1. Strong magnetic fields

At a temperature of molten metals T ~2300 K (0.2 eV), the density of electrons is ϱ ~(1-3)·10^{22} см$^{-3}$, which corresponds to the average distance between them ~(5-3)·10^{-8} cm. The volume of a sphere with a radius equal to the de Broglie wavelength or the coherence length $\lambda \approx \xi$ ~30·10^{-8} cm contains ~(1-3)·10^3 electrons. At a density of ϱ ~10^{21} см$^{-3}$, the volume of such a sphere contains ~ 100 electrons.

In an ensemble of unidirectionally moving electrons with the number n and volume W, both spins and magnetic moments are parallel. Parallel magnetic moments of electrons generate a collective, magnetic field $\mathbf{B}\boldsymbol{\mu}$.

Electrons with parallel spins are attracted to each other due to the exchange interaction. Each electron attracts electrons in itself, which are in the volume of the correlation sphere with a radius $\lambda \approx \xi$. The volume of the electrons ensemble W can be larger than the volume of the correlation sphere; however, all electrons that make up the ensemble are cross-attracted to each other. Therefore, the ensemble of electrons forms, due to the exchange interaction, a collective exchange field in its micro- and more than microvolume W. The energy of one electron ε_i with a wave function φ_i can be determined using the Hartree-Fock self-consistent field method from the equation:

$$\left\{-\frac{\hbar^2}{2m}\nabla^2 - \sum_A \frac{Z_A e^2}{r_{iA}}\right\}\varphi_i + \left[\sum_{j=1}^{n}\int d\vec{r}\,\varphi_j^* \frac{e^2}{r_{ij}}\varphi_j\right]\varphi_i -$$

$$-\left[\sum_{j=1}^{n}\int dr\,\varphi_j^* \frac{e^2}{r_{ij}}\varphi_i\right]\varphi_j = \varepsilon_i\varphi_i, \quad i = 1,2,3,...,n.$$

The curly brace gives the sum of the operators of the kinetic energy of an electron and its potential interaction energy with all ions Z_A. We can assume that Z_A =1. The first square bracket shows the operator of the energy of the usual, interelectronic Coulomb repulsion – the Hartree contribution, the operator of the interelectron exchange Coulomb attraction energy – the Fock contribution – is given in the second bracket.

The contribution of Hartree (E_H) to the self-consistent field can be neglected, since the repulsion of electrons is compensated at densities of ~10^{21} cm^{-3} by their attraction to positively charged ions, because Debye radius − the distance over which the action of the electric field of a separate charge in a quasi-neutral medium extends, has the size of an atom $r_D = \sqrt{\frac{\varepsilon_0 kT}{\rho e^2}} = 69\sqrt{\frac{T}{\rho}} = 10^{-8} cm,$ where $\varepsilon_0 = 8.8\cdot 10^{-12}\ F/m$ is electric constant.

Therefore, a self-consistent field is formed only due to the Fock contribution (E_F), which is determined by the multi-exchange Coulomb attraction between electrons with parallel spins. The Hartree-Fock equation takes the following form:

$$\left\{-\frac{\hbar^2}{2m}\nabla^2 - \sum_A \frac{e^2}{r_{iA}}\right\}\varphi_i - \left[\sum_{j=1}^{n}\int dr\,\varphi_j^* \frac{e^2}{r_{ij}}\varphi_i\right]\varphi_j = \varepsilon_i\varphi_i.$$

Strictly speaking, the Fock contribution to the self-consistent field potential must be larger than the Hartree contribution for electron pairing in liquids, $E_F > E_H$. The exchange attraction between electrons associated with the overlap

of their wave functions decreases exponentially with an increasing distance between electrons (Fig. 7). Therefore, since the net interelectronic repulsion is much greater than the interelectronic exchange attraction, and to satisfy the condition $E_F > E_H$, in a liquid plasma it is necessary that $\lambda >> r_D$.

$$\lambda = \frac{h}{\sqrt{3m_e kT}} \gg \sqrt{\frac{\varepsilon_0 kT}{\rho e^2}} = r_D,$$

then,

$$\rho \gg 3m_e\varepsilon_0\left(\frac{k}{he}\right)^2 T^2 = 4.1\cdot 10^{11} T^2 [cm^{-3}].$$

At temperatures of liquids of 300-2300 K, the last ratio is fulfilled at electron densities above 10^{18}-10^{20} cm^{-3} respectively. The densities of electrons in liquids with values of $\rho \geq 10^{21} cm^{-3}$ are important for the formation of seed magnetic and exchange fields in them.

