Search for Not-High Energy Neutrino (NNN) Manifestation in Nature:
IV. Neutrino - Driven Nuclear Reactions

V.A.Filimonov

The reactions of D-D fusion and β-decay (perhaps, α-decay and fission, too) are the neutrino driven ones. The not-high energy neutrino (NNN) interaction with nuclei is indirect one and its initial step is NNN coupling with electron in atom thus forming an electron-neutrino couple. The hypothesis is based on the novel concept of neutrino suggested by the author, according to that a neutrino is a quantum of so-called torsion radiation, to be yielded under proceeding of any irreversible process, to be emitted or absorbed under phase transitions in matter and to be generated easily using appropriate devices. The hypothesis provides explication to conformities to natural laws of radioactive and "stable" nuclides transmutation rate variation by low energy non-nuclear actions on nuclei.

I. Introduction

The term "neutrino - driven nuclear reactions" (NDR) is usually attributed to some reactions of direct or reverse β-decay having, as a rule, extremely small section and applied for detection of neutrino (antineutrino). We consider, contrary, that great majority of intensely flowing reactions of β-decay, nuclear fission and partly of fusion, formerly described without participation of neutrino on an inlet, are a neutrino-driven ones. The concept includes also vast domain of so-called "cold fusion and transmutation of nuclei" that is intensely investigated recently.

Constancy of a radioactive decay rate and its independence on the exterior factors was discovered experimentally per 20th years of last century:

$$N_t = N_0 \exp \ (-\lambda t) \tag{1}$$

where N_t, N_0 are current quantity of a radioactive nuclei and the same at the initial moment, correspondingly, λ is a decay constant, t is the time period past from the initial moment.

This experimental fact became a basis of the conventional theories of β- and α-decay developed per the same years, according to that the rate of decay is caused "from inside" by excitations of nuclei or their fragments (with parameters identical for all nuclei of a particular nuclide).
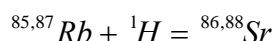
However, there are facts testifying of essential acceleration of nuclear transformations (transmutation) as after a variation of structural and chemical environment of a radioisotope (for β-decay, isomerisation of nuclei), and after low energy non-nuclear actions (for fusion, fission, β-decay) on radioisotopes containing media. Also, imply of so-called torsion fields on reactions of β-decay is experimentally observed and theoretically justified. These facts demonstrate that the reactions of direct and reverse β-decay, including nuclear fission and partly nuclear fusion, are driven from the outside.

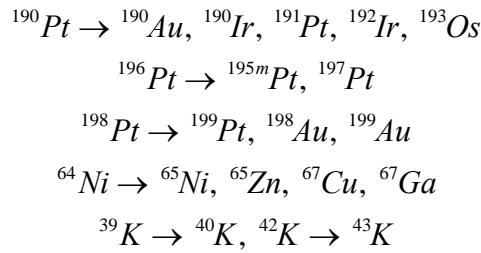## 2. Experimental proof of externally initiated nuclear transmutation

The significance of a radioactive decay rate variation and its correlation with the solar activity variation is demonstrated after some decades long observations [1].

The variation of decay rate after variation of crystalline and chemical environment was observed since the 40th years. So, the rates of ^{7}Be decay by means of an electron capture differ by 0,1 % in pure beryllium and its oxide BeO [2]. It was stated, that the rate of ^{99m}Tc decay by internal conversion increases in compounds such as $RTcO_4$, where R is the alkali metal, as related to pure metallic technetium [3]. It is also shown that the decay of ^{32}Si is retarded by 6 percent after substitution of its crystalline environment by a specially designed matrix [4].
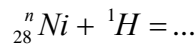
The variation of nuclear transmutation rates are even more significant after low energy non-nuclear actions on media (so-called cold fusion and transmutation of nuclei). So, the activity of tritium ^{3}T, absorbed by Ti, is possible to vary reversible within 30 percent by a temperature variation [5]. There are data about an opportunity of a variation of decay rates by means of electronic excitation, action of pressure, temperature, electrical and magnetic fields, of mechanical stresses in monomolecular layers, etc. [3]. The various nuclear reactions occur under water (H_2O and D_2O) electrolysis. At electrolysis of an ^{87}Rb radioisotope containing solutions [6] its decay accompanied by formation of short-lived radioisotopes (half-decay period of about 3,8 days) was detected. Formation of a set of stable nuclides affiliated to ^{85}Rb, ^{87}Rb is also observed, down to $^{108-114}$Sn [6]. These products are supposed to be derived as a result of total reactions of a type:

