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VIRTUAL NEUTRONS AND MINIATOMS IN LOW ENERGY NUCLEAR REACTIONS OF HYDROGEN AND DEUTERIUM

ABSTRACT

They are considered the roles of miniatoms and virtual neutrons in LENR reactions of hydrogen and deuterium absorbed in solids. Has highlighted the role of virtual neutrons in restructuring of the nucleus, when the strong force provides the required energy for the virtual neutrons becomes real neutrons.

Some behaviors can be facilitated in hydrogen by alternation of the proton-electron system between the condition of miniatom and the condition of virtual neutron. This alternation could increase range and duration of the compressed system <p/e> to allow the proton to meet with a nucleus of the solid.

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1 – The hypothesis of virtual neutrons is required in orbital capture

The orbital capture (generally K capture) is usually considered an event of beta interaction (thus be attributed to the weak nuclear force). However, it is easy to realize that in the process the strong force has a role and that the K capture affects not only the nucleus, but also the entire atom. For example, can not happen if the atom is fully ionized, as in certain astronomical situations.

It should be noted that the K electron not goes to the nucleus because attracted by the Coulomb force. This force is actually the one who “keeps” the electron in the K orbital: if this was to bring the electron on the nucleus it would perform work, and the electron would arrive with much more energy. Instead the energy is the one that competes to the K orbital, because the electron moves to the nucleus for fluctuation of the distance from it, according to the probability determined by quantum mechanics, and according to the Uncertainty Principle.

Among the nuclei which exhibit orbital capture We can remember ^{40}K and ^{136}La, which are very different examples of instability, ^{40}K being most stable (half-life of billions of years) and ^{136} La very unstable (half-life of 9.5 min). So the K capture process can occur with very different values of the reaction rate.

The capture of an orbital electron from the nucleus can be seen as a reaction :

(1) $p + e = n + \nu$ (Q = - 0.78 MeV)

of one of Z protons of the nucleus.

At the level of the quark, this process is shown in fig.1 : the W- boson absorbed by the proton, enables the transformation of one of the quark-up of the proton in the second (virtual) quark-down of the neutron, the latter being a temporary association of a quark-up and of an electron, between which the weak interaction acts. The virtual neutron can be thought as a neutron “pending validation”, that is waiting to receive the necessary mass-energy. But this energt can be provided by the strong force, while she tries to reassemble the nucleus. *In this attempt the virtual neutron is treating as if it were real.*

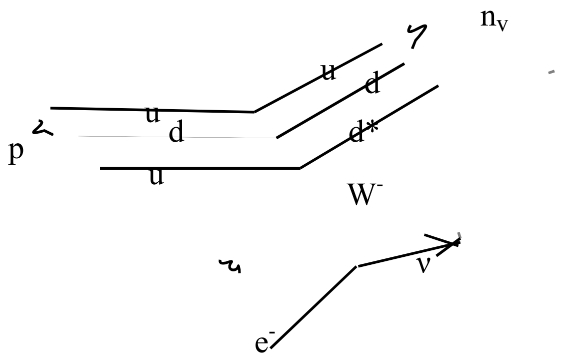

Fig.1 : **K capture** : p belongs to nucleus Nu (Z,A) ; e = K electron; d* virtual quark-down

This, in detail, the chronology.

1 – The K electron go on the nucleus.

2 – To explore the possibility of capture, the electron form a virtual neutron with a proton (forming a virtual quark-down with a quark-up).

3 – The nucleus tries to restructure, replacing the proton with the virtual neutron as if this was real. If in the restructuring, brought about by the strong force, is made available the required energy for the process, the initial nucleus Nu(Z,A) becomes the nucleus Nu(Z-1,A).

The orbital capture involves the subsequent rearrangement of electron shells of the atom because of the tendency of the outer electrons to occupy the inner levels that gradually are free (with emission of a multiplicity of photons with energy in the X-ray field).