Since the electrons in the ensemble W are attracted to each other, then, consequently, the first Cooper condition on their pairing is satisfied [30]. According to L. Cooper condition for pairing electrons, the attraction between them can be arbitrarily small. It is important in our case that the exchange potential is greater than the energy of the thermal motion of electrons. Then, the continuous spectrum of electronic states in the negative field potential of volume W will transform into a discrete spectrum with their n_a, ℓ, m, n_b – quantum numbers that satisfy the Pauli principle. It is noteworthy that the exchange field generated by electrons with parallel spins affects them only. Since all electrons in the exchange field have parallel spins, then practically the only way to fulfill the Pauli principle is the pairing of electrons into orthobosons $S = 1\hbar$. This pairing is carried out due to the fact that electrons in a magnetic field acquire new, oscillatory quantum numbers n_b [20]. The electrons that make up the orthoboson have oscillations, which are correlated in the pulses $\mathbf{P}_{1e} = -\mathbf{P}_{2e}$ — this is the second condition for electron pairing [30]. Due to the fulfillment of the condition $\mathbf{P}_{1e} = -\mathbf{P}_{2e}$, the oscillatory quantum numbers of paired electrons are equal to each other in absolute value, but opposite in sign $n_b^1 = -n_b^2$, n_b = 1,2,3… The Pauli principle is satisfied.

Consequently, pairing of electrons into orthobosons will be carried out automatically in local regions of weakly excited liquids, in which electrons move unidirectionally and have a density ≥ 10^{21} cm^{-3}.

The trajectories of motion of electrons in the orthoboson can be represented as closed spirals nested into each other, located on the toroid surface. An orthobosonic pair is a toroidal ring current with a radius (**Fig. 8***a*). In contrast to the atom, in which the atomic nucleus with charge Z is always in the center, the counter flux of positive ions in the orthopair in its "center" can be not only different, but it also changes in time.

According to Bohr's theory, the radius of the electron orbital in a hydrogen-like atom with a nuclear charge Z and a principal quantum number na is equal to:

$$r_Z = \frac{4\pi\varepsilon_0\hbar^2}{m_e Ze^2} n_a^2. \qquad (2)$$

The electron velocity on the orbital is equal to: $V_Z = n_a\hbar / m_e r_Z$. The ring current of the orthoboson $2e^-$ is equal to:

$$I_Z = 2eV_Z / 2\pi r_Z = en_a\hbar / m_3\pi r_Z^2. \qquad (3)$$

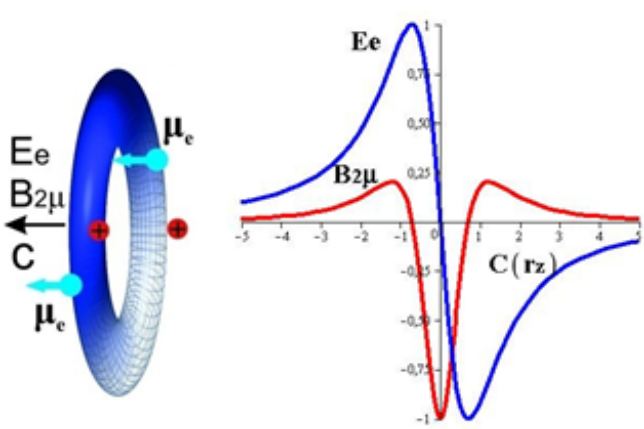

Fig. 8. *a – orthoboson; b - dependence of the electric Ee and magnetic $B_{2\mu}$ fields in relative units along the C axis.*

Let us assume that the correlation between the electrons, which make up the orthoboson arises from the minimum average distance between free electrons in metal melts to the minimum size of "capsules" 0.3–1 nm (r_Z = 0.15–0.5 nm). Then, the magnetic field formed by the parallel magnetic moments μ_e by a pair of electrons in the center between them according to (1) $\boldsymbol{B}_{2\mu} = -\mu_0 2\boldsymbol{\mu}_e / r_Z^3$: varies in the range from 7 to 0.2 *T*. The average effective ion charges for electron correlations at such distances according to formula (2) for the principal quantum number n_a = 1 are, respectively, *Z* = 0.35-0.1. The physical meaning of such values is that the ions are not constantly in the center of the orthobosonic pair, since they and electrons move towards each other. In addition, the Coulomb field of the ions is screened by the field of other, uncorrelated electrons.