$$^{85,87}Rb + {}^1H = {}^{86,88}Sr$$

etc. A shift of stable nuclides ^{86}Sr/^{88}Sr relation towards the diminution of a share of the latter as related to the natural isotopes mixture testifies convincingly for the benefit of the above. The opportunity of massive transmutations of Fe, Cr, Ni to Cu and Zn was exhibited in experiments on a high-voltage electrolysis of water and other liquids using stainless steel electrodes [7]. Transmutations of stable nuclides into radioactive by-products of fusion (and fission) were detected at an electrolysis of a solution K_2CO_3 in H_2O on Pt and Ni electrodes [8]:
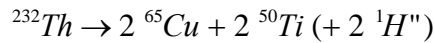
$$^{190}Pt \rightarrow {}^{190}Au, \; {}^{190}Ir, \; {}^{191}Pt, \; {}^{192}Ir, \; {}^{193}Os$$
$$^{196}Pt \rightarrow {}^{195m}Pt, \; {}^{197}Pt$$
$$^{198}Pt \rightarrow {}^{199}Pt, \; {}^{198}Au, \; {}^{199}Au$$
$$^{64}Ni \rightarrow {}^{65}Ni, \; {}^{65}Zn, \; {}^{67}Cu, \; {}^{67}Ga$$
$$^{39}K \rightarrow {}^{40}K, \; {}^{42}K \rightarrow {}^{43}K$$

The formation of a series of Cr, Mg, Fe, Co, Cu, Zn, Ag isotopes was observed under an electrolysis light water (H_2O) solution of Li_2SO_4 with application of a boiling bed of plastic beans covered with a Ni thin film as the cathode [9]. Those isotopes to be the products of fusion:

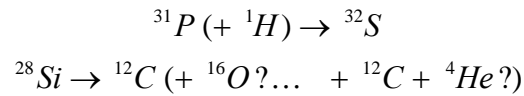$$^{n}_{28}Ni + {}^{1}H = ...$$

and subsequent α-, β-, p-decay [9].

The data on an effective method of long-lived radioisotopes (^{232}Th and ^{239}Pu) disintegration in an electrolysis cell appeared [10]:

$$^{232}Th \rightarrow 2 \; {}^{65}Cu + 2 \; {}^{50}Ti \; (+ \; 2 \; {}^{1}H'')$$

The nuclear transformations ^{105}Pd→^{107}Ag, ^{106}Pd→^{108}Ag etc. were observed at a glow discharge in deuterium gas using Pd electrodes [11]. The method permitting to decompose long-lived radioisotopes under action of the atomic hydrogen-oxygen torch flame was designed [3,12]. In particular, a drop of a radioactivity of a ^{60}Co containing waste from 580 to 220-240 mR/hour and from 115-120 to 42 mR/hour is reported, and also drop of activity of a ^{241}Am-containing waste from 300 down to 1,5 Cu after a five minute exposure [12]. The data on implementation of accelerated fission of long-lived radioisotopes ^{226}Ra, ^{232}Th under a detonation of explosives were also reported [13]. The transmutations accompanied by formation of a mixture of short-lived nuclides, the activity of which ones is reduced down to a natural background level for 60 days, were reached by the latter method.

There are some data on an opportunity of initiating radioisotopes decay and other nuclear transformations by means of so-called torsion radiation. The properties of the latter are manifested, in particular, by a reorientation of nuclear spins and magnetic moments of atoms [14] which yields a disordering of matter structure and variation of nuclear reactions rates [3,15]. It is reported that the generator of a torsion field having power of 5 Watts is capable to lower a radioactivity of an experimental site of terrain contaminated with an mixture of radioisotopes from 0,5 down to 0,015 mR/hour, or by 97 percent (the time of action is not indicated) [3]. The "installation for nuclear transformations of light elements of

ferromagnetic substances" based on the generator of torsion high-power fields is tested [16], and transmutation of a set of stable nuclides is implemented:

$$^{31}P\,(+\,^{1}H) \rightarrow\,^{32}S$$
$$^{28}Si \rightarrow\,^{12}C\,(+\,^{16}O\,?\ldots\;+\,^{12}C +\,^{4}He\,?)$$

It was stated [17] that the Chernobyl accident produced radioisotopes (in particular, ^{137}Cs) during some years after their fallout had reduced half-life periods (3.5 and 17 years for 1988 and 1992 years' samples, correspondingly), hereinafter asymptotically incremental up to the conventional values (30.6 years).