2 – Hydrogen miniatoms and their alternance with virtual neutrons

A temporary presence of a K electron on the nucleus should be considered *possible for the nuclei of all atoms.* All nuclei should have the ability to capture a K electron to convert a proton into a neutron, but only those able to obtain energy from the restructuring, brought about by the the strong force (as set out in chronological order) have this type of beta decay.

Even the electron of the hydrogen atom can be found in the proton, especially if the atom is not bound in a molecule. The atomic state (or nascent) of hydrogen is rare in nature, however can be achieved under certain conditions, for example when hydrogen is absorbed by metals that favour the molecular dissociation (preferably finely divided, and/or in presence of a catalyst).

The presence of the electron on the proton greatly reduces, up to nuclear dimensions, the size of the atom, which becomes a “miniatom” [1]. So it behaves like a neutral particle, able to approach a nucleus Nu(Z,A) of the metal without undergoing the Coulomb repulsion. For a complete theory of miniatom see CONTE [2], according to which the its life is much longer (even a thousand times).

The short life of the hydrogen miniatom limits the likelihood of encountering a nucleus.

The reactions of protons and deuterons with nuclei of the lattice are commonly referred to LENR (Low Energy Nuclear Reactions). As these are distinguished from “cold fusion” between protons and deuterons.

The miniatom (p,e) is still an hydrogen atom, consisting of a proton and an electron separated, between which the Coulomb attraction acts, but the weak interaction not yet .In the hydrogen miniatom the electron is attracted *by both* *quark -up* of the nucleus (but, of course, is rejected by the quark-down).

We also consider the "free virtual neutron" in which the electron (still subject to the Coulomb force) *interacts essentially with one of the quark-up* of the proton through the weak interaction (as the electron in the virtual neutron We have seen in the K capture). From now We call simply "virtual neutron" the free virtual neutron.

A Feynmann diagram (Fig.2) can describe the *alternation* of the compact <p/e> system between the condition of virtual neutron n_v and that of hydrogen miniatom (p,e). After many alternations, the life of the <p/e> system can be significantly increased compared to that predicted simply by the uncertainty principle: from this point of view the distinction between miniatom and virtual neutron is conceptually important.

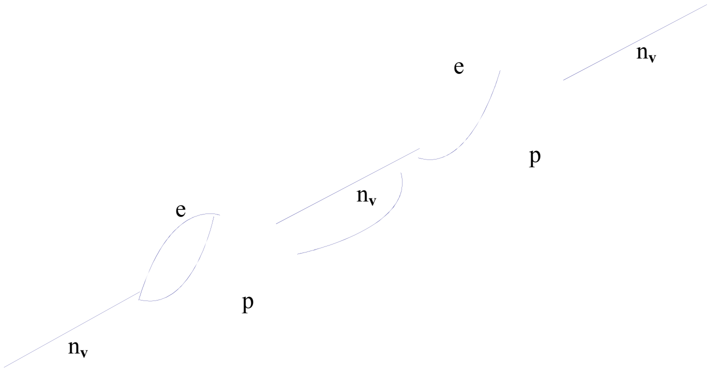

Fig. 2 – Alternation between virtual neutrons (n_v) and miniatoms (p,

Both the virtual neutron and the miniatom are able to avoid the Coulomb repulsion and get close to a nucleus.

Firstly, it may be the only capture of the proton, for tunneling, while the electron is missing. This would be the real LENR reaction, it generally leaves the nucleus Nu(Z+1,A+1) in the excited state, whose excess energy can be used for the capture of an electron, it is one of the orbital electron of the atom or the same electron of the <p/ e> system. The excitation energy can be used to yield real the virtual neutron (which can be quickly absorbed by the nucleus). The dual absorption of the proton and electron, evidently equivalent to the capture of a neutron (slow), with the well known neutron reactions, especially of the type (n, γ).

Important is the case in which an orbital electron (especially of the K-shell) is absorbed because this reaction is followed by several X-ray emission (due to the cascade of transitions in which electrons fill atomic orbitals) which are released gradually. Their absorption contributes to the total heat produced.