It is known from [20] that the radius of the orthoboson decreases by a factor of three compared to the initial radius at which the correlation arises. This is due to the fact that electronic oscillations generate additional binding energy of electrons with ions. And since the energy of rotation of electrons around ions and the energy of oscillations depend on each other, then an additional energy connection of electrons with ions arises. In addition, the exchange Coulomb attraction between electrons in an orthobosonic pair completely compensates for their Coulomb repulsion: electrons in an orthoboson interact only with ions. Because of this, the orthoboson radii r_Z decrease threefold and become equal to ~0.05-0.15 r_Z, and the magnetic fields at the center of the orthoboson increase, respectively, up to $B_{2\mu}$ ~ (190–7) T.

The ring current of the orthoboson ($2e^-$) also forms the magnetic field B_e. In the center: $B_e = \mu_0 I_Z / 2r_Z$. We substitute the value of the ring current (3) for n_a = 1 in the formula, we obtain, $\boldsymbol{B}_e = -\mu_0 \boldsymbol{\mu}_e / \pi r_Z^3$, $(\boldsymbol{\mu}_e = e\hbar / 2m_e)$. The magnetic field at the center of the ring current is 2π times less than the field created by the magnetic moments of the electrons μ_e.

Thus, electrons move in an ionized liquid in one direction and have a density of ≥ 10^{21} cm^{-3}, a seed magnetic field $B_{\mu 0}$ is generated. The saturation magnetic field B_μ and the exchange field of electrons with parallel spins produce orthobosons *S* = 1ħ, each of which is formed from a pair of correlated electrons. Orthobosons create a strong magnetic field $B_{2\mu}$ in the liquid. A "spontaneous" magnetization of the liquid occurs [34].

4.2. "Capsules", unknown particles and high-temperature superconductivity

The ring current of radius r_Z with charge e creates electric and magnetic fields on the *C* axis, respectively: $E_e = (ec/4\pi\varepsilon_0)\cdot(r_Z^2 + c^2)^{-3/2}$ and $B_e = \mu_0(I\cdot r_Z^2/2)\cdot(r_Z^2 + c^2)^{-3/2}$, where *I* is the ring current [35]. The joint solution of these equations gives a potential well on the *C* axis at a distance $r_Z / \sqrt{2}$ from the center of the ring (Fig. 8).

The magnetic field $B_{2\mu}$ generated by the magnetic moments of the orthoboson, has a maximum value in the center. In this case, the magnetic induction vector $\mathbf{B}_{2\mu}$ is directed against the direction of the magnetic moments of the electrons μ_e. The magnetic field becomes zero on the *C* axis, at a distance $c = r_Z / \sqrt{2}$ from the center of the ring. The direction of the field changes sign at this point. Further, it coincides with the direction of the magnetic moments. The maximum of the external field is located at a distance $r_Z\sqrt{3/2}$ from the center of the orthoboson. And its value is five times less than the maximum value of the field in the center. In accordance with the values calculated in the previous chapter, the maximum values of external magnetic fields will be 40−1.5 *T*. Further, the magnetic field decreases with increasing distance c as $4\mu_0\mu_e/c^3$ (1), (Fig. 8*b*). The *C*-axis distance is given in r_z units in Fig. 8*b*.

Orthobosons are attracted to each other due to their external magnetic fields. In this case, magnetic self-focusing is carried out and