3. The concept of a neutrino-driven nuclear transmutation

The difficulty of universal description of the above mentioned phenomena is caused by a vast variety of low energy actions initiating anomalously fast nuclear transformations. However, their general property is the strong non-equilibrium of systems and irreversibility in principle of the processes noted transformations are implemented under (see, e.g., [18]). As to transmutation, all experimental observations of nuclear transformations acceleration – irrespectively of a type of reactions (fusion, decay, fission) and of participating nuclides features (radioactive or "stable" ones) – occur in non-equilibrium and (or) self-organizing systems under high intensity flows of matter and energy, that confirms the thesis qualitatively.

We suggest the concept of neutrino-driven nuclear reactions for explication of abnormally fast nuclear reactions surveyed above and conformities to natural laws observed under the noted reactions proceeding.

This concept based on the series of the author's papers [19-21] according to that the neutrino capture by nuclei sections has a resonant mode for not-high energy (<< 1 MeV) of the former. Indeed, it is stated earlier [22,23] under suggestion of non-zero mass of neutrino that sections of capture of the latter by nuclei become substantially different of zero. Contrary to the authors of [22,23] we guess indirect neutrino interaction with nuclei and suggest that the initial step of such process to be the neutrino interaction with electron shell of atom forming the neutrino-electron pair (NEP) [21].

Various not-high energy neutrino (NNN) manifestations were experimentally observed [24-28] but misinterpreted. We guess also that W.Smith's [15] and B.Bolotov's [16] installations were high-capacity NNN generators. NNN identifying with so called torsion radiation [19,20] that is generated by various processes accompanied with the entropy

variation in a system allows to explicate intensive abnormally fast nuclear reaction proceeding under non-equilibrium processes and phase transitions implementation in a matter.

We have surveyed all possible sources of excessive not-high energy neutrinos (NNN). Noted excess flows of neutrinos over the cosmic background can stipulate anomalously fast reactions of nuclear transmutation, including those of "stable" nuclides. The above described experimental facts are easily interpreted within the framework of the present concept.

So, "spontaneous" natural variations of β-decay rate [1] can be explained by significant variation of a solar NNN flow density after a solar activity (that is intensity of nuclear fusion reactions in the Sun) variation.

The dependence of decay rate of a radioisotope on its chemical environment is caused by different captured neutrino content in the metal and oxidated phases and, therefore, by different "volatility" of the neutrino above these phases [2,3]. The different degree of ordering of a matrix containing a radioisotope also causes the different content of bound neutrinos (the more perfect crystal lattice, the more captured neutrino content) [4].

Due to strong enough neutrino-matter bounds and, therefore, low volatility of neutrino, the indicated factors imply on the rate of decay is quite weak. However, the situation changes essentially under dynamic conditions. So, the heating of Ti-^{3}H system is accompanied by a series of phase transformations conjugated with neutrino emission-absorption. The maximal tritium decay rate variation as related to the initial situation (ambient temperature of a sample) is observed not at a new crystalline phase but at the process of phase transformation [5].

The most of electrolytic transmutation effects is caused by two factors: (i) highly non-equilibrium conditions of mass and electrical charge transfer at an electrolysis under large current densities and (ii) metastable metal-hydride phases formation and decay in bulk or on a surface of the cathode [6-9]. The same concerns cold fusion and transmutation experiments carried out in the field of a glow discharge [10]. Both these factors are sources of neutrino generation and/or emission [19].

The chemical reactions of burning (especially, of atomic burning) are much more intense sources of the NNN generation [11] being the most irreversible processes and occurring under highest non-equilibrium conditions. As to the latter conditions, the processes of solids detonation exceed by some decimal degrees of magnitude the burning processes having a subsonic rate of combustion front, so being the strongest intensifier of abnormally fast nuclear reactions [12].