3 – Other hypothesis on the formation of <p/e> compact systems

In the recent past, various other hypotheses of formation of miniatoms and of virtual neutrons have been advanced as a mechanism to overcome the Coulomb repulsion in cold fusion.

To note the miniatoms proposed by WIDOM and LARSEN [3], based on a possible increase of the electron mass (electron coated, or heavy) as a result of local fluctuations of the electromagnetic field. According to W and L the relationship $\beta = m_i / m_o$ between the increased mass m_i and the rest mass m_o must have a value at least equal to 2.53 to give a Q positive value for fusion $p + e = n + \nu$. At the end, very slow neutrons were obtained.

DUFOUR [4] designed instead Hydrex, also miniatom, which would be formed in solids wich absorbed hydrogen , subjected to intense electromagnetic fields. The Hydrex, the half-life of which would be a few days, according to its inventor, should play an important role in LENR reactions. If the proton was captured along with the electron the miniatoms, there would be an equivalent event in the capture of a neutron

MILLS [5] provided a universal theory with its theoretical basis which allows the electron/proton, after forming the so-called "hydrino", to approach close to the nucleus. It would require the atomic state of the hydrogen and a catalyst (potassium or strontium ions). For this miniatoms the radius r obey the equation: $r = r_0 / n$, with n integer from 1 to 137.

According to HEFFNER [6] a quark up of a hydrogen nucleus, being positive, has the ability to place themselves at the center of a "collapsed state" of the atom. The weak interaction is unlikely with these collapsed states (being unstable and too short). However, the combination with another nucleus (tunneling) produces a trapped electron with a nucleus which determines additional time in order to the weak reaction occur.

A different proposal STREMMENOS [7], that no hydrogen atoms, but protons, spread defects in the crystal structure of Ni. Thus, electron capture to form an unstable miniatoms (duration 10^{-18} sec) and would be immediately captured by Ni nuclei. Their sizes ($<10^{-14}$ m) allow a closer matching, to make up the predominant nuclear forces of cohesion.

Formation of virtual neutrons was considered by MILEY [8] to justify the LENR reactions in solids.

4 – Cold reactions in Ni-H systems

In the FOCARDI – ROSSI reactor [9] are present nickel powder and gaseous hydrogen; an unidentified "catalyst" is said to be adding . Since heat is produced in quantities much greater than would be expected from chemical reactions, it should come from nuclear reactions at low temperature (LENR) between nickel and hydrogen nuclei. The reduction of nickel in powder of course facilitates meetings between these nuclei compared to similar experiments that used the nickel bars (as in the first experiments of PIANTELLI in Siena [10]).

And it is unlikely that hydrogen can remain in molecular form, so it should occur prior dissociation into individual atoms. At this probably provides the catalyst, for example, potassium or strontium (but the same nickel may, in part, serve the purpose).

In this paper We keep in mind the considerable difference between the natural abundance of isotopes of nickel majority (mass 58 to 67.6 % and mass 60 to 26.2%) and low abundance of other stable isotopes. So We will make the assumption that the nuclear reactions are essentially those of ^{58}Ni and ^{60}Ni:

(2) $^{58}\mathrm{Ni} + p = {}^{59}\mathrm{Cu}$ and $^{60}\mathrm{Ni} + p = {}^{61}\mathrm{Cu}$.

The following table will help us in the discussion.

^{58}Ni **67,6 %**	**^{59}Ni** **ε 8 10^4 y**	**^{60}Ni** **26,2 %**	**^{61}Ni** **1,25 %**	**^{62}Ni** **3,66%**	**^{63}Ni** **β^- 8 y**	**^{64}Ni** **1,16 %**
^{59}Cu β^+/ ε **51 s**	**^{60}Cu** β^+/γ **24 m**	**^{61}Cu** β^+/ ε **3,3 h**	**^{62}Cu** β^+ **9,8 m**	**^{63}Cu**	**^{64}Cu** β/ε **13 h**	**^{65}Cu**

The condition of miniatoms or virtual neutron allows the <p/e> system to approach a nucleus of Ni overcoming the Coulomb barrier, which obviously would repulsive effect between the proton and nucleus of the nickel.