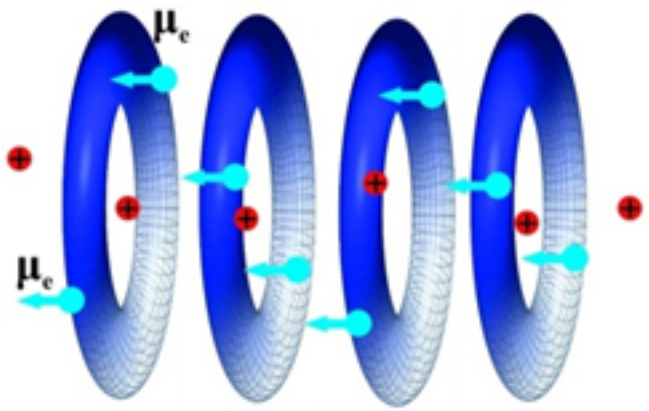

Fig. 9. *"Capsule" – orthoboson "solenoid".*

an orthoboson "solenoid" is formed with equal distances $r_z/\sqrt{2}$ between the centers of the orthobosons. Since the flux of positive ions inside the orthobosonic "solenoid" are the same for all orthobosonic pairs, their diameters will be equal to each other (**Fig. 9**). The orthobosons of the "solenoid" do not form a single Bose-Einstein condensate, since each orthoboson has no constant central positive charge. Positive ions which pass inside the orthobosons constantly change their location from one orthoboson to another, neighboring orthoboson. Therefore, there is no directional Coulomb attraction of neighboring orthobosons to neighboring ions. Unlike transatoms, which have Bose-Einstein orthobosonic condensates and have central, positively charged atomic transnuclei. Therefore, Bose-Einstein condensates of transatoms are combined into one, common condensate. With such a combination, a nuclear transmolecule is formed, in which transnuclei enter into low-energy nuclear reactions. **Fig. 10**, as an example, shows the formation of the sodium transmolecule $_{11}Na^{M}$ from the transatoms of boron $_5B^{T}$ and carbon $_6C^{T}$.

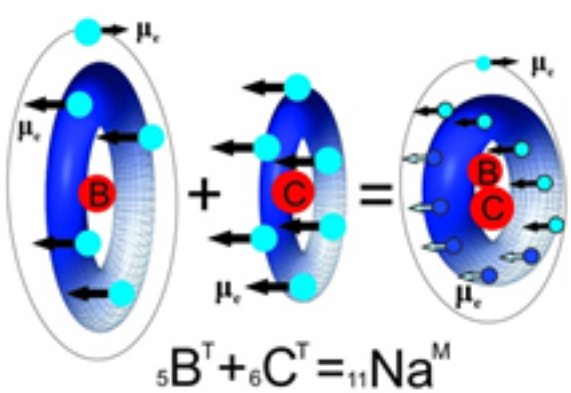

Fig. 10. *The formation of sodium transmolecule from boron and carbon transatoms.*

The orthobosonic "solenoid" is the very "capsule" that was discussed at the beginning of chapter 3. The number of orthobosons in "capsules" can be different. It depends on the state of a weakly excited liquid, on its temperature, on its chemical composition, and on the density of the electron flux.

Although the orthobosons of the "solenoid" do not create a **united** Bose-Einstein condensate, when they join into a "capsule", they nevertheless form a common condensate **distributed** in space. All electrons in the "capsule" have equal energies, and the orthobosons have additional binding energy due to the exchange interaction, but this time due to exchange interaction of bosons with each other. This relation makes the "capsule" resistant to both external and internal influences. "Capsules" will exist as long as there is a sufficient amount of free electrons in the condensed matter, which are formed as a result of external influence or due to transmutation reactions.

It is obvious that inside the orthobosonic "solenoid" magnetic fields multiply increase, thus creating conditions for the transformation of atoms into transatoms and triggering low-energy transmutation reactions. Despite the fact that nuclear transmutation reactions take place inside the "capsules", as mentioned above, "capsules" are stable objects. Low-energy nuclear transmutation reactions are non-radiation reactions. Energy is released in these reactions in the form of kinetic energy of multiply charged ions. The scattering positive multiply charged ions will pull with them a separate orthoboson or the entire orthoboson "solenoid" and can pull it out of the liquid.

It is known that the process of transmutation is accompanied by the emission of rare, unknown particles, which leave "strange" traces in photographic emulsions, on thin sections

of metals and which, when interacting with a substance, change its structure and chemical composition. It is the "capsules", which generate in a condensed matter, move inside and outside it, are that exact "strange" radiation that is recorded in many experiments [6,7,10,36,37]. "Capsules" possess strong electric and magnetic fields. If the "capsules" together with the interacting transatoms inside them move along the surface of the "detectors", then they create bizarre patterns on them, which are observed in experiments.

It was emphasized in [38] that the higher the energy density of the excited matter, the more atoms can be involved in the input channel of the transmutation reaction. This means that the size of the "capsule" changes, and the higher the density of electrons moving in one direction in the liquid, the more orthobosons are formed in it and the larger is the linear size of the orthoboson "capsule".