As to the action of a torsion irradiation on the transmutation rate of radioactive and "stable" nuclides, it testifies convincingly for the benefit of that radiation quanta (torsions) identification with neutrinos of the relevant energies [19].

Also, observed Chernobyl track radioisotopes "aging" [17] along with magnification of their half-life periods (up to conventional values) is conditioned by these nuclides formation under activity of high intensity neutrino flows produced by nuclear reaction of fission. This experimental fact demonstrates that the absorption of neutrinos by nuclei causes a prolonged aftereffect. No doubts that similar facts could be observed earlier. However, only neutrino-saturated products of fission reactions implemented under above-critical mode of the reactor, have maintained their neutrino-induced anomalous behavior within several subsequent years, that has allowed authors of [17] to find out and to identify them (products) in natural media.

The concept is consistent with an entire set of the facts and observations concerning transmutation without any exception. This can also explain various facts of other fields that have not accepted till now by conventional science; namely, it concerns the torsion fields research area, some data of an elementary particle physics, astrophysics, cold fusion and transmutation of nuclei, and also biologic transmutation [29].

One can see that radioactive decay rate and its dependence on time equations (1) don't vary within a suggestion that the decay is "externally driven" and proceed under an external factor having constant or slightly varying intensity:

$$\lambda_i = I_\nu \sigma_i p_i \qquad (2)$$

Here λ_i is an i-th nuclide decay constant, I_ν is an external factor (space neutrino flow) intensity, σ_i is a NNN capture section by i-th nucleus, p_i is a probability of resulted nucleus decay. The space NNN flow focusing might result in deducing (and the former shielding in reducing) the radioactive decay rate. Experimental facts described above conform easily to proposed concept of neutrino-driven nuclear reactions.
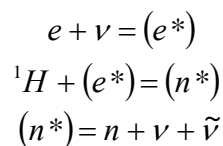
4. Probable mechanisms of neutrino-driven nuclear reactions

The guessed abnormally fast nuclear reactions activation by neutrino is caused by noted NNN interaction with an electron shell of atom. Let's remind that both electron and neutrino have a half-integer spin, that should result in coupling of an alone electron of free atom of, say, hydrogen (deuterium) or in substitution of one of electrons in an electronic couple, if the atom H or D forms chemical or hydrogen bond with an atom of the same or
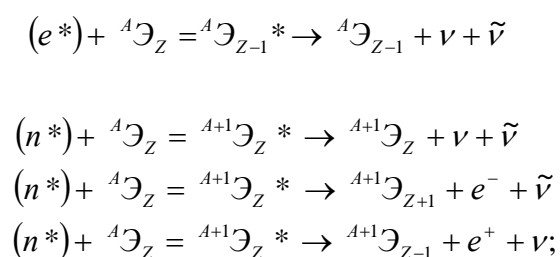
different nuclide. Let's consider, for example, these processes in a molecule of H_2 (D_2) (see fig.).

Here 1, 2, 3 stand for the levels of energy of an atomic orbital of H (D) atom, bonding molecular orbital of H_2 (D_2) molecule and breaking molecular orbital of H_2 (D_2) molecule, correspondingly. In a case of neutrino absorption by H* (D *) atom or H_2* (D_2*) molecule the former can form a pair with the electron situated on a bonding orbital 1* or 2*, correspondingly, displacing another electron of electron-electron pair to a breaking orbital 3*. Thus formed state of the "neutrino-activated molecule" to have redistribution of energy in a molecule. So, the energies of "electron - neutrino" orbitals (see 1* - 3* at fig.) not necessarily coincide the energies of "electron-electron" atomic and molecular orbitals 1 – 3. That can cause a variation (a diminution, in particular) of chemical bond length between atoms in a molecule (or a distance between a nucleus and electron in an atom) as related to an equilibrium value. The case of the distance diminution can result in the dramatic diminution of an electronic orbit radius and in considerable screening of hydrogen atom nucleus charge by an electron cloud, which used to be considered as a requirement of "cold" fusion and transmutation of nuclei implementation. The opportunity of such extreme cases implementation were considered, as the formation of the "Barut-Vigier atom" [29] having a radius of an electron orbit r reduced up to 0,01 of an equilibrium one r_0 (and 10^6 times as much as related to an equilibrium state electronic density close to a nucleus, correspondingly), and the same of "the hydrino molecule" [30] for hydrogen isotopes, and the same of "a stable bineutron" for deuterium atom [31,32]. The hypothetical channels of the subsequent nuclear transmutations were proved experimentally by observation of the relevant nuclear products.

If one considers a presumable participation of neutrino in those reactions on both inlet and outlet, types of reaction channels for a protium are as follows:

$$e + \nu = (e*)$$
$$^1H + (e*) = (n*)$$
$$(n*) = n + \nu + \tilde{\nu}$$

There (e*) is a planetary electron of hydrogen atom paired with a neutrino; (n*) is the Barut-Vigier hydrogen atom that represents itself, properly, a quasi-neutron. As to other chemical elements nuclei, the following nuclear reactions proceeding with (e*) and (n*) participation is possible:

$$(e*) + {}^A\Im_Z = {}^A\Im_{Z-1}* \rightarrow {}^A\Im_{Z-1} + \nu + \tilde{\nu}$$

$$(n*) + {}^A\Im_Z = {}^{A+1}\Im_Z * \rightarrow {}^{A+1}\Im_Z + \nu + \tilde{\nu}$$
$$(n*) + {}^A\Im_Z = {}^{A+1}\Im_Z * \rightarrow {}^{A+1}\Im_{Z+1} + e^- + \tilde{\nu}$$
$$(n*) + {}^A\Im_Z = {}^{A+1}\Im_Z * \rightarrow {}^{A+1}\Im_{Z-1} + e^+ + \nu;$$

etc.

The implementation of the first NDR stage with formation of NEP can cause also β-decay reactions without participation of hydrogen isotopes. So, according to quantum-mechanical insight, the electrons of atom are statistically distributed in its surrounding having various probability density in different places. The former is not equal to zero within the nucleus. Thus, the electron periodically penetrates inside a nucleus, but does not interact with its nucleons. Contrary, NEP, while having nonzero density within the nucleus, can interact with nucleons, so it is a boson (spin of NEP is equal to zero) and is capable to act as an ersatz substitute of an intermediate boson in weak interactions that responsible for the β-decay.

Such an effect should be the most exhibited in the cases when the squeezing of an electron equilibrium orbit due to NEP formation yields in drastic increase of the NEP probability density within a nucleus. Due to considerable difference in an intermediate boson and NEP masses such substitution causes a disruption of charges exchange between protons and neutrons and provokes a decay of typical β-decay-unstable nuclei, that explains the relevant data described in [2-5,11].

Similar to that, it is possible to explain also nuclear reactions initiation of both α-decay and fission. The NEP occurring within a nucleus can act as an ersatz substitute of another boson, namely π-meson being a carrier of strong interactions between nucleons. In this case, due to the fact that the NEP mass is about a half per cent of the π-meson mass, the radius of action of such an ersatz substitute is two hundreds times as more. This allows some nucleons or groups of nucleons within nucleus (say, α-particle) to be separated under action of NEP at a greater distance than normal distance of a strong interaction, that causes a fracture of the relevant bonds in a nucleus and decay (fission) of the latter, as soon as NEP leaves its surrounding.

Thus, the proposed concept explains a series of effects observed during last years that look abnormal and inexplicable within the dominant paradigm of nuclear physics.

5. Conclusion

The NDR concept justifies an opportunity of nuclear transmutations rate variation by low energy non-nuclear actions and explains all features of the phenomenon.

The concept unites a series of observed phenomena in various fields; some of them are outside conventional scientific consideration till now. Attempts to ascribe noted phenomena to neutrino interactions were made earlier [13,32,33] but that was hindered by a known point

of conventional neutrino theory: according to that the sections of a neutrino interaction with a matter are extremely small, dependent proportionally of a neutrino energy and essentially distinct from zero point if the latter is more than 100 eV. This is a reason for the fact that a series of NNN interactions with matter observed in various types of experiment, were misinterpreted and erroneously ascribed to the action of other (hypothetical) particles.

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Fig. Pattern of electron orbits of hydrogen:

Here E – energy, X – spatial coordinate;

1, 1* – atomic orbits, 2, 2*, 3, 3* – molecular ones;

1-3 – normal ones; 1*-3* – under neutrino absorption