When a nucleus of Ni absorbs only the proton even without capturing an electron produces a copper nucleus in the second line of the table where, in red letters are the radioactive isotopes, while the stable ones are black. The half-life of radioactive nuclei of copper is short, so as to enable them, decaying, to contribute to the heat produced in the reactor.

From the table we see that for ^{62}Ni and ^{64}Ni single proton capture leads to the formation of stable nuclei of copper (^{63}Cu and ^{65}Cu, whose isotope ratio is is so variable over time and therefore in general is different from the natural one).

FOCARDI and ROSSI [9] have actually occurred a difference (1.6 instead of the natural value of 2.24). This result is important from a conceptual point of view, but probably not significant to the effects of the heat carried out because the isotopes involved are, as we have seen, definitely the minority.

In general the nuclei of copper obtained by absorption of the proton are formed in the excited state. The de-excitation would result in emission of gamma rays, but the excess energy can instead enable an orbital capture, ie, the capture of an orbital electron from the Ni nucleus. Many of these excited nuclei can capture a K electron almost immediately.

For the most abundant isotopes the final results of these protonic captures followed by orbitals captures would nuclei ^{59}Ni (almost stable, whose activity gradually builds up) and ^{61}Ni (stable).

It should be remembered that the capture of a K electron by a copper nucleus excited after absorption of a single proton is not a beta radioactivity, but reaction immediately following of the proton absorption. The capture leaves a void in the K orbital, with a resulting a cascade of atomic electrons of the outer shells to fill it. The resulting X-rays, easily shieldable, could make a significant contribution to the heat produced into the reactor.

When the entire system <p/ e> is captured , this event being equivalent to the capture (n, γ) of a thermal neutron, very often, as seen from the table, produces a stable nucleus of Ni. Apart from the ^{59}Ni who, having half-life of nearly 105 years, can be considered stable (it is radioactive for K capture).

However, in addition to K capture, every other time that the absorption of the proton is followed by that of an electron (eg. conduction electrons) the final nucleus, immediately to the right in the line containing the isotopes of nickel, is almost always stable.

In some cold fusion experiments in the Ni-H systems by the group PIANTELLI / FOCARDI [10] in Siena, a rather intense neutron flux appeared to leak from the reaction cell. Outside it was activated gold from ^{197}Au to ^{198}Au,. The neutron emission process lasted for several weeks, but, outside of this period, apparently, no longer appeared. A gamma radiation was also observed, so confirming the nuclear nature of the process.

5 – Cold processes in deuterium

The deuterium can undergo the reaction:

(3) $d + e = p + n + n + \nu$ (Q = - 3.01 MeV) .

One may consider the formation of miniatom (d,e) and subsequent conversion into a neutron (first virtual, then real) of the proton in initial deuteron. We can think of the possibility that both neutrons of (3) are absorbed by a nucleus Nu(Z,A) with the reaction :

(4) $Nu(Z,A) + (d,e) = Nu(Z,A) + n + n_v = Nu(Z,A+2) + \nu$.

According to which OHMORI [11] observed transmutations from ^{39}K to ^{41}K. But it could be absorbed only the virtual neutron, whike the other remains free :

(4') $Nu(Z,A) + (d,e) = Nu(Z,A) + n + n_v = Nu(Z,A+1) + n + \nu$

that would explain at least partially, the transmutation of ^{6}Li to ^{7}Li observed by COUPLAND [12] and the transmutation of ^{53}Cr to ^{54}Cr viewed by MIZUNO [13].

Simultaneously the neutron n would be free, so that the deuterized solid will operate as a source of neutrons. The (4) and (4') may include the capture of virtual neutrons by deuterium. Tritium is found frequently in research, although often attributed to D+D fusion.

6 - Conclusion

This paper wants to prove the possibility of LENR, by the nature of new nuclei generated from those reactions, without taking into account, in any way, the energy produced and its usability: heat could come from other causes.

It address only the LENR and ignores the D+D fusion and other “cold fusions” between nuclei of the hydrogen isotopes.

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