The "capsule" has strong, symmetrical magnetic and electric fields at its ends and it will draw in itself, along its axis, positively charged ions. The number of ions drawn in will be as much as is necessary to maintain the size of the diameters of the orthobosons in the "capsule". Moreover, these electromagnetic fields separate the energies of free electrons that surround the "capsule" and capture them in orbitals of large radii with different principal quantum numbers according to formula (2). After being captured in the orbital, electrons will carry out transitions to lower electronic levels, as happens in atoms. The transitions will be accompanied by the emission of photons. And since electrons rotate on orbitals, and additionally oscillate around them, the electrons begin to pair into orthobosons and join the "capsule". Consequently, a "capsule" in a condensed matter saturated with free electrons will stimulate the formation of orthobosons and, thus, will automatically increase its size. Formation of a "capsule" can begin with one orthoboson.

The maximum size of the orthoboson "capsule", in the case of the passage of electrons through the liquid, can be from the cathode to the anode. Orthobosons form continuous, unbreakable "filaments" from one electrode to another. It is this orthoboson current, in the form of a specific electric discharge that was observed in A.V. Vachaev and N.I. Ivanov installation (see **2.1**) [3]. The orthobosonic current has the property of superconductivity, since it is impossible to destroy it due to the energy of the thermal motion of the atoms of the medium. Consequently, high-temperature superconductivity can, under certain conditions, be realized in weakly excited liquids.

5. CONCLUSION

Numerous experiments on low-energy transmutation reactions have shown that nuclear reactions occur at low energies in weakly excited condensed matter. The properties of transmutation reactions contradict the properties of conventional nuclear reactions. This circumstance allows us to assert that, the process of paradigm change in science starts at present [21].

The analysis of the experiments on transmutation revealed the conditions under which they occur. The main condition is the presence of regions with a strong magnetic field in the excited matter, more than 30 *T*. It turned out that atoms pass into another, altered state, into transatoms in such fields. Transatoms combine into one common transatom, and their transnuclei form multinuclear molecules and enter into transmutation reactions.

It follows from the proposed model of the emergence of strong magnetic fields in excited liquids, that there must be free electrons and free ions in it with a concentration of $\geq 10^{21}$ cm^{-3}. It is also necessary that all or some of the electrons move predominantly in the same direction. Unidirectionally moving electrons have parallel spins and, accordingly, parallel magnetic moments. Parallel magnetic moments

of electrons generate a common seed magnetic field. Electrons with parallel spins, due to the exchange interaction, create a collective self-consistent field with a negative potential. Under such conditions, correlations arise between pairs of electrons, and they form orthobosons with $S = 1\hbar$. Orthobosons, in turn, are attracted to each other and create an orthoboson "solenoid" – "capsule" with a strong magnetic field. Transmutation reactions take place inside such "capsules".

To enhance pairing of electrons, the excited liquid can be placed in an external magnetic field, which direction coincides with the direction of motion of electrons [3,12]. It is also helpful to create directional vortex flows in the fluid. A natural process that increases the density of electrons and ions in orthobosonic liquids is low-energy reactions, the products of which, due to their ionization losses, generate additional free electrons and ions in the matter. The largest ionization losses correspond to high-energy ions: protons, alpha particles, fragments from uranium fission and other multicharged ions. This property of ions can be used to generate "capsules".

It should be remembered that spontaneous orthobosonic electron pairing can occur in liquid and solid-state, melted-down industrial fuel cells. Such pairing will lead to transmutation reactions, to additional uncontrolled energy release and, possibly, to explosive destruction of energy generators!

It is worth paying attention to the fact that:

- the Coulomb repulsion between electrons, in an ordinary atom, is many times greater than the interelectron exchange Coulomb attraction;

- but already in orthobosones of transatoms, the energy of exchange attraction between two electrons is exactly equal to the energy of Coulomb repulsion between them;

- and, finally, the exchange attraction between free electrons completely dominates over their electron-electron Coulomb repulsion in a spin plasma.

A well-known, useful rule follows from the above: If unequal forces act on an object under normal conditions, then there must exist such conditions, that when the object is placed into them, the ratio of the forces that act on it will not only change, but some of the forces can be significantly suppressed, i.e. the ratio of the forces that act on an object depends on the conditions in which it is located.

Due to exchange forces in weakly excited condensed matter [39], ordinary liquids turn into quantum liquids, and their theoretical and experimental studies will make it possible to control low-energy nuclear reactions, and not just that.